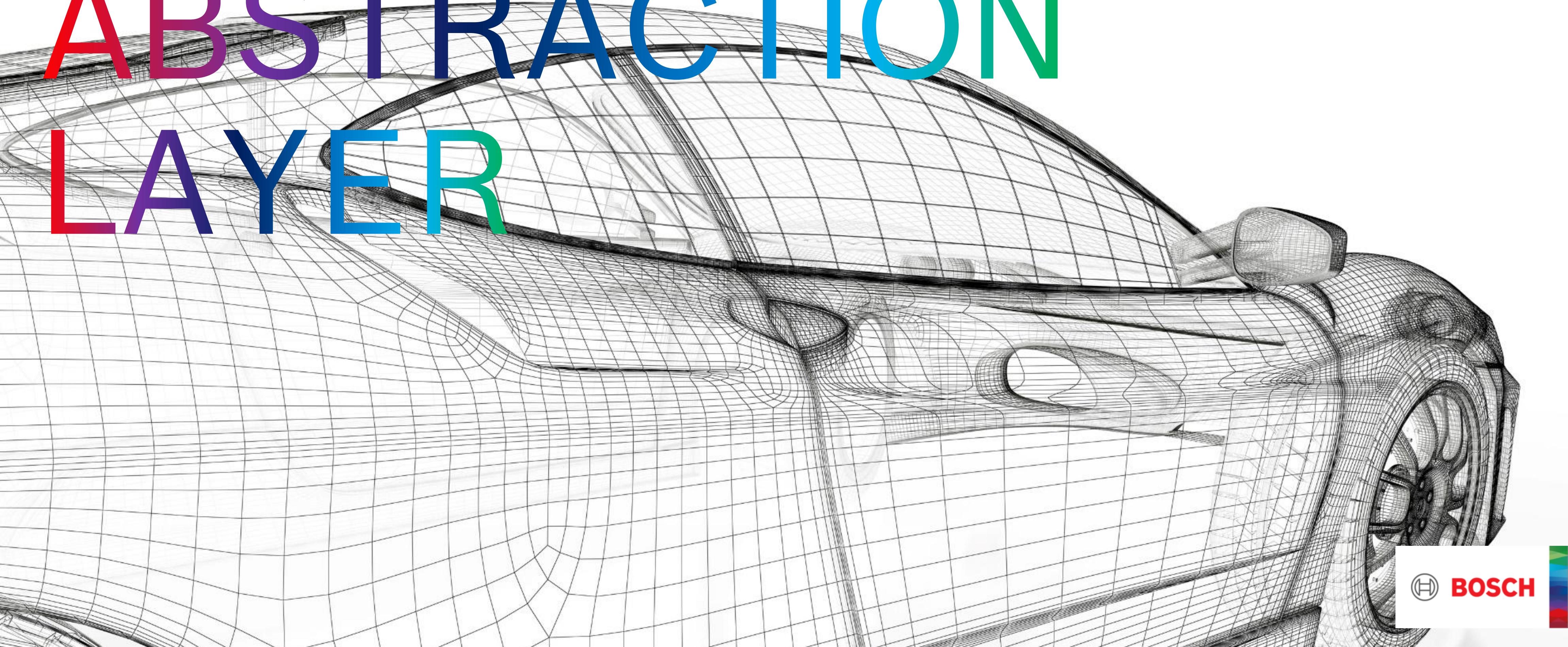
VEHICLE ABSTRACTION LAYER



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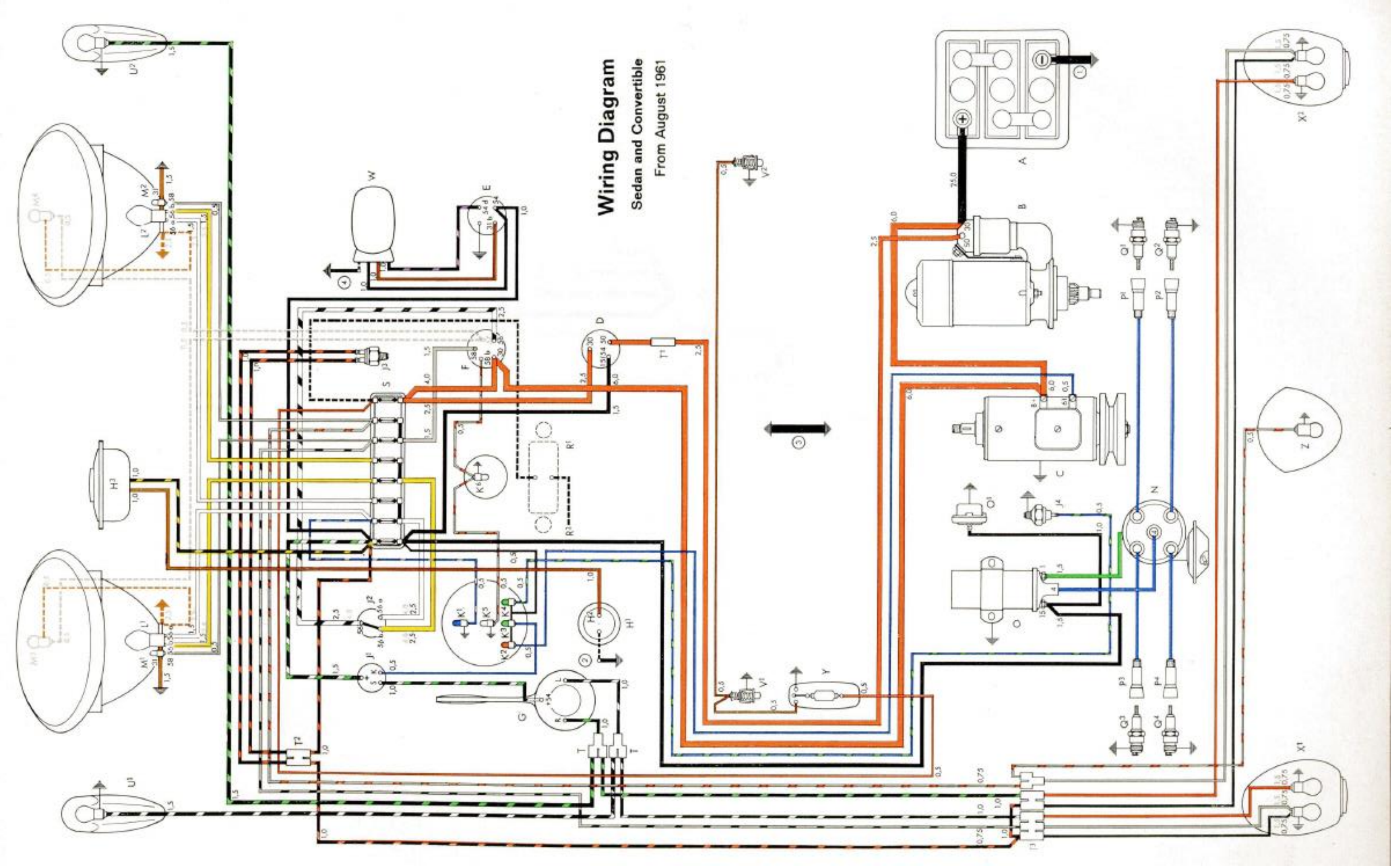
Vehicle Abstraction Layer
Automotive: 1962



