
# Road to Cloud Ecosystem

## CAEdge, Virtualization, HPC, Zones

www.continental-automotive.com

# Agenda

# Agenda

# Transformation of Mobility

## Global trends revolutionizing the automotive industry

**Automated Driving**

**Cloud Services**

**Internet of Things**

**UX Applications**

**Shared Mobility**

**36 %**

Cars with over-the-air capabilities by 2026

**2026**

66% of OEMs plan to partner with software firms and system integrator firms

**+400 %**

New vehicles based on common software platforms grow from 7% today to 35% by 2031

**$640 billion**

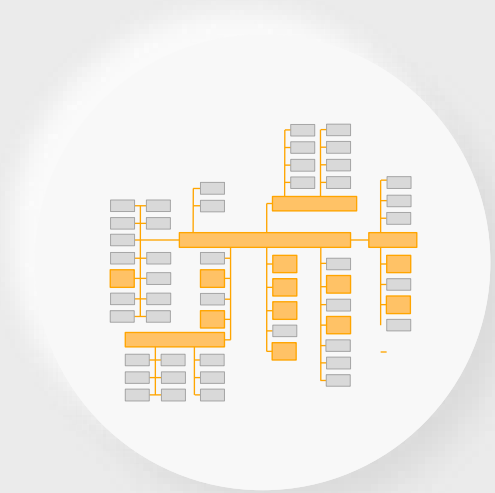
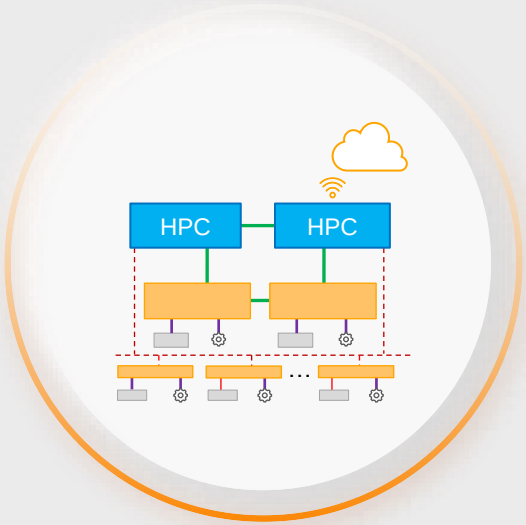
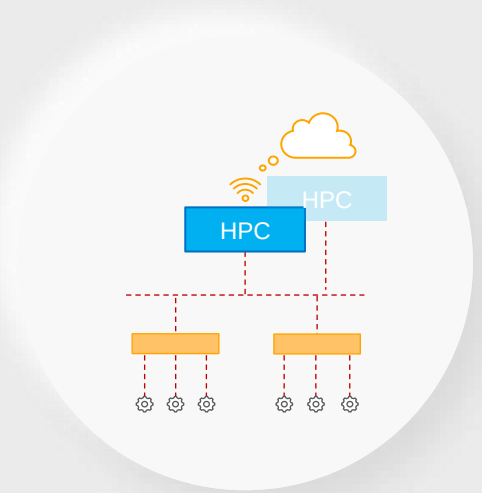
By 2031 software-based features and services will be a market worth $640 billion

