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Trends for future  
in-vehicle communication

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**MOBILE & BEYOND**

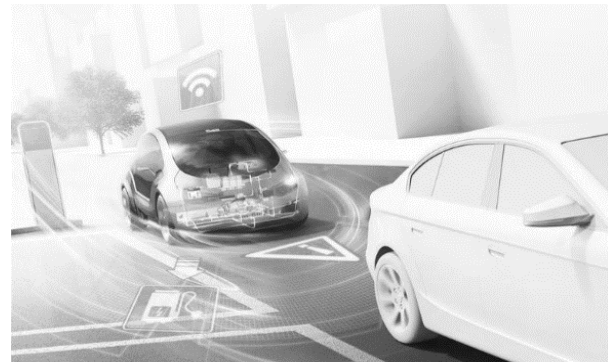
**MIPI ALLIANCE  
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**22-23  
SEPTEMBER  
2020**

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# Trends for future in-vehicle communication

## Future Mobility: Electrified, Automated and Connected



costs    hybrid    e-motor  
eBike    power electronics

legislation    driver assistance  
emergency braking    autopilot

electronic horizon  
smartphone integration

# electrified

# automated

# connected

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

highway-pilot    sensors  
redundancy    electric steering  
valet parking

eCall    cloud  
services    fleet management  
car2car    augmented reality

# Trends for future in-vehicle communication

## (R)Evolution of the E/E Architecture



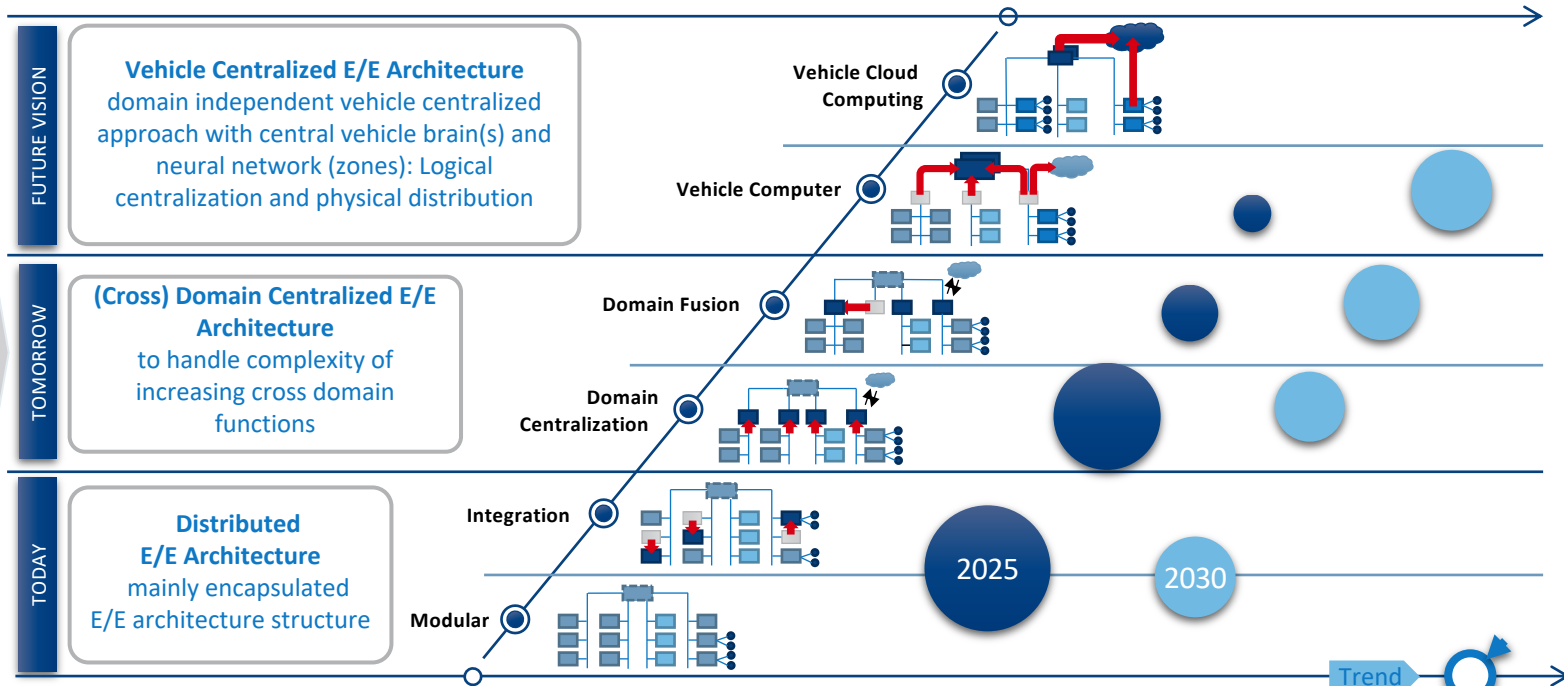
*connected*



*automated*



*electrified*



typ. state of the art automotive ECUs (function specific)