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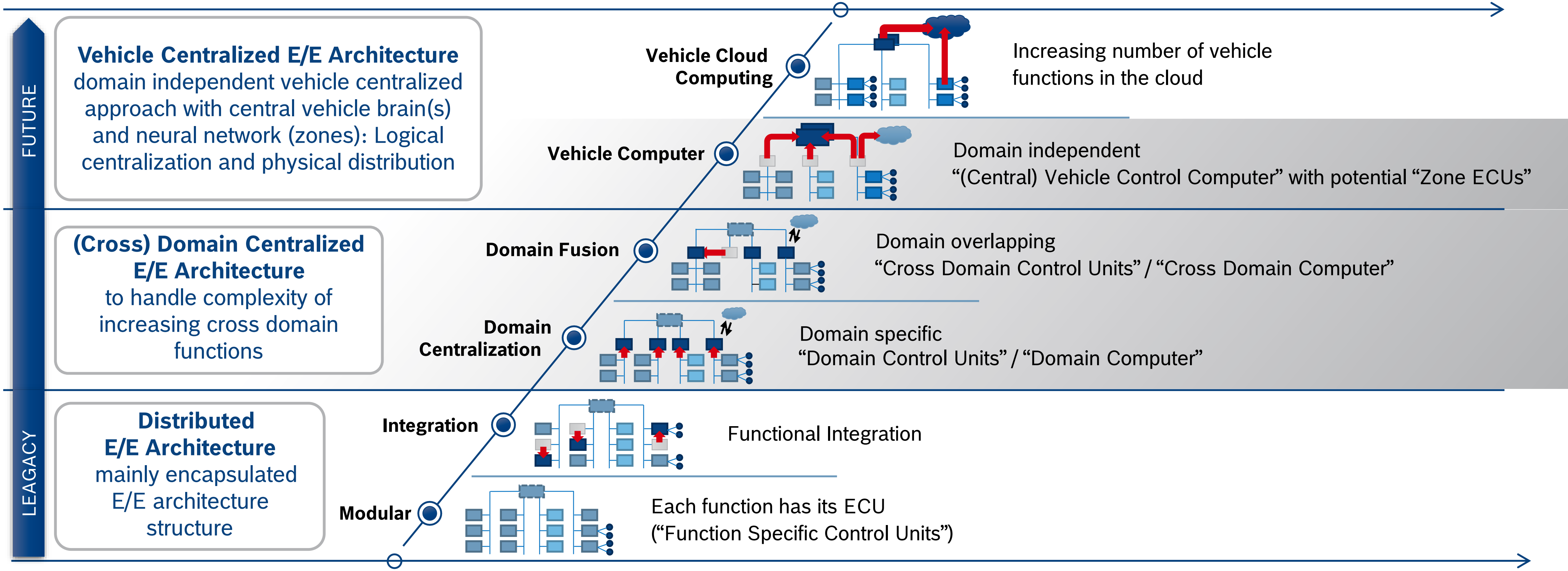
Trends for Future Mobility Systems
E/E Architecture Roadmap



FUTURE

Vehicle Centralized E/E Architecture
domain independent vehicle centralized approach with central vehicle brain(s) and neural network (zones): Logical centralization and physical distribution

(Cross) Domain Centralized E/E Architecture
to handle complexity of increasing cross domain functions

LEAGACY

Distributed E/E Architecture
mainly encapsulated E/E architecture structure

Vehicle Cloud Computing – Increasing number of vehicle functions in the cloud

Vehicle Computer – Domain independent "(Central) Vehicle Control Computer" with potential "Zone ECUs"

Domain Fusion – Domain overlapping "Cross Domain Control Units" / "Cross Domain Computer"

Domain Centralization – Domain specific "Domain Control Units" / "Domain Computer"

Integration – Functional Integration

Modular – Each function has its ECU ("Function Specific Control Units")

increasing SW amount

▨ typ. state of the art automotive ECUs (function specific)	▨ Optional ECUs (e.g. Central Gateway)	⋖ Sensors/Actuators	ECU = Electronic Control Unit
■ Performance ECUs e.g. (Cross-)Domain Control Unit, (Cross-)Domain Computer, Vehicle Control Computer	■⋖ Domain independent Zone ECUs	▨ Domain specific Zone ECUs (e.g. todays Door ECU)	