# Vehicle Architecture Transformation

## A radical shift in the automotive industry

Up2now

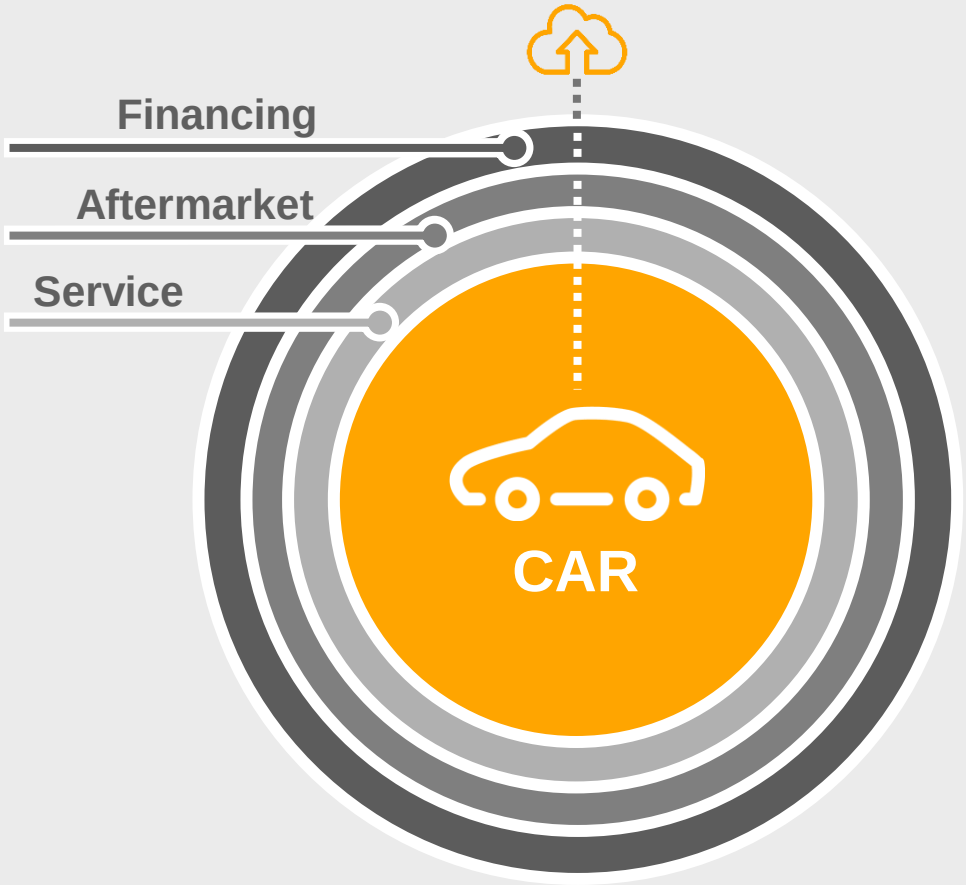
Going forward

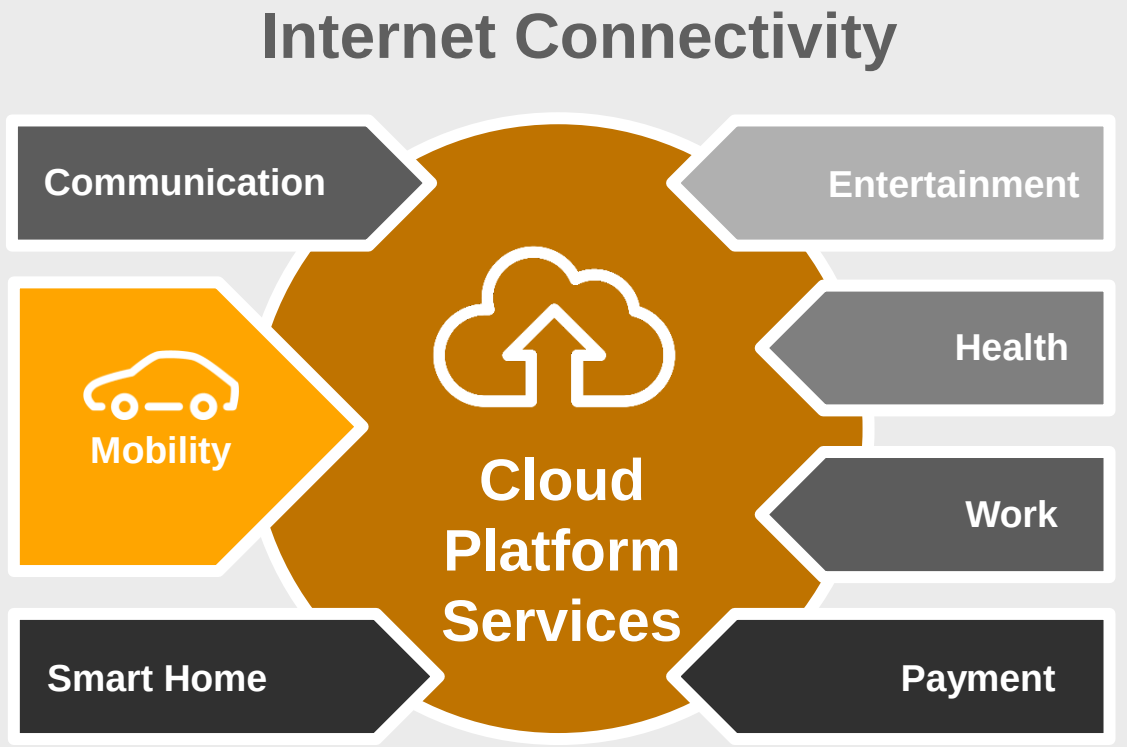
| PAST | | TODAY | | FUTURE |
|---|---|---|---|---|
|  | REVOLUTION |   | EVOLUTION |   |
| Distributed Architecture | | **Server-Zone Architecture with domain / x-domain HPCs** | | Server-Zone Architecture with Central HPC |

HPC: High-Performance Computer

# Transformation of Mobility

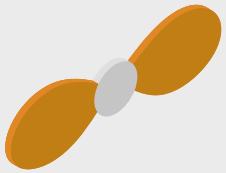
## The car is turning into a system within a system of systems



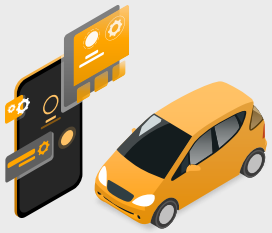



# Advantages of the Software-defined Vehicle

## Service-oriented Architecture as Transformation Enabler



Continuously field data inflow to improve algorithm & product



Reduce test effort and time on the road by >50%

"Code to road" within 1 day

**Service-oriented Architecture**

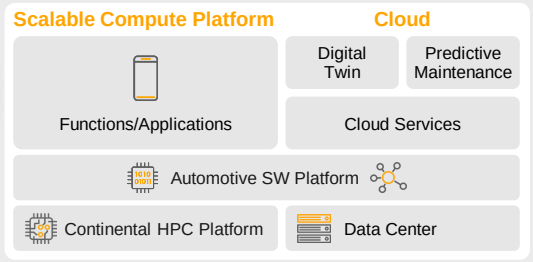
- **New business models**
- **Data-driven development**
- **Software separation from hardware**
- **Virtual development**
- **Shorter time to market**
- **Shorter development, test and integration cycles**

**Digital Lifecycle**

**(HW/SW/Services until EOL)**

RFQ SOP EOP EOL

Software as a Product, or Service (SaaS) business models




Open architecture for 3rd party software

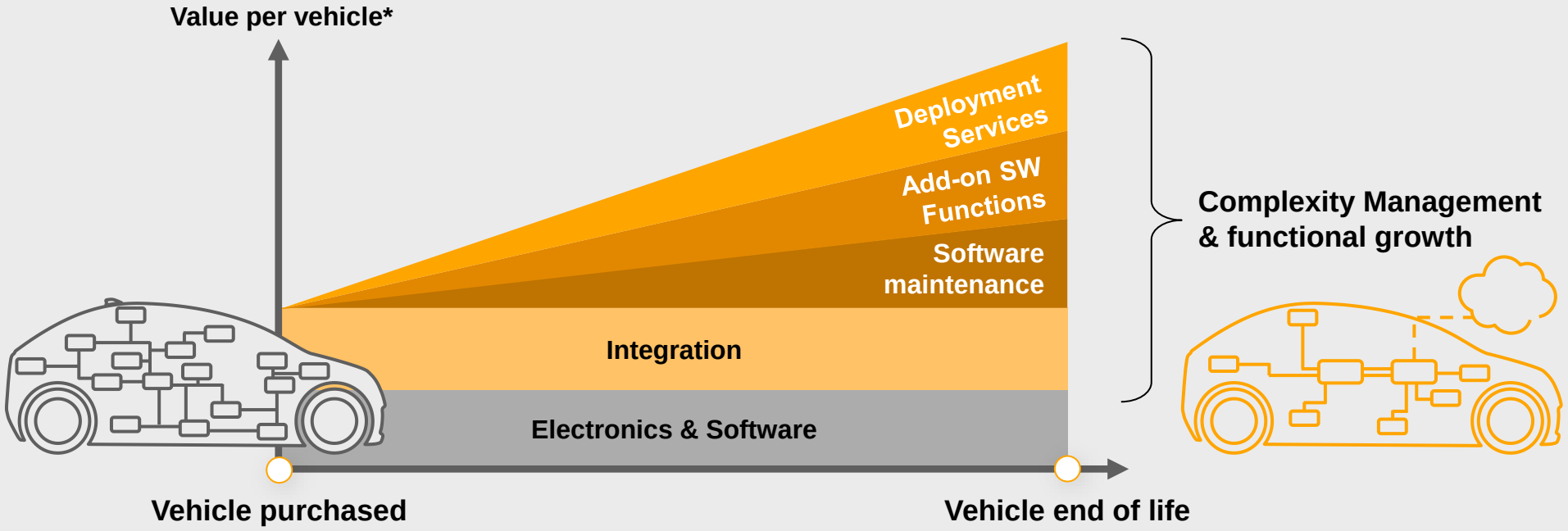
Shorter time for vehicle SOP with increased platform lifetime

HW: Hardware; SW: Software; HPC: High-Performance Computer; RFQ: Request for Quote; SOP: Start of Production; EOP: End of Production; EOL: End of Life