Performance ECUs e.g. (Cross-)Domain Control Unit, (Cross-)Domain Computer, Vehicle Control Computer

Optional ECUs (e.g. Central Gateway)

Domain independent Zone ECUs

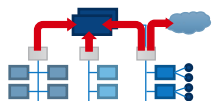
Sensors/Actuators

ECU = Electronic Control Unit

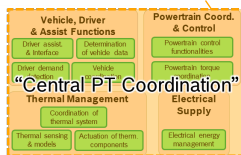
Domain specific Zone ECUs (e.g. today's Door ECU)

# Trends for future in-vehicle communication

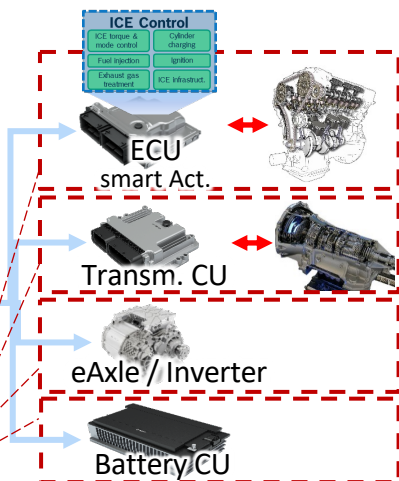
## Function Repartitioning - Example: Function Split in Powertrain



SW-Adaption to equipped actuators & topology



Modular extension/replacement dependent on PT type



Function Split in Powertrain is...

- ... in field w/ some passenger car OEMs
- ... state of the art for commercial vehicles
- ... aligned with market trends
- ... analyzed & proven in VIP demonstrator vehicles

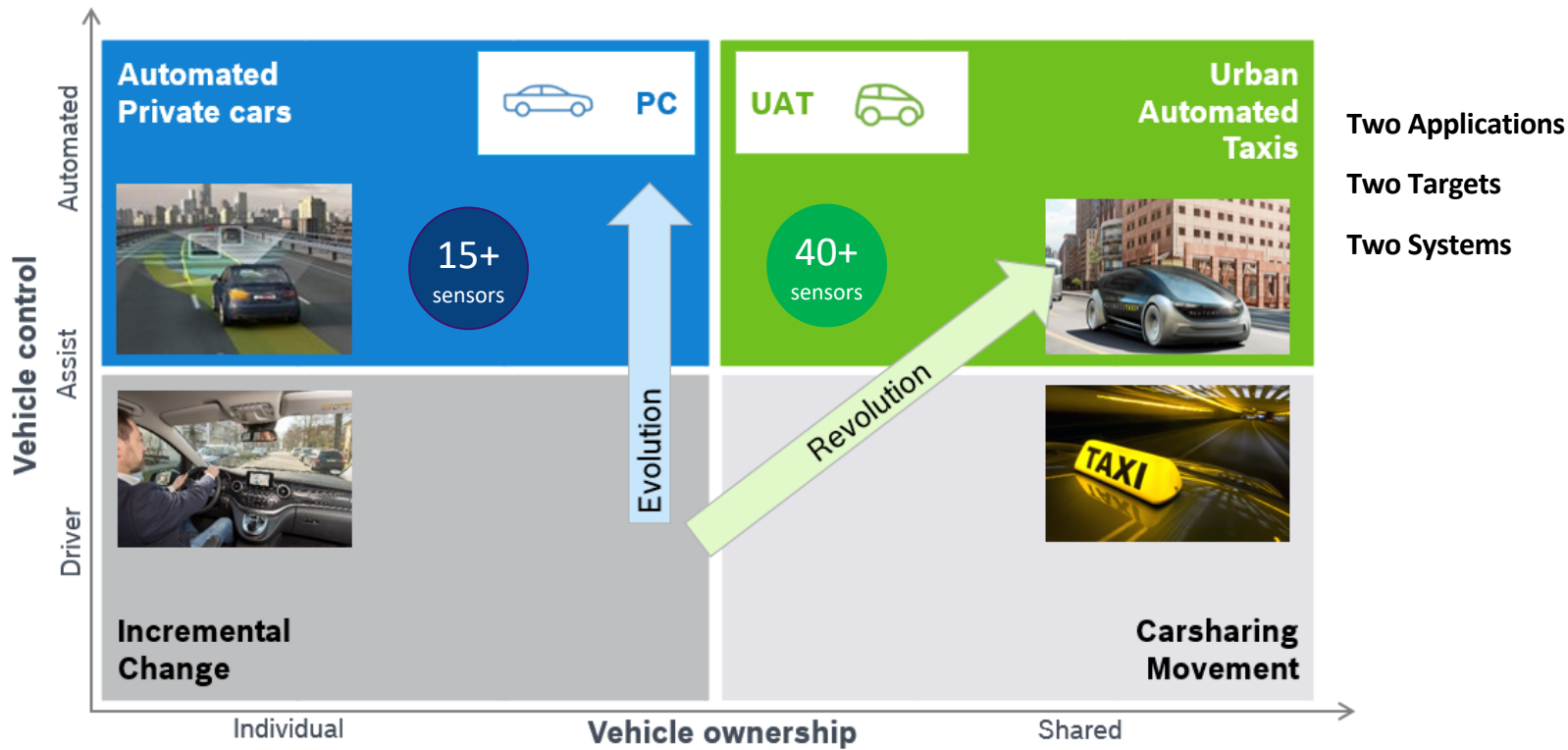
### Benefits:

- Encapsulation of HW variance of different powertrain types
- Focus of OEM differentiation on Central CU
- Flexibility in the choice of powertrain actuators like internal combustion engine, gearbox, e-machine, ...
- Chance for higher degree of standardization on Engine CU to „Smart Actuator CUs“.

High performance computing servers in combination w/ separation technologies allow a repartitioning of functions and a split of control loops and signal chains boosting requirements on IVN

# Trends for future in-vehicle communication

## PC and UAT systems have different configurations & capabilities

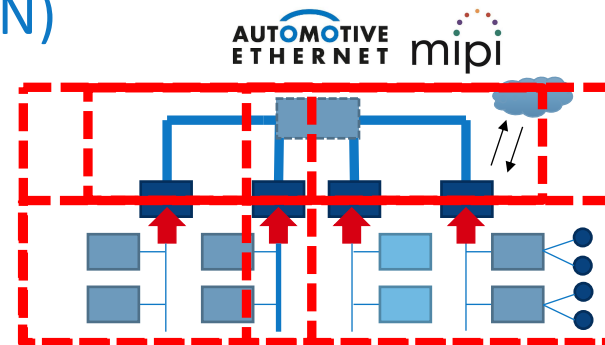


UAT: Urban Automated Taxi

# Trends for future in-vehicle communication

## Requirements for future In-Vehicle Network (IVN)

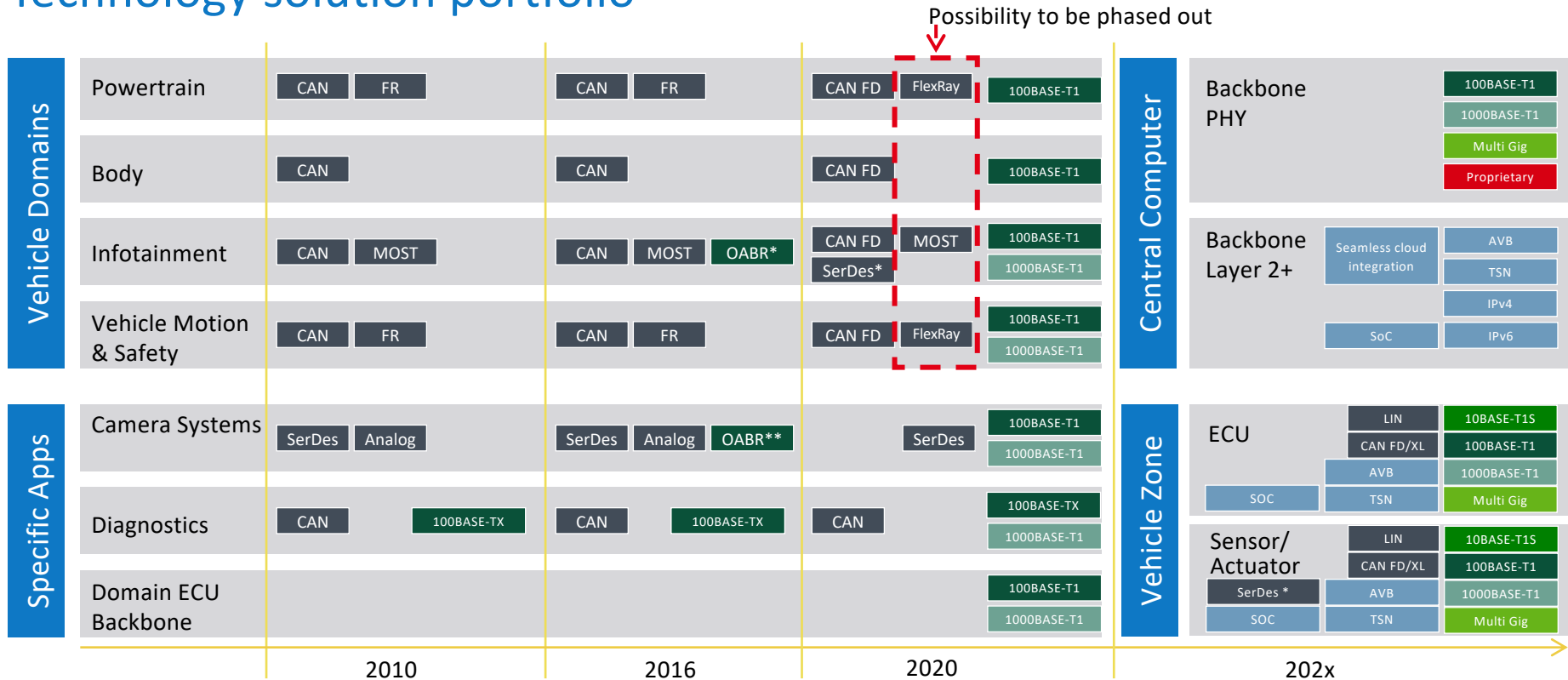
- ▶ High bandwidth, high throughput
- ▶ Complementary SerDes asymmetric high speed communication for end point devices (cameras, displays, sensors)
- ▶ Fill the gaps in embedded area (10BASE-T1S, CAN XL)
- ▶ IVN homogenization towards Ethernet / IP but
- ▶ Coexistence with legacy automotive technologies
- ▶ Demand on QoS, network availability, security, ... → Ethernet/TSN
- ▶ Dynamic reconfiguration → Software Defined Networking (SDN)
- ▶ Cloud connectivity (quickly becoming a more integral part of E/E-A)



Distributed & new functions and split signal chains lead to increasing requirements for the IVN