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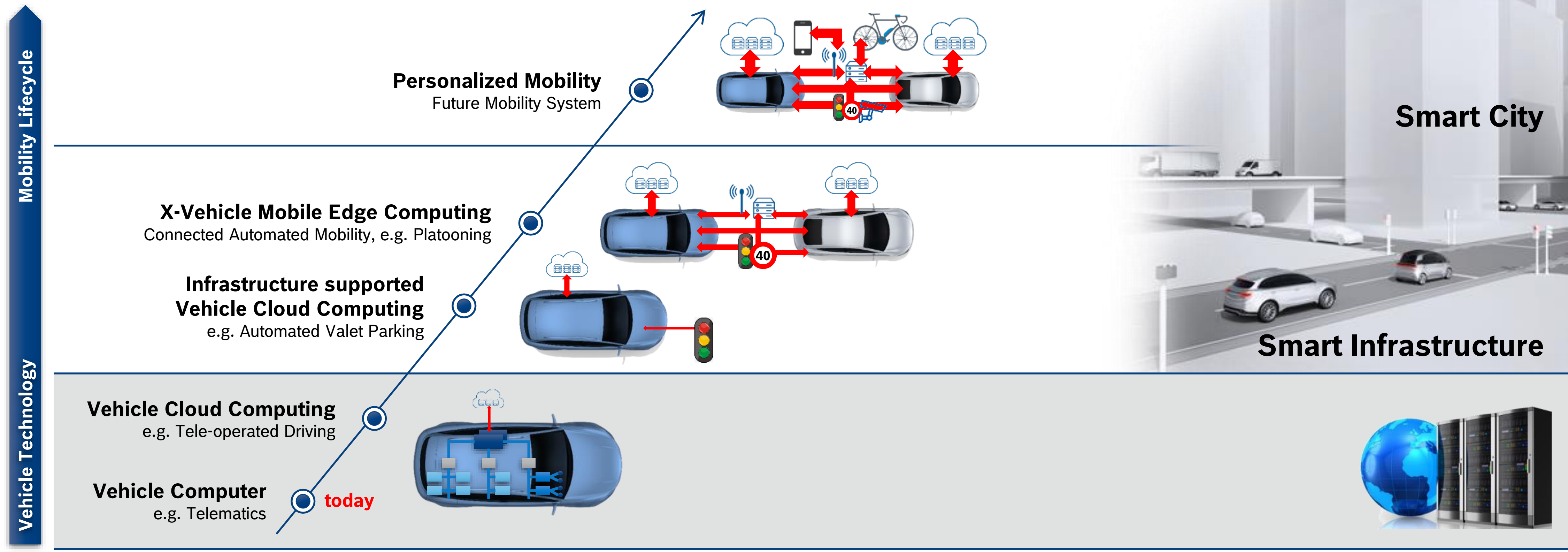
Trends for Future Mobility Systems
E/E Architecture Extension to Cloud Connectivity



Mobility Lifecycle

Vehicle Technology

Personalized Mobility
Future Mobility System

X-Vehicle Mobile Edge Computing
Connected Automated Mobility, e.g. Platooning

Infrastructure supported Vehicle Cloud Computing
e.g. Automated Valet Parking

Vehicle Cloud Computing
e.g. Tele-operated Driving

Vehicle Computer
e.g. Telematics

today

Smart City

Smart Infrastructure

State of the art ECU

Zone ECUs w/ sensors/actuators

Vehicle Computer

(Cross-)Domain ECU

Cloud

Infrastructure

Edge

Personal µMobility

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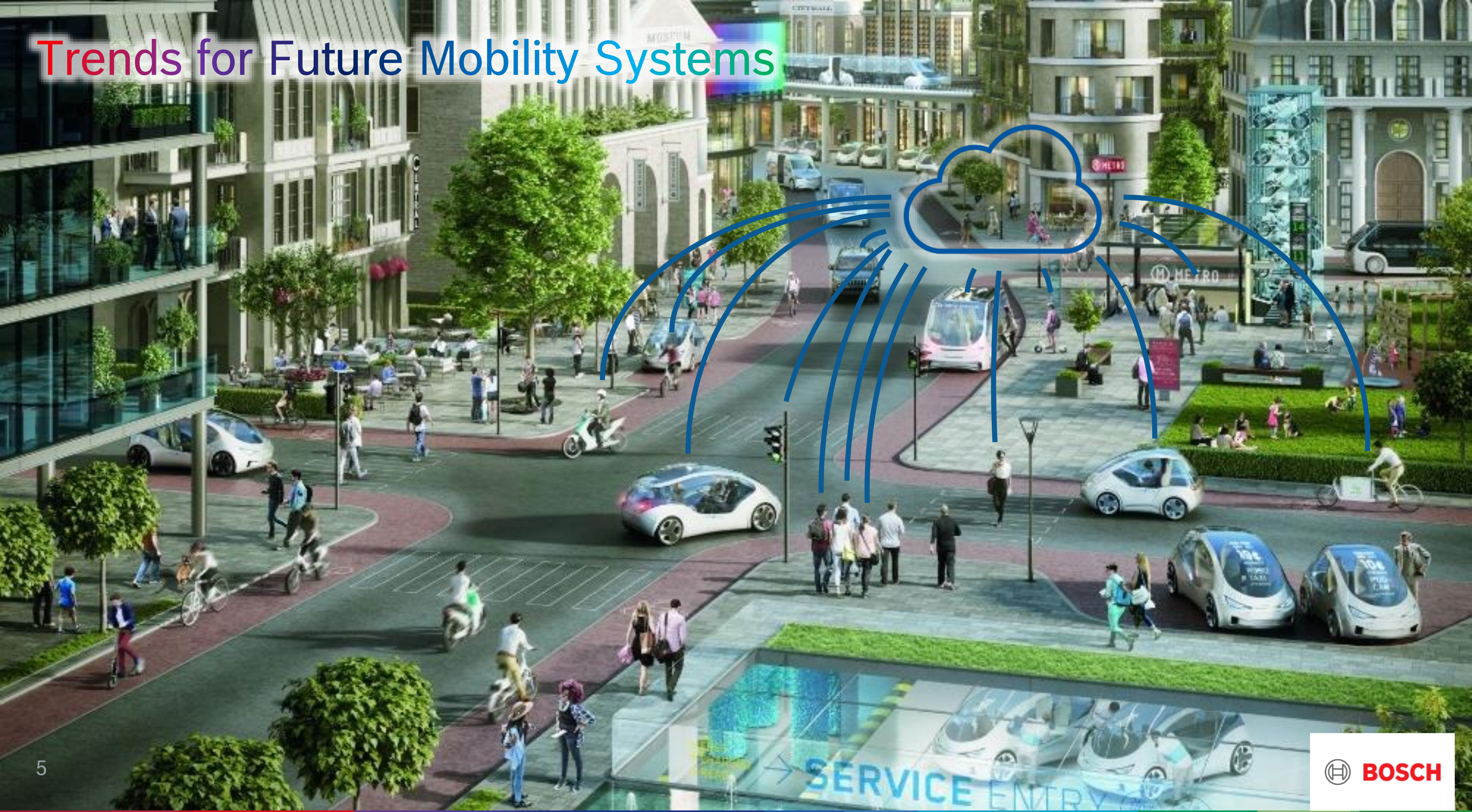
Trends for Future Mobility Systems