# Software-Defined Vehicle (SDV)
extends business lifecycle

Up2now

Going forward



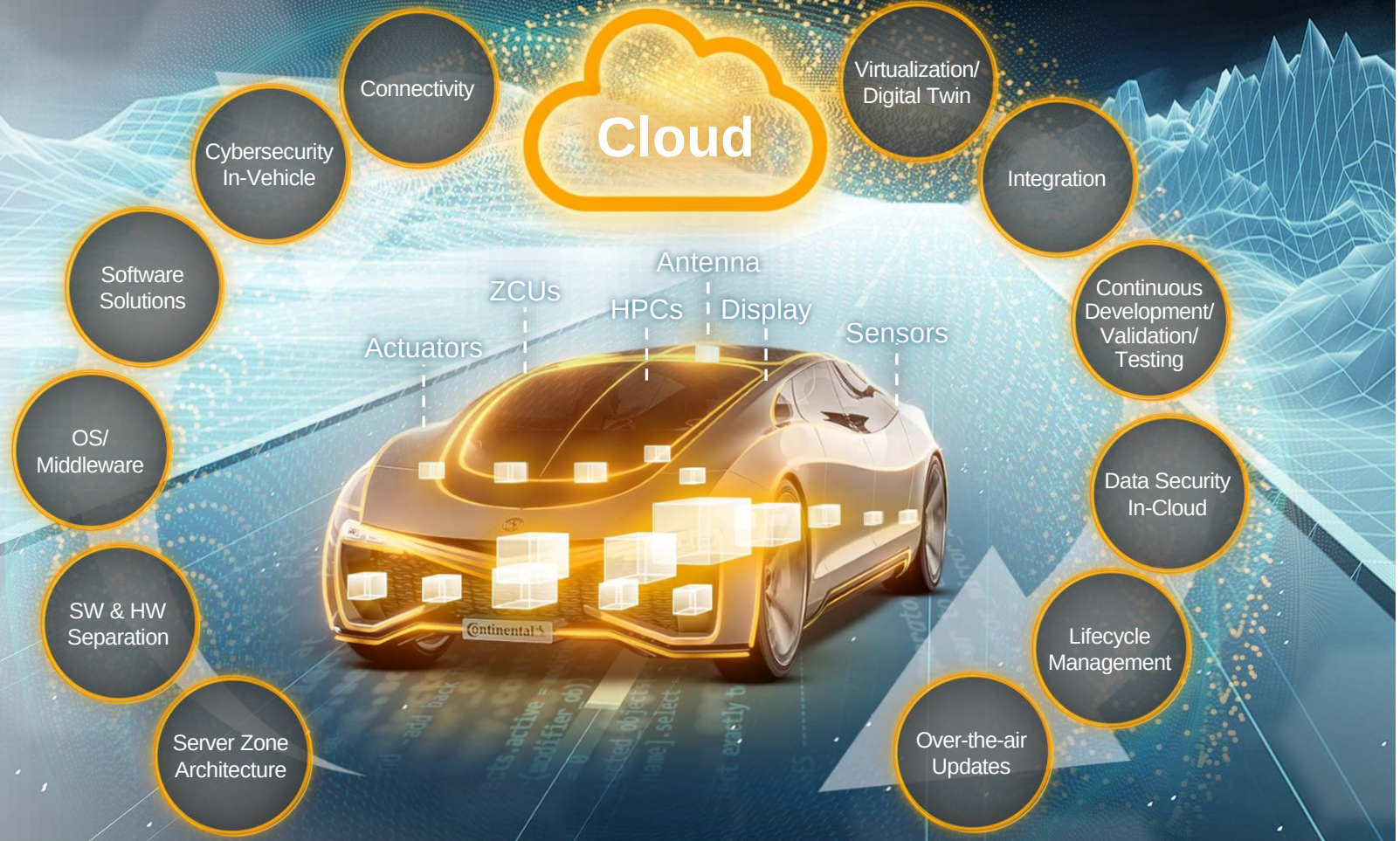

* Not to scale; for illustrative purposes only

# Road to Cloud Ecosystem

## Enable. Develop. Integrate.

**In the Software-defined Vehicle (SDV), functions are enabled by software.**

Decoupling software from hardware enables swift and continuous development, testing & implementation of new functions and software updates throughout vehicle lifetime.

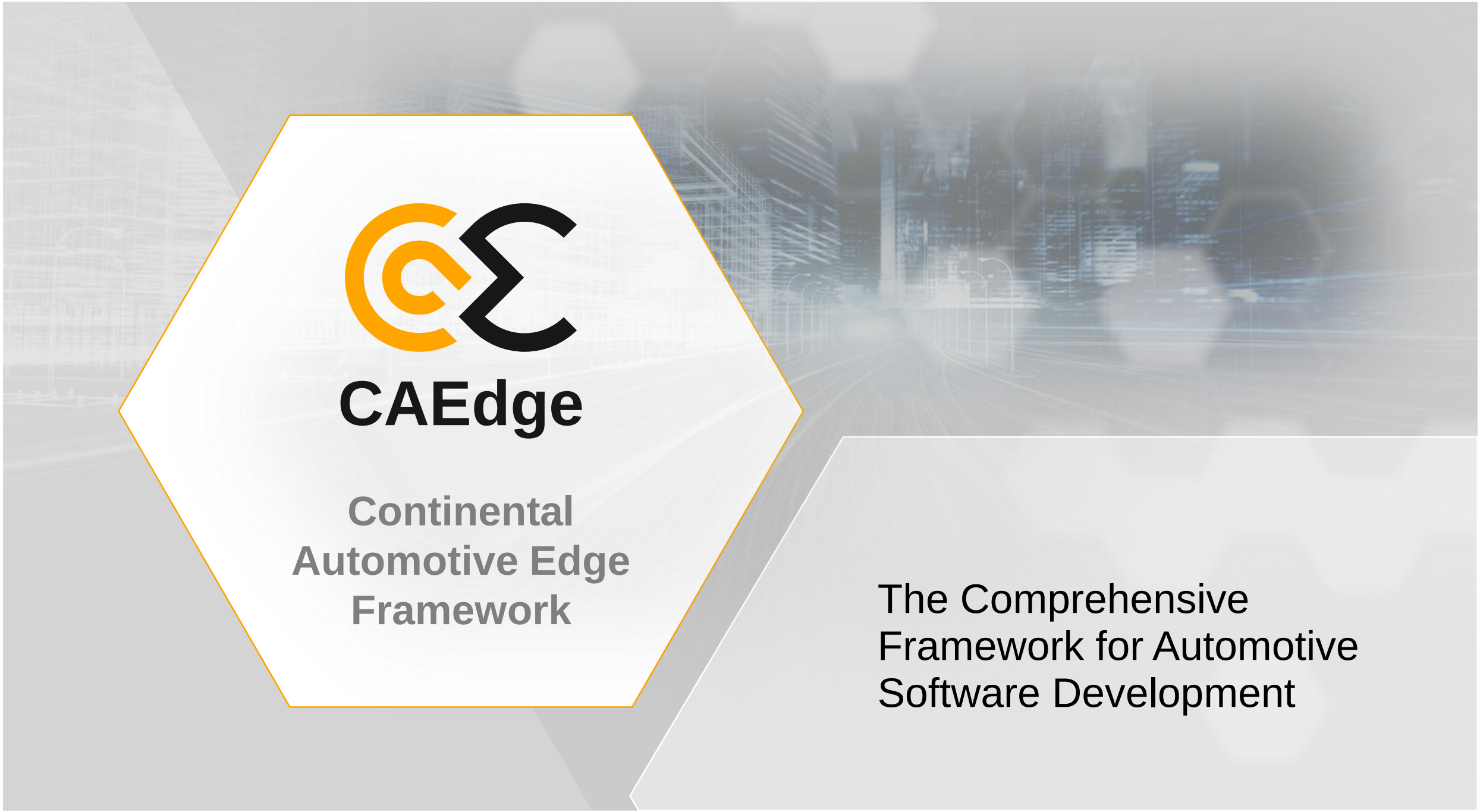



OUR APPROACH:
**The road to cloud ecosystem**

**Within this we deliver:**

› enabling technologies,
› hardware components and
› software solutions and functions.