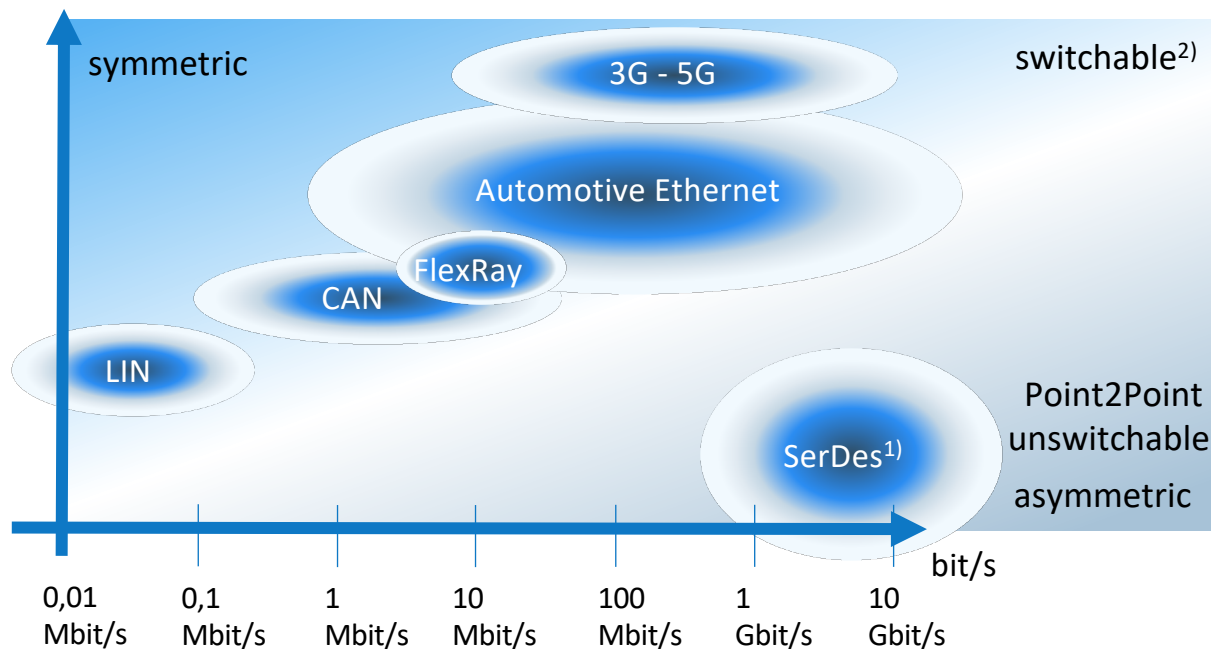
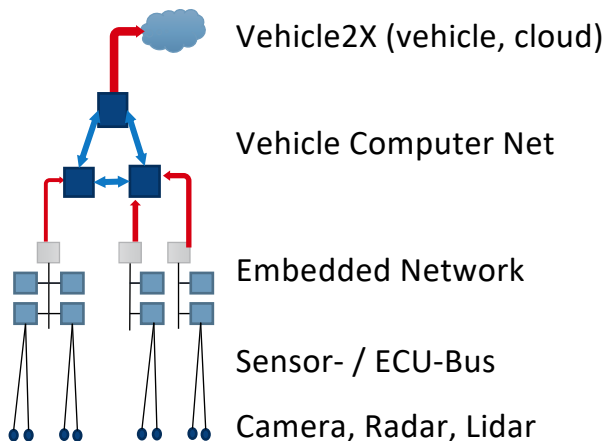
# Trends for future in-vehicle communication

## Technology solution portfolio



# Trends for future in-vehicle communication

## Bandwidth of Technologies in Automotive Landscape

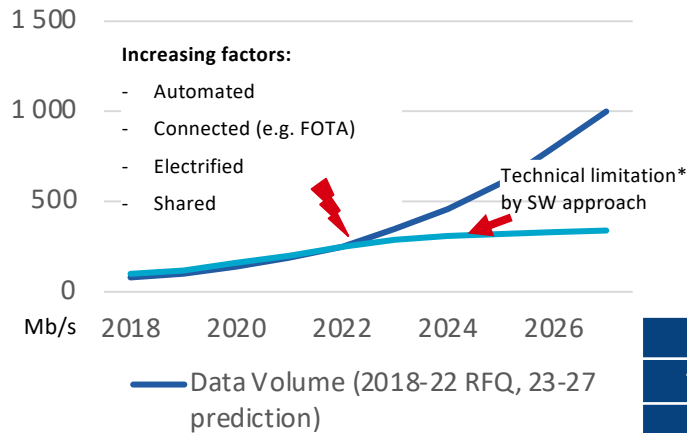




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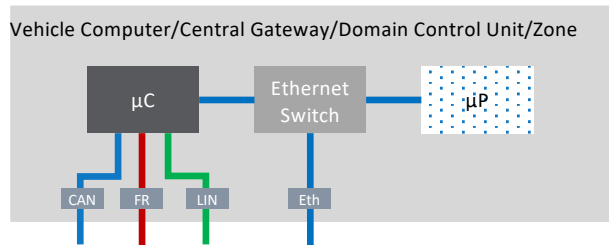
## Hardware Acceleration (HWA) – a possible solution for future IVN