Vehicle Abstraction Layer

Point of View Cloud

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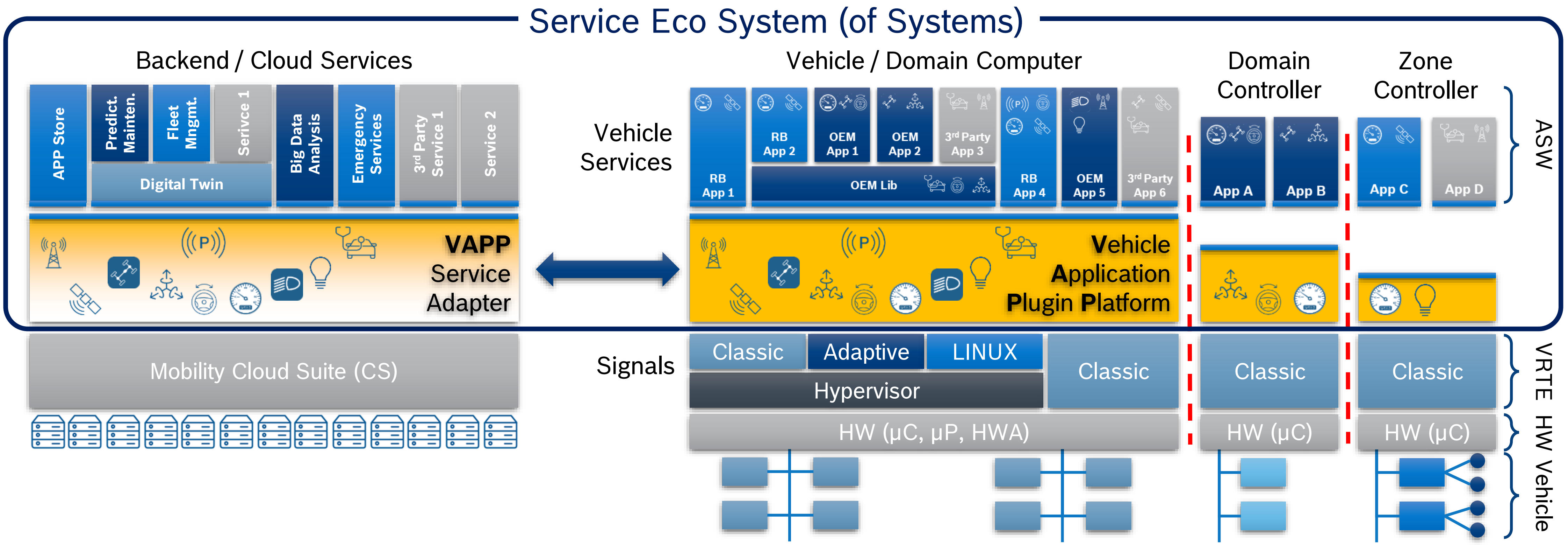
Vehicle Abstraction Layer
Vehicle Application Architecture



Service Eco System (of Systems)

Backend / Cloud Services

APP Store

Predict. Mainten.

Fleet Mngmt.

Serivce 1

Digital Twin

Big Data Analysis

Emergency Services

3rd Party Service 1

Service 2

VAPP Service Adapter

Mobility Cloud Suite (CS)

Vehicle Services

Signals

Vehicle / Domain Computer

RB App 1

RB App 2

OEM App 1

OEM App 2

3rd Party App 3

OEM Lib

RB App 4

OEM App 5

3rd Party App 6

Vehicle Application Plugin Platform

Classic

Adaptive

LINUX

Classic

Hypervisor

HW (µC, µP, HWA)

Domain Controller

App A

App B

Classic

HW (µC)

Zone Controller

App C

App D

Classic

HW (µC)

ASW

VRTE

HW

Vehicle

Digital Twin as virtual representation of the Vehicle

Vehicle Application and Service Interfaces are evolving as trend in automotive service area