# Agenda



# CAEdge

## Continental Automotive Edge Framework

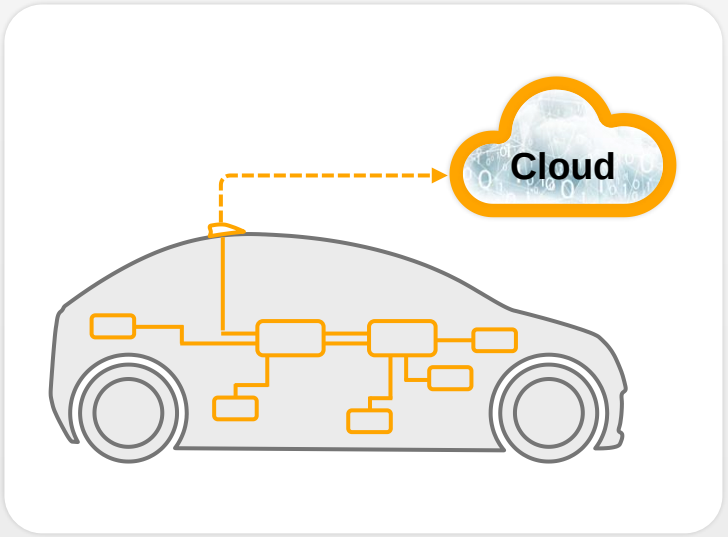
The Comprehensive Framework for Automotive Software Development

CAEdge is the ecosystem to embrace software-defined vehicles, from architecture to software integration.

With the most diverse building blocks, it is the tool set for individual development, optimal collaboration, testing and validation.

# Our Approach: Continental Automotive Edge Framework

## Our Full-Stack IoT Architecture Solution




Software-defined vehicle

DevOps Workbench

High-Performance Computer

Functions / Applications

Cloud

aws

Cloud Services

Automotive SW Platform

Middleware

Core SW/OS

Simulation & Validation Services

Continental HPC Platform

Data Center

Vehicle Infrastructure

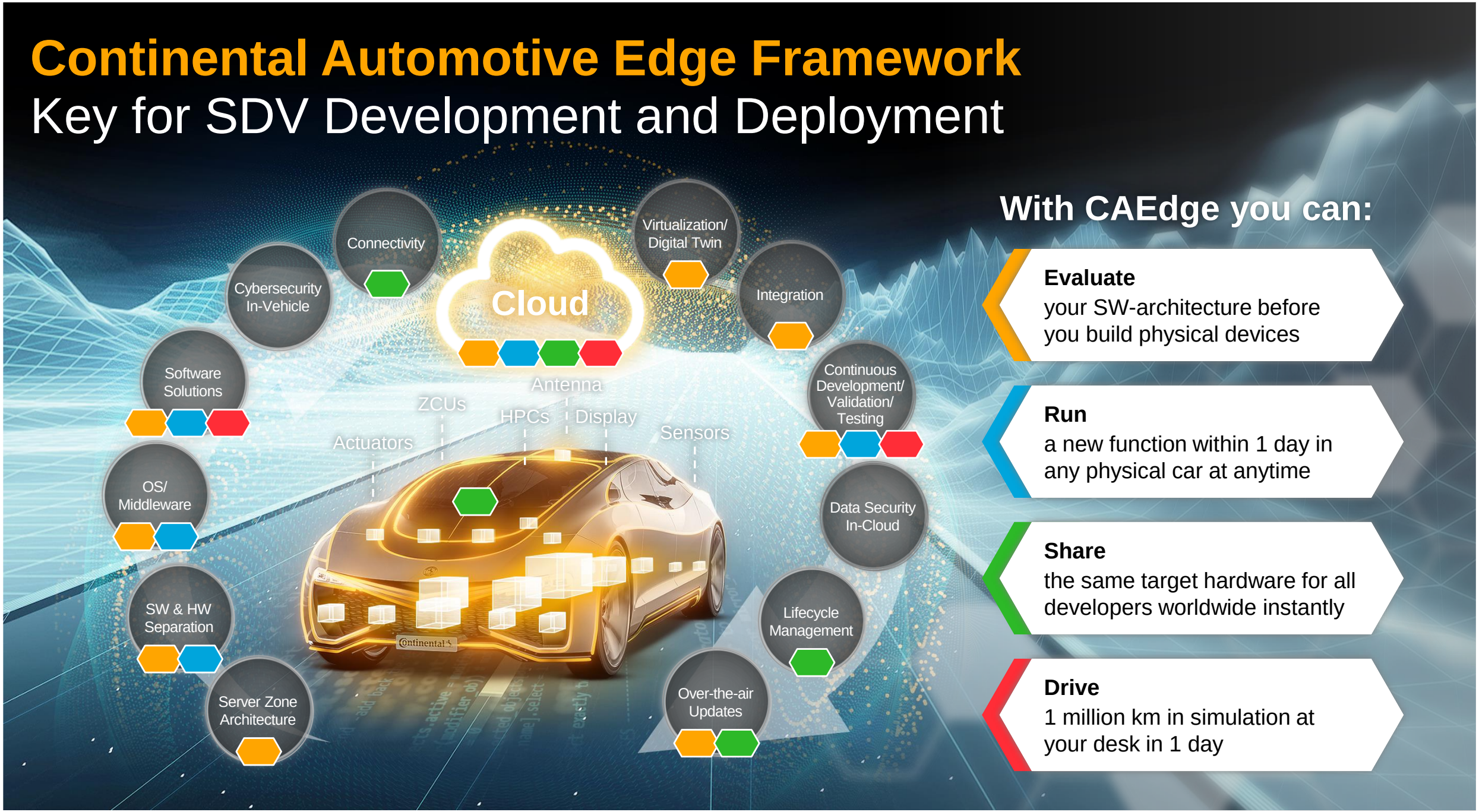
* µP: Micro-Processor, SoC: System on Chip, SoM: System on Module; CI/CD: Continuous Integration / Continuous Deployment

# CAEdge
## is a cloud-based framework for:

- SW development decoupled from HW development
- Virtualization and simulation
- Seamless collaboration
- Validation and improvement of system functions

# Continental Automotive Edge Framework

## Key for SDV Development and Deployment




### With CAEdge you can:

**Evaluate**
your SW-architecture before you build physical devices

**Run**
a new function within 1 day in any physical car at anytime

**Share**
the same target hardware for all developers worldwide instantly

**Drive**
1 million km in simulation at your desk in 1 day

# CAEdge Offerings for the Software-defined Vehicle

**Evaluate**

› vECU Creator

**Run**

› Cloud-based Workbench for Software Development
› Continental Cooperation Portal

**Share**

› Hardware Development Kit HDK 2.0/3.0
› Hardware Farm

**Drive**

› Workbench for Data-driven Development

# Continental Automotive Edge Framework

## Automotive System Development from Idea to Roll out in Just a Glimpse

**CAEdge enables faster development and deployment**

**CAEdge provides interchangeable building blocks**

**Customers can start immediately**

**Modular and scalable compute platform**

**Automotive grade designed building blocks**

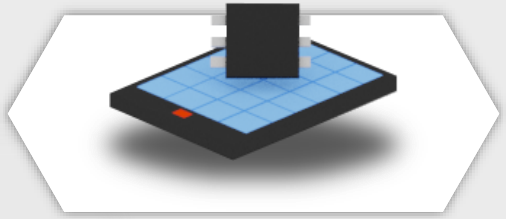
**Cohesive, integrated tool framework**

**Non-differentiating automotive-grade OS and middleware**

**Cloud as scalable extension of embedded and on-prem resources**

# Agenda

# Automotive Virtualization Levels



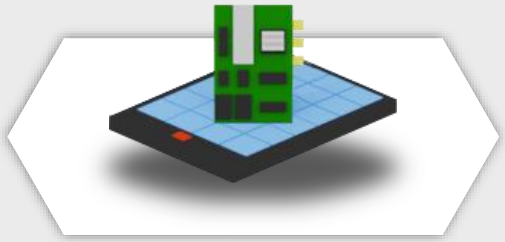
## Virtual Micro

Hardware is simulated to run the real target binary software on a PC

**Target to test:**

› MCAL/BSW functions

SYNOPSYS® Virtualizer



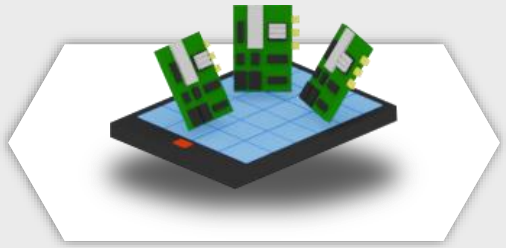
## Virtual ECU

Lower software layers are simulated to run target C code on a PC

**Target to test:**

› BSW functions
› ECU communication
› ASW functions
› SW modules

SYNOPSYS® Silver



## Virtual ECU-System

Several ECUs are simulated to run ASW functions and their interactions

**Targets to test:**

› ASW functions
› SW modules
› ECU communication
› Network/cloud services

CAEdge

## Virtual Car

All relevant ECUs are simulated to run all system and ASW functions as well as their interactions