### Throughput demand

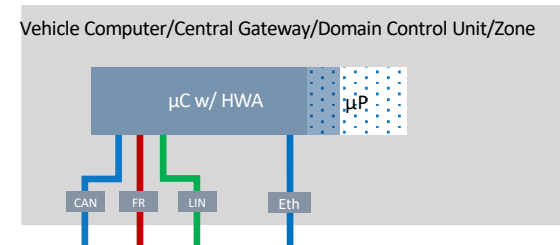


\* single core

### Today solution with software



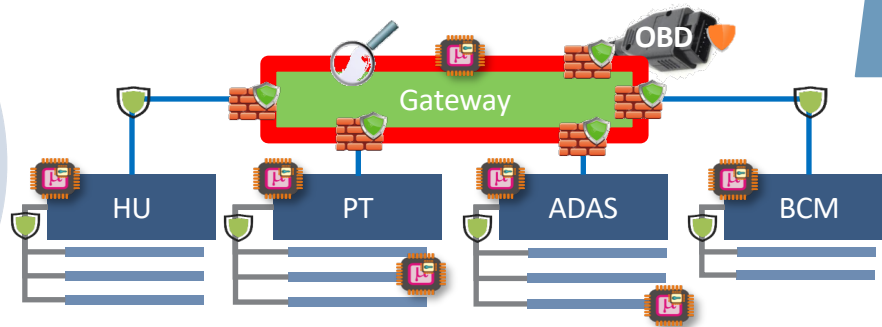
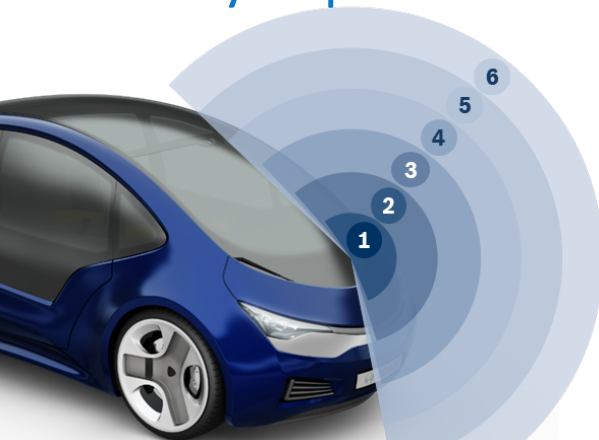
### Future solution with HWA



	Today's solution with software	Future solution with HWA	Improvement
Throughput	< 1 Gb/s (multi core)	> 10 Gb/s	> 10 x
Throughput in events/s	< 200k	> 10M	50 x
Jitter/Latency	up to 1ms	< 20μs	50 x
Multi-protocol	Implemented in SW	implemented in HW	
Virtualization	Available for Ethernet	Generalized virtualization concept	
Security	DMA based SW offload encryption/authentication	In band encryption/authentication	
Configuration	Typically pre-build configuration	Runtime configurable	

# Trends for future in-vehicle communication

## Security Aspects



ADAS	=	Advanced Driver Assistance System
BCM	=	Body Control Module
ECU	=	Electrical Control Unit
GW	=	Gateway
HU	=	Head Unit
PT	=	Power Train

1

**Individual ECU**  
ECU software and data integrity protection

2

**In-vehicle network**  
Integrity protection of critical in-vehicle signals and messages

3

**E/E-Architecture**  
Protected and separated domains by E/E architecture and gateway

4

**Connected Vehicle**  
Vehicle firewall and security standards for external interfaces

5

**Intrusion Detection Sys.**  
Network communication behavior is monitored and analyzed

6

**Secure Manufacturing**  
Secure generation and injection of cryptographic material

➤ Increasing communication bandwidth in future EE-architectures and the call for more and more Security Functionality in the car requires **Hardware Acceleration** for **Firewall** and **Intrusion Detection System (IDS)** functionality and efficient implementations of Security protocols (e.g. SecOC, MACsec).

# Trends for future in-vehicle communication

## Summary

- ▶ Automated, Connected , Electrified & Shared (ACES) drive ...
  - ▶ ... the significant growth of (cross domain) functions and system characteristics like safety and cyber security
  - ▶ ... the functional centralization and hence introduction of vehicle integration platforms (central / zonal)
  - ▶ ... increasing interactions with the cloud, infrastructure and other mobile devices (C2X)
- ▶ Modern In-vehicle communication will provide
  - ▶ Higher bandwidth, QoS enforcement and management of dynamically changing communication requirements
  - ▶ Integration of different bus technologies preserving investments in legacy communication
  - ▶ Excel in performance and security at competitive costs leveraging HW accelerators (e.g. EDE, HSM)
- ▶ Automotive industry will increasingly build on synergies between automotive and mobile device technologies (esp. MIPI® D-PHY<sup>SM</sup>, MIPI® A-PHY<sup>SM</sup>, MIPI® I3C<sup>SM</sup>)
- ▶ Specific automotive requirements might be introduced into MIPI-standards (e.g. longer reach, harsh environment, high temperature, reliability, safety, security)



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**THANK YOU**

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