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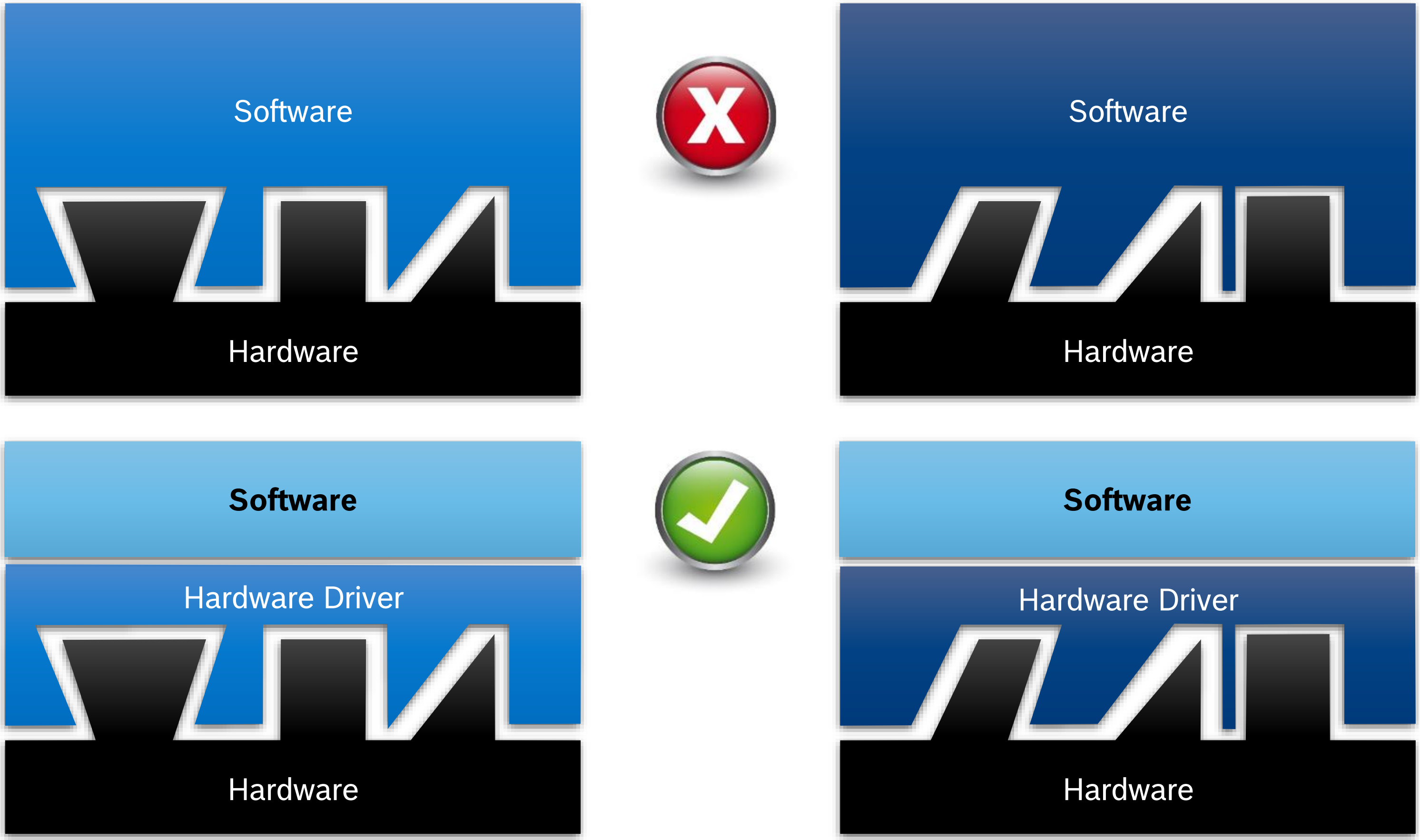
Vehicle Abstraction Layer
Abstraction and Freedom from Interference – ECU / Hardware

Introduction of HW-drivers allows independent development of hardware and software

- Reduction of dependencies and complexity
- Reduction of porting effort to different hardware
- Separation of driver and software development