**Targets to test:**

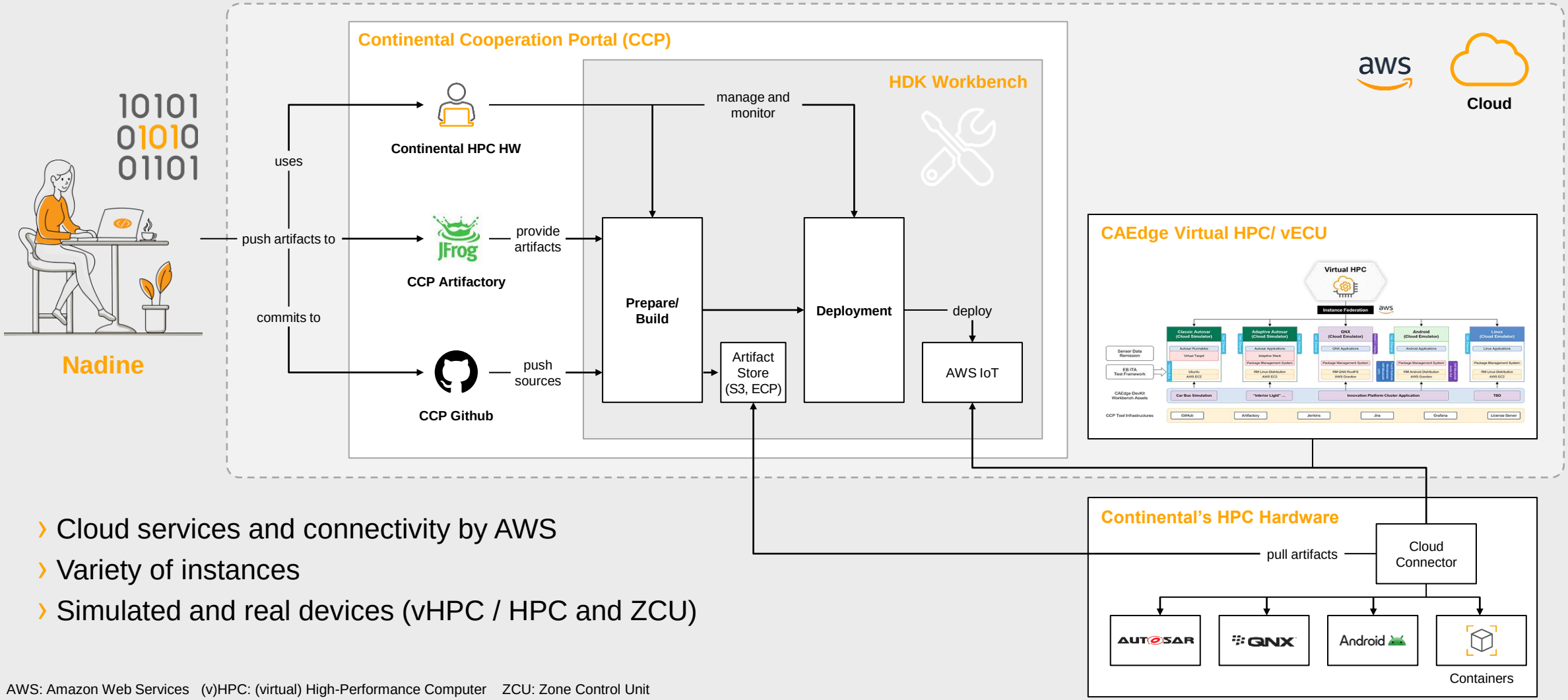
› System functions
› ASW functions
› SW modules
› Communication
› Network/cloud services

In the future

MCAL: Micro Controller Application Layer; BSW: Basis Software; ASW: Automotive Software

# HPC Development Kit / Virtual HPC Workbench

## Development Workflow



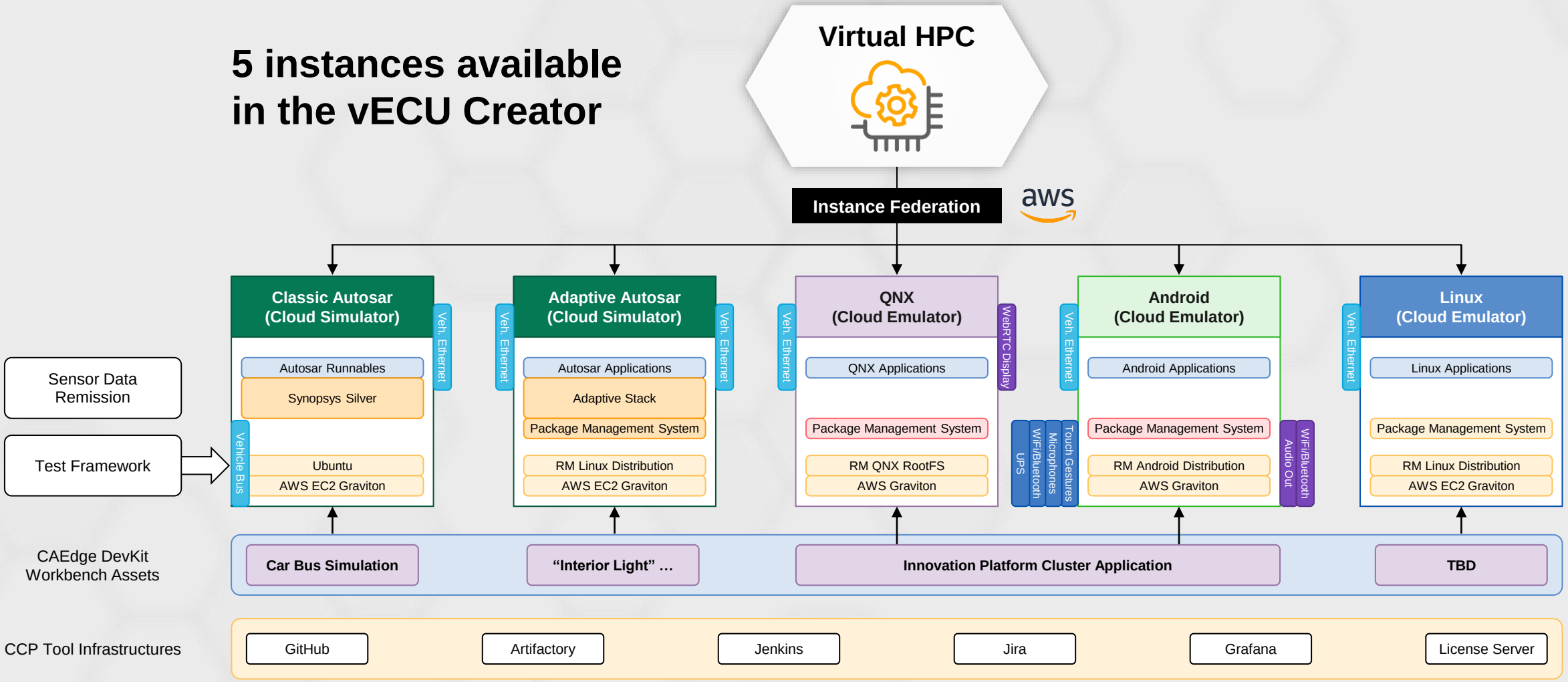

- Cloud services and connectivity by AWS
- Variety of instances
- Simulated and real devices (vHPC / HPC and ZCU)

AWS: Amazon Web Services (v)HPC: (virtual) High-Performance Computer ZCU: Zone Control Unit

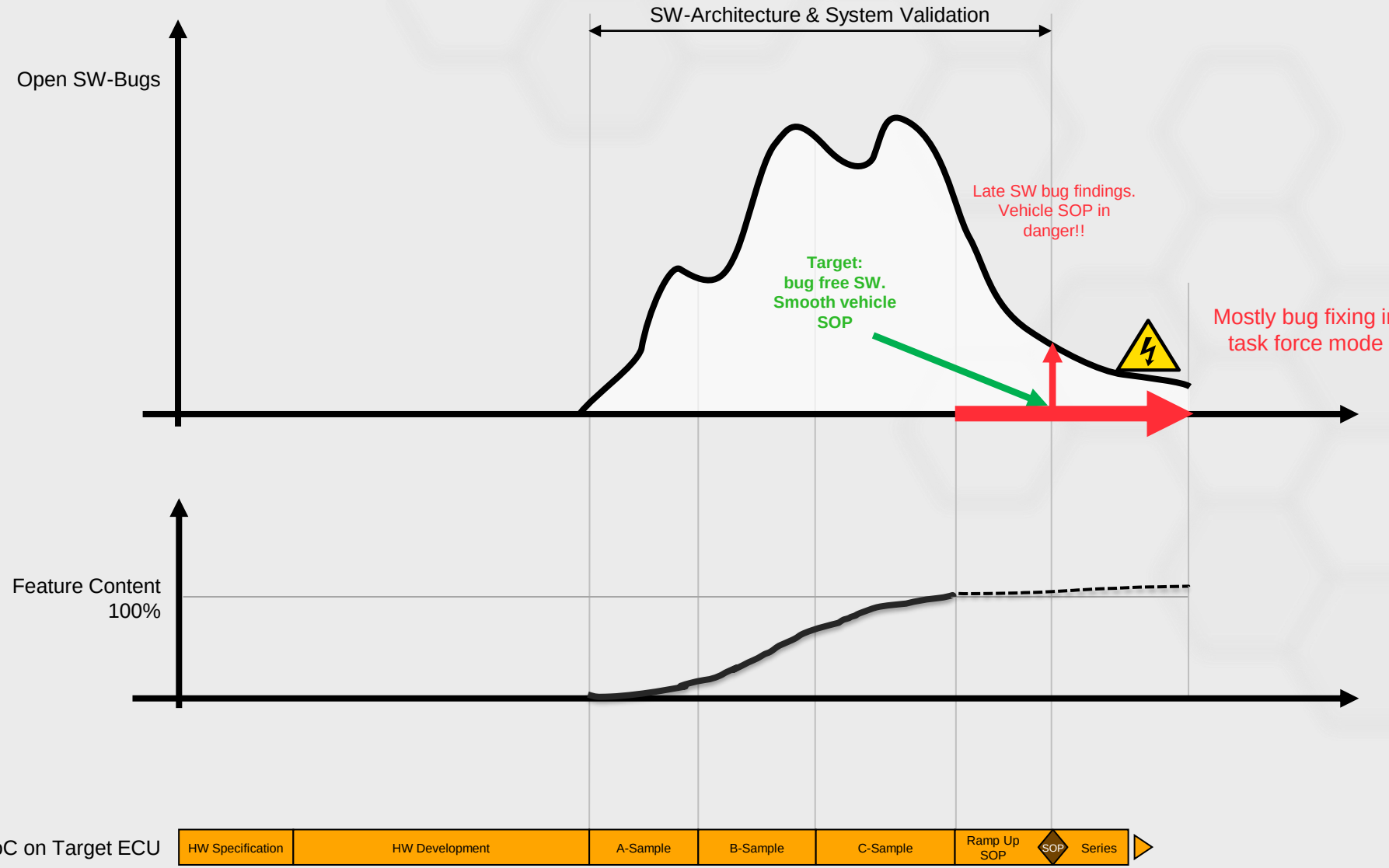
# CAEdge Virtual HPC / vECU

## Digital Twin of the Physical HPC

**5 instances available in the vECU Creator**



# Situation Today Without HW/SW Virtualization



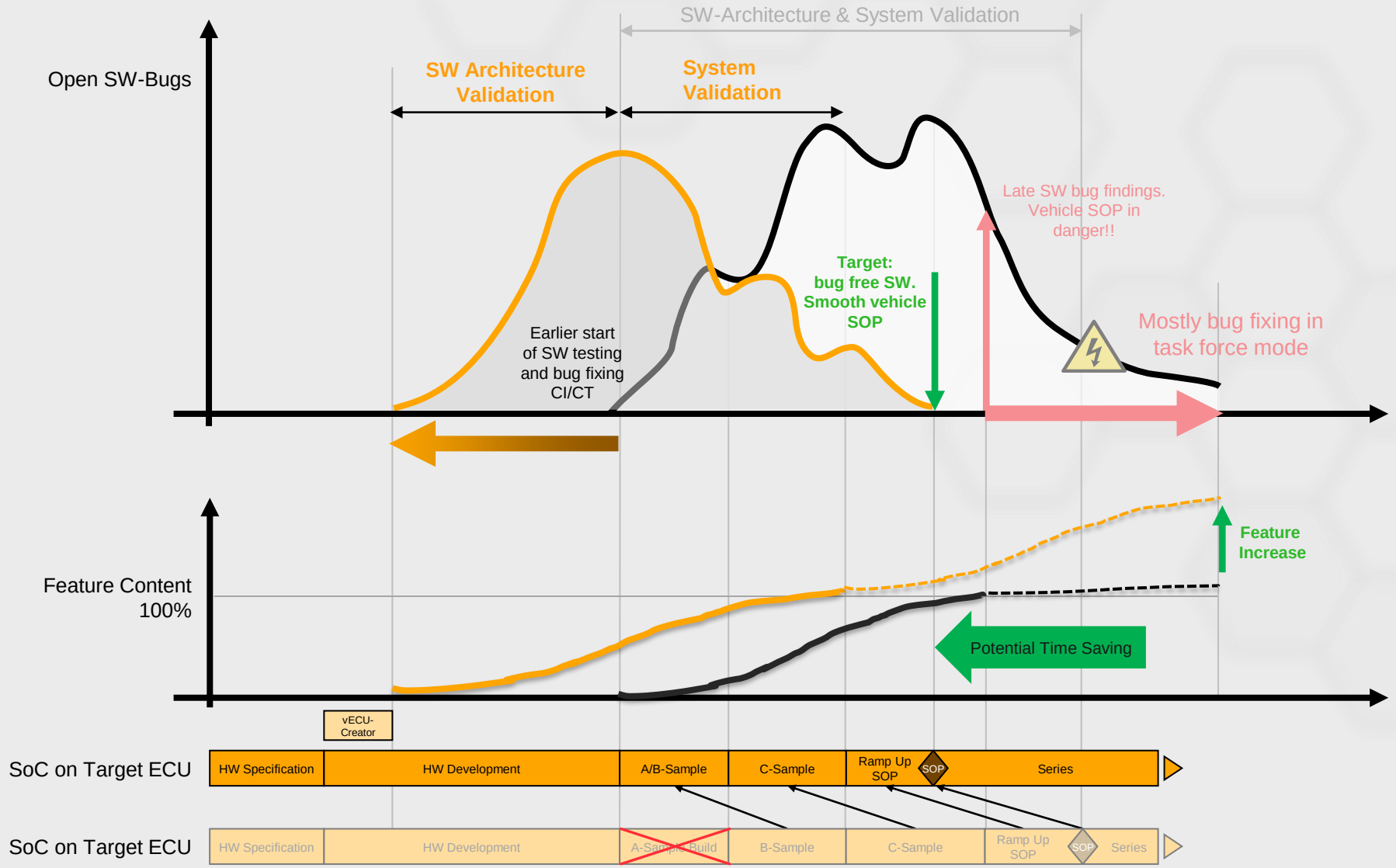

**Low customer satisfaction**

SoC on Target ECU

| HW Specification | HW Development | A-Sample | B-Sample | C-Sample | Ramp Up SOP | SOP | Series |
|---|---|---|---|---|---|---|---|

— Actual Development cycles

# Situation Today With HW/SW Virtualization




**Higher customer satisfaction**

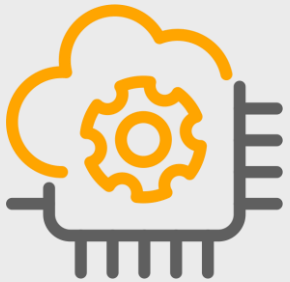
Development supported with vECU

Actual Development cycles

# Virtualization / vECU Creator
## Advantages

### Targets/Achievements

- **Risk reduction** by separation/ decoupling from SW-architecture validation and system validation
- **Resource-saving** development
- **Save costs** for samples
- Save costs for HiL tests through the use of in **parallel virtual tests**



### Result

- **Smooth entry into series production**
- **Reduction of task forces**
- **Faster SOP**
- **Faster transition to update/ upgrade development mode**
- **Higher customer satisfaction**