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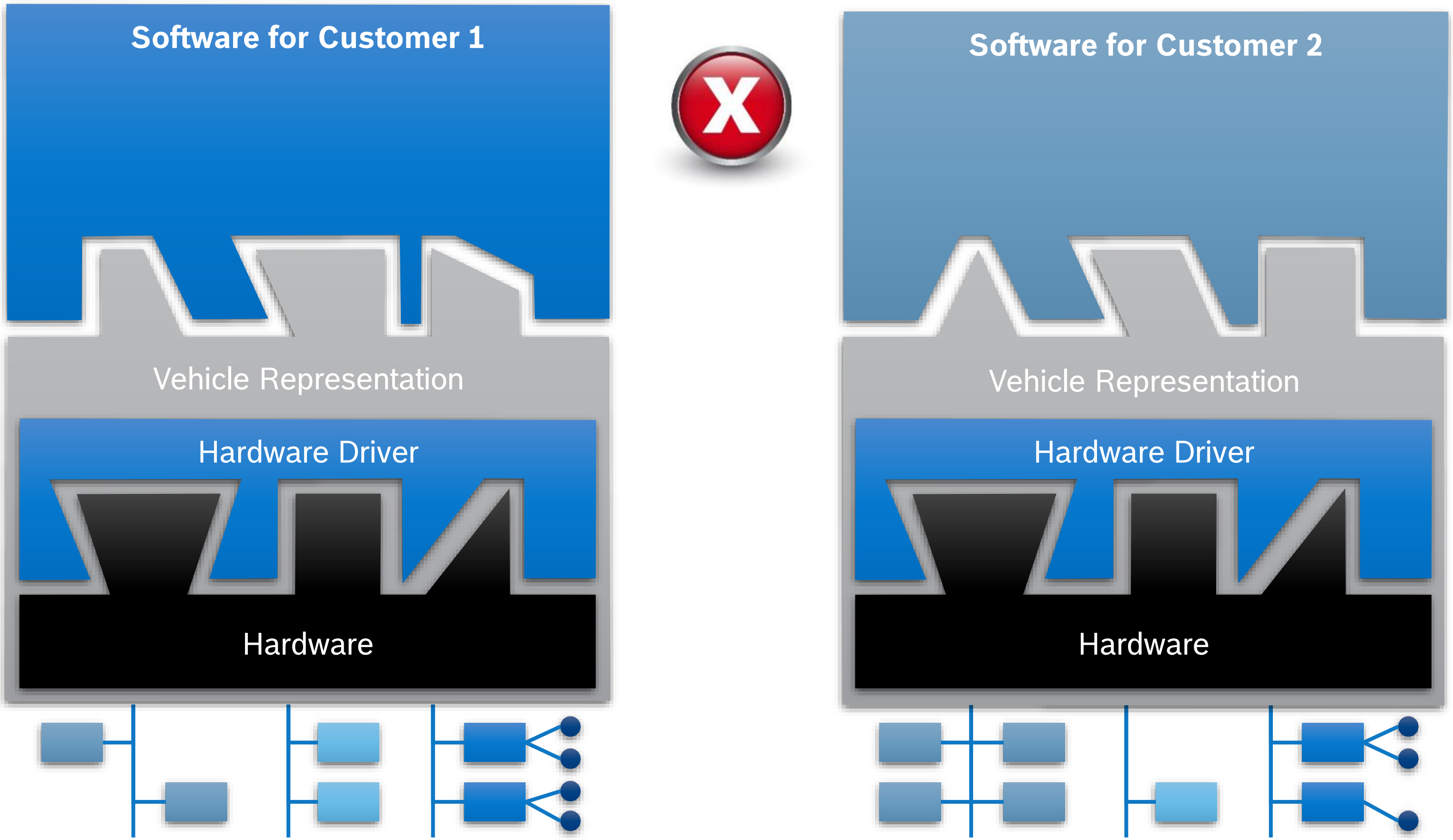
Vehicle Abstraction Layer
Abstraction and Freedom from Interference – E/E Architecture

Each Embedded System is reflected on implementation level due to communication, resources and specific component selection

- ▶ Porting software from a device depending on dedicated E/E architecture concept to another concept requires high adaptation efforts



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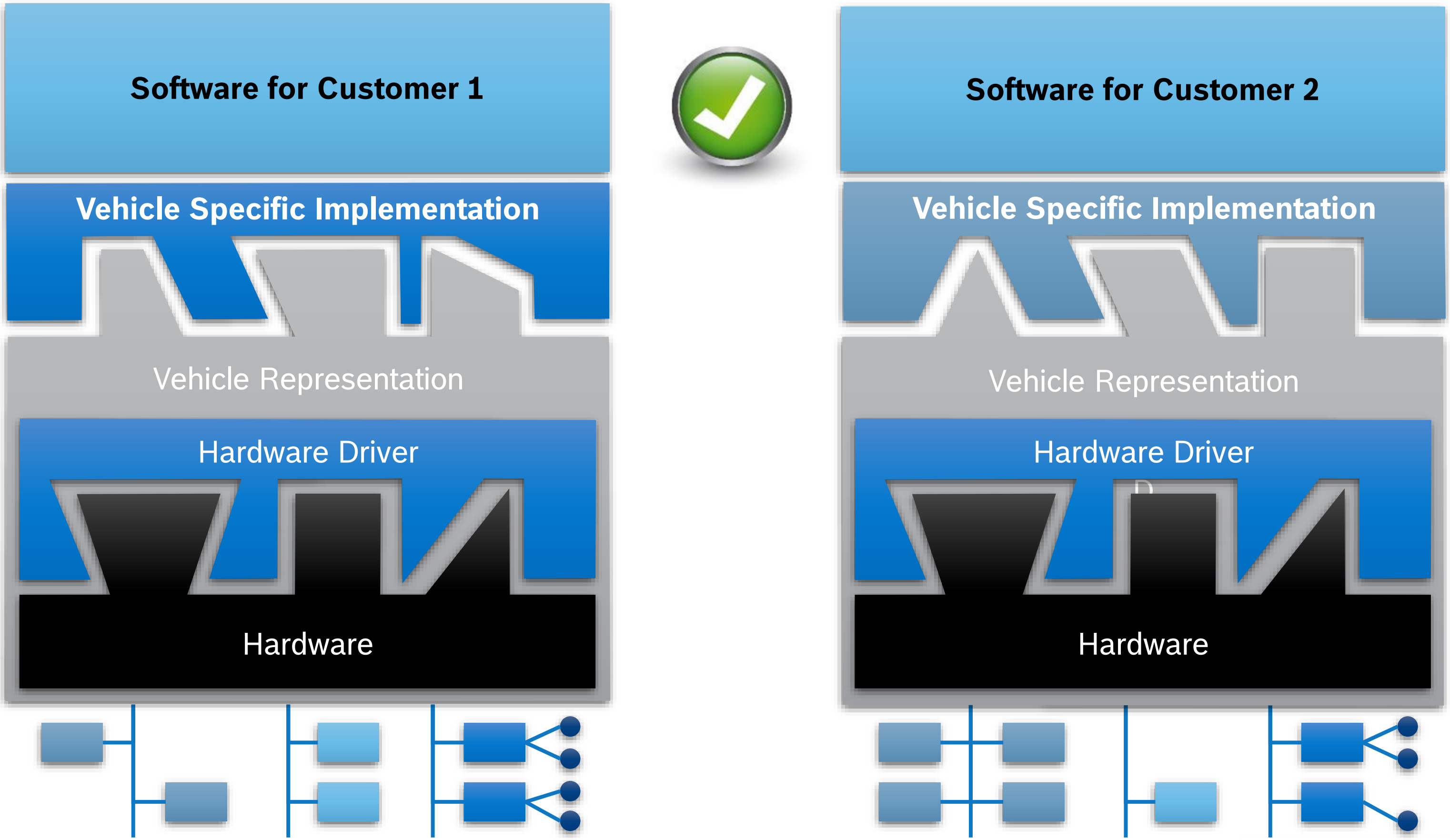
Vehicle Abstraction Layer
Abstraction and Freedom from Interference – E/E Architecture