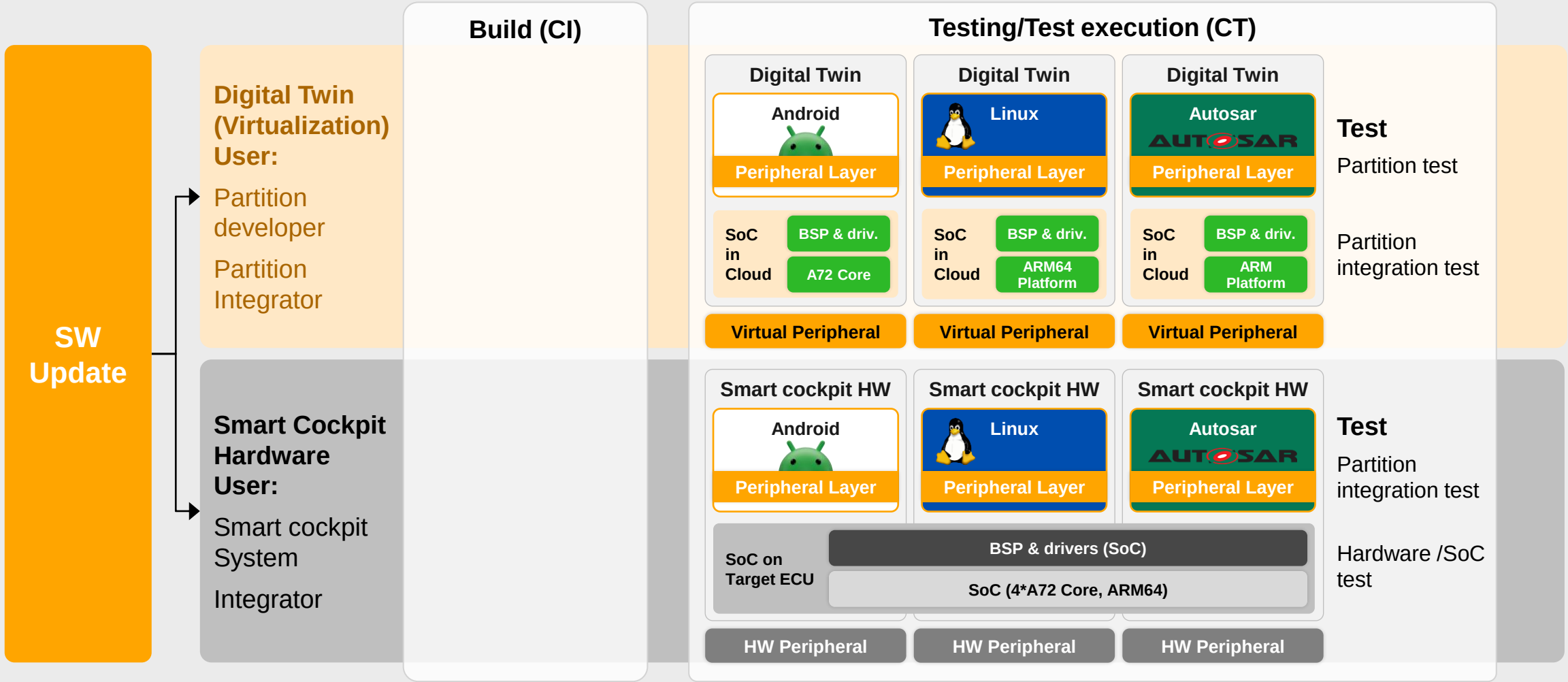
# Virtualization Examples

## Demonstration Projects


Example: Virtualization of  Smart Cockpit HPC

# Smart Cockpit HPC Virtualization

## Integration and Test Strategy for Multiple Partitions – Testing




*HPC: High-Performance Computer; SoC: System on Chip; BSP: Board Support Package

# Agenda

# Full Scale Solution Provider for the SDV

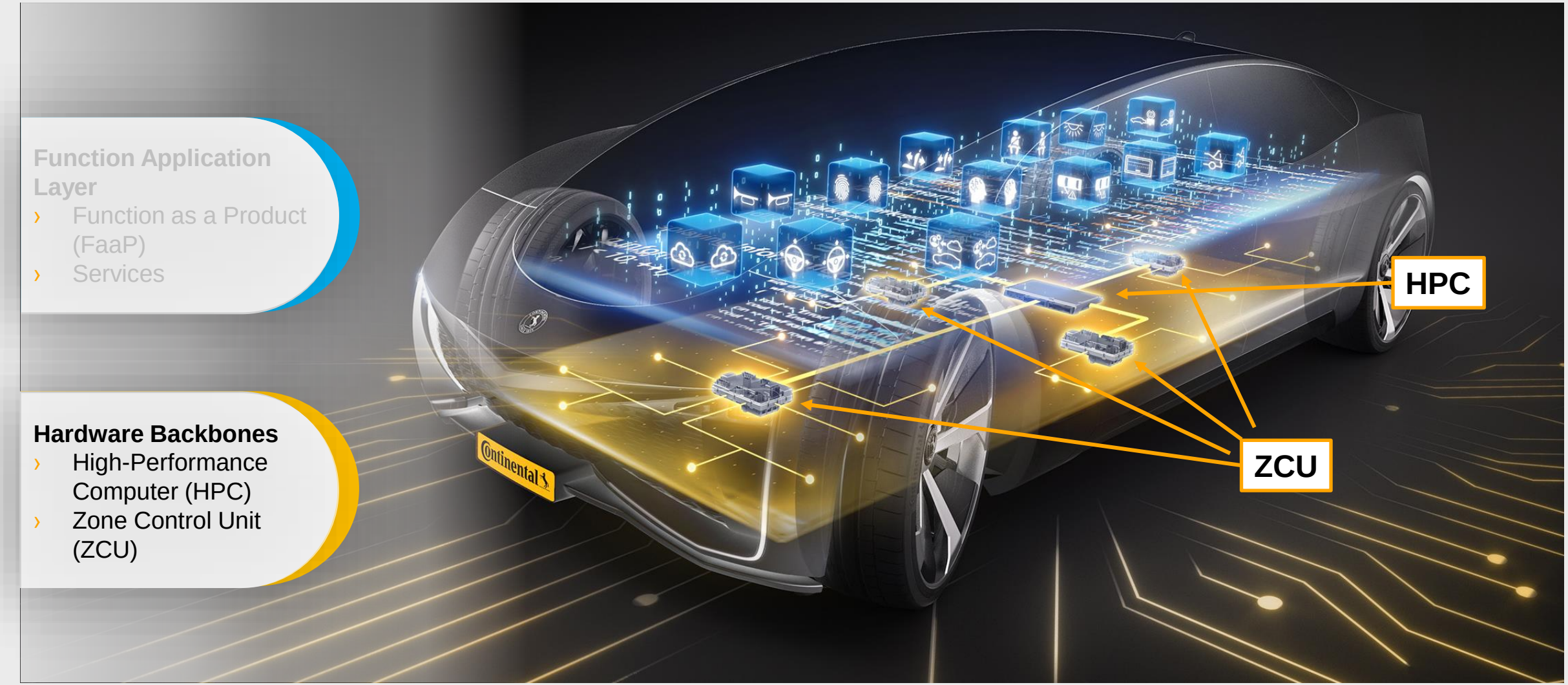
## Function Application Layer / HW Backbone Provider

**Function Application Layer**

- Function as a Product (FaaP)
- Services

**Hardware Backbones**

- High-Performance Computer (HPC)
- Zone Control Unit (ZCU)



# HPC Product Portfolio

## Flexible Solutions for Unique Customer Demands

**Vehicle Control HPC**

**Cockpit HPC**
(Cluster + Infotainment)