A vehicle specific software layer allows independent development of E/E architecture and software

- Reduction of dependencies and complexity
- Reduction of porting effort in case of integration into new E/E architecture
- Separation of vehicle dependent and independent software development



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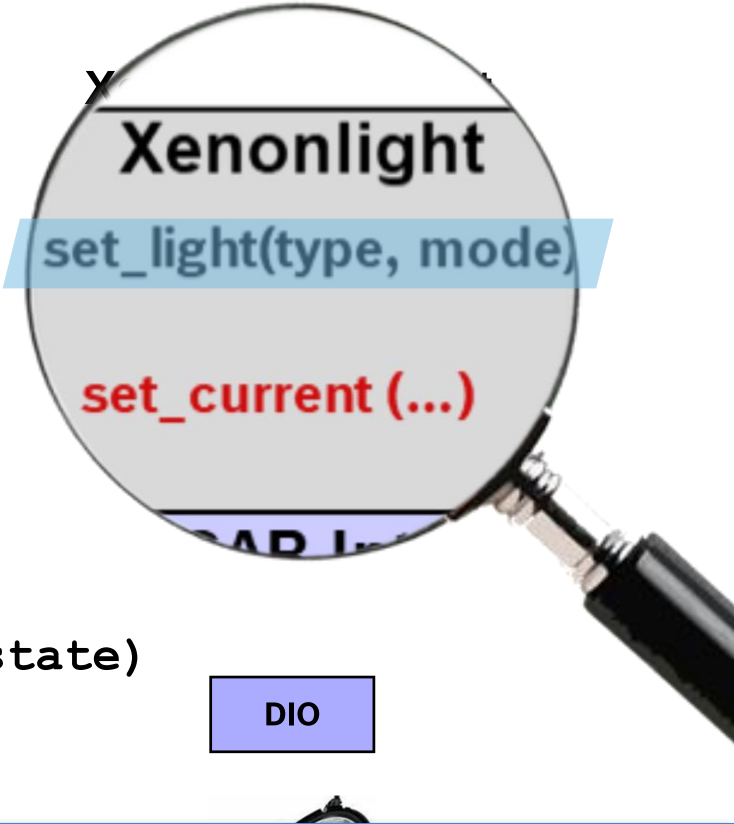
Vehicle Abstraction Layer
Example: AUTOSAR: Exchange type of Front Light

```
setLight(enum state)
Set_Light(bool state)
switchHeadLight(enum type, enum mode)
lightOn()
setLight(bool state)
SetLight(bool state)
Set_Beam(enum range)
OP_MOD_Light_Func2(enum param1)
g_DrvReqHB(enum state)
lightSwitchEvent(enum state)
```



Remaining Challenge: NO Standardized Application Interface over OEMs / Project Borders

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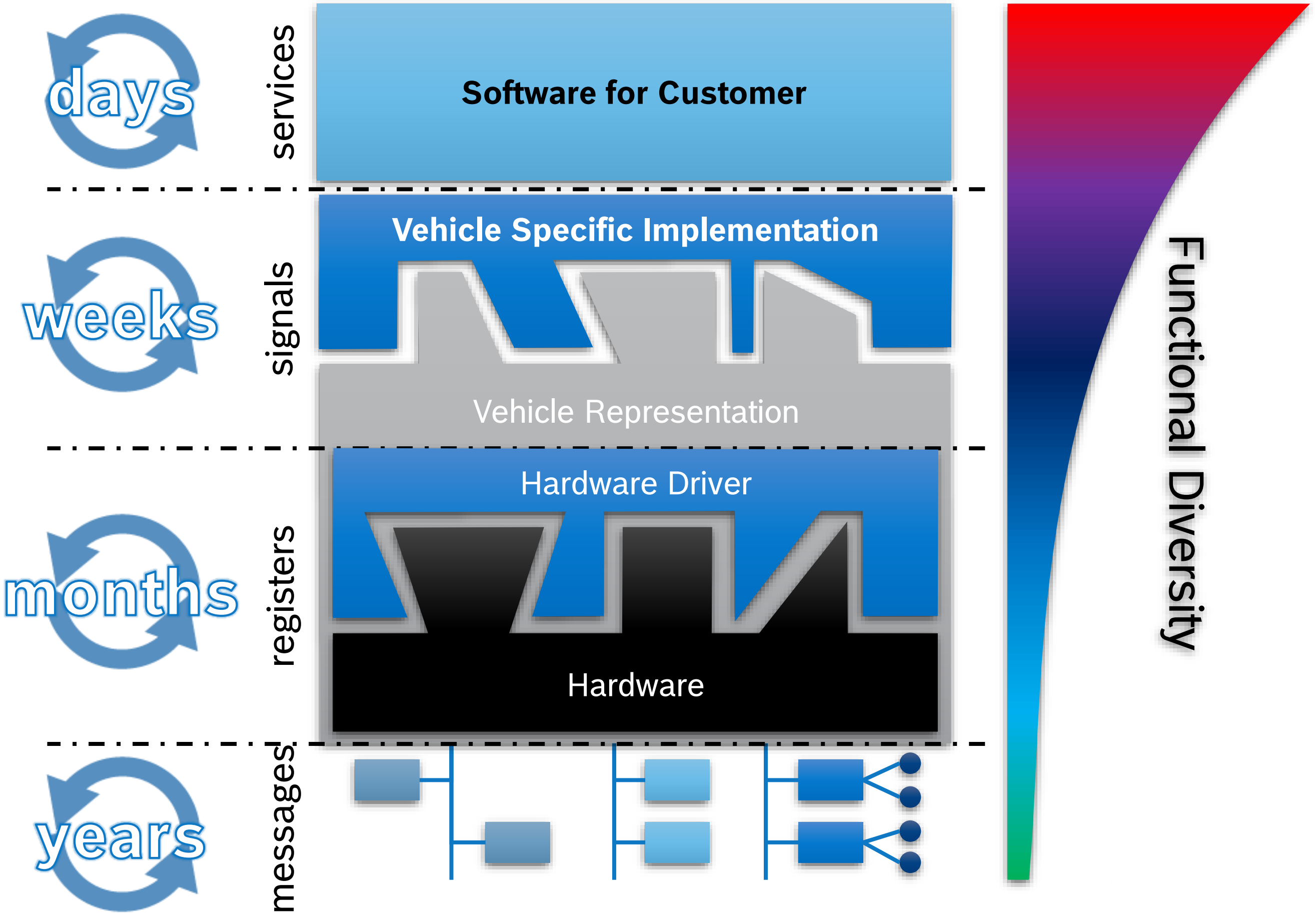
Vehicle Abstraction Layer
Decoupling of Development & Deployment Cycles