**Software Development & Integration, Virtualization**

**Automated Driving HPC**

**System Exploration Kit** (Reference Integration)

**ADAS-Cockpit (AC) HPC**

**Mechanical Housing and Cooling Solutions**
(Cooling, Rack & Stack concepts)

**Central HPC**

**Architecture & Consulting** | **HW & SW Development** | **Integration & Testing** | **Production & Maintenance**

# From Domain Centric Towards Central HPC

## Overview About Domain Migration

**Domain Centric**

**A**utomated **D**riving **HPC**

**C**ockpit **HPC**

Body HPC

Chassis & Motion HPC

**Domain Migration**

X-Domain Integration

**A**DAS-**C**ockpit **HPC [AC HPC]**
(AD L2+ Cockpit)

*Various combinations of x-Domain HPCs*

**V**ehicle **C**ontrol **HPC [VC HPC]**
(Body + Chassis & Motion)

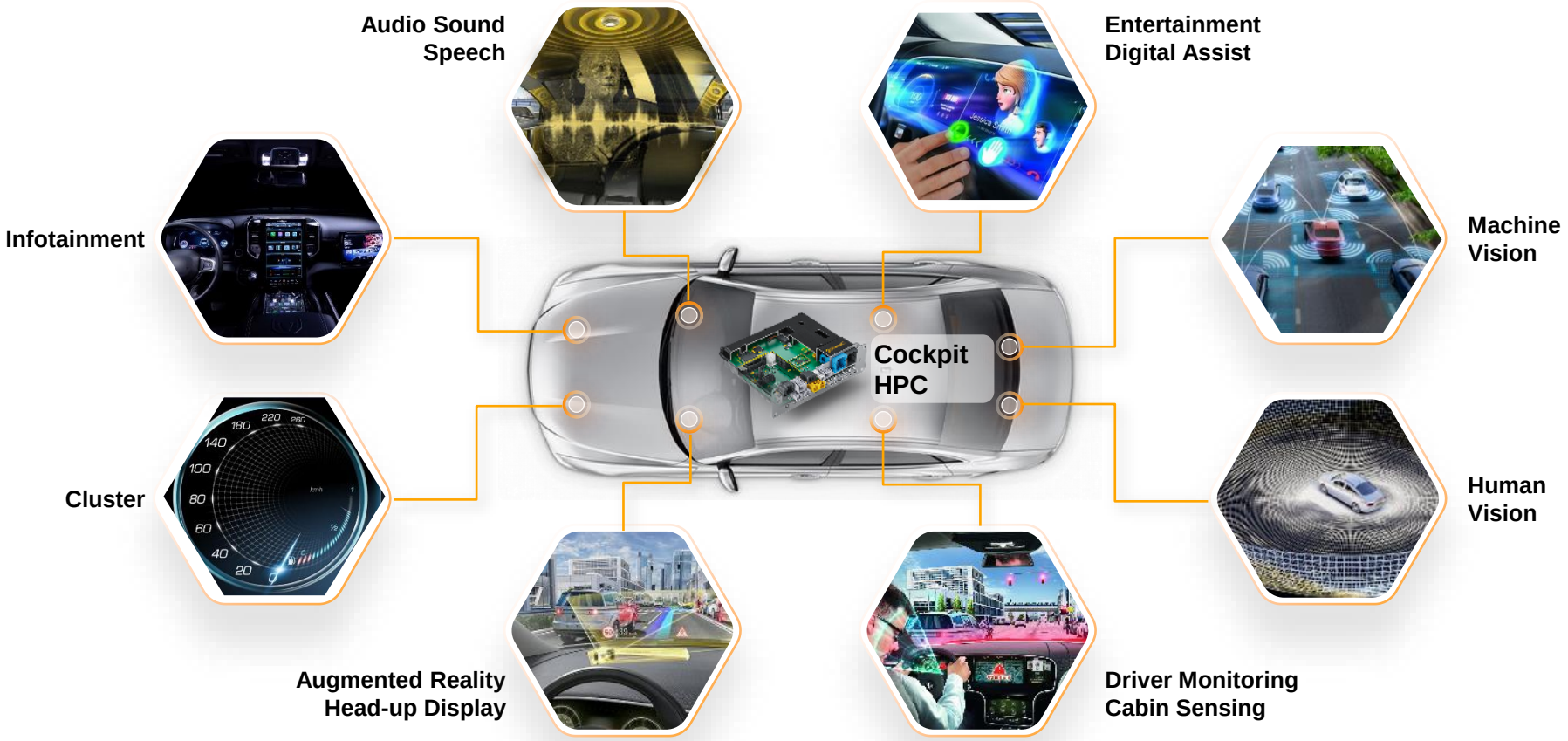
**Central HPC**

*HPC: High-Performance Computer

# Cockpit High-Performance Computer