- ▶ Decoupling of implementation reduces effort and complexity
- ▶ Decoupling of deployment cycles allows fast updates for high level features and well-proven processes for embedded functionality
- ▶ Service development does not require knowledge of all future functionality
- ▶ New business models possible due to independent deployment



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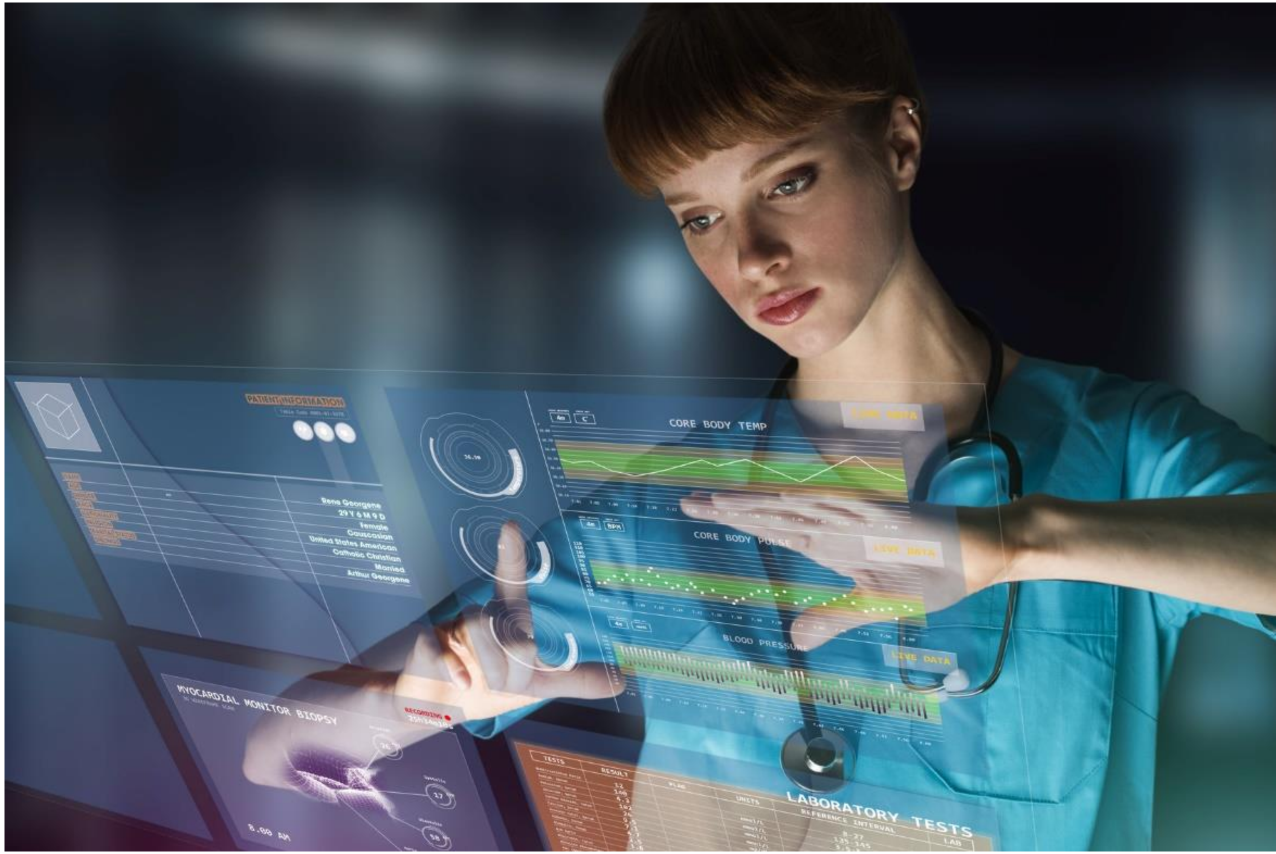
Vehicle Abstraction Layer
“Double Shift Left” utilizing Vehicle APIs and Service IFs

Simulation and Shared Models

- Simulated Vehicle Services for early agile software development
- Increased coverage
- Accelerated test cycles
- Enable early discovery of functional gaps
- Improved cost, time to market, quality

SW Development before HW

- SiL - test bench enables regression and high coverage even before hardware is available



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Vehicle Abstraction Layer Conclusion

We need

- Standardized interfaces
- to easily develop functionalities for all kind of vehicles
- which can be distributed faster in a flexible way
- within the vehicle or in the digital twin

Let‘s define this together

Thank you!

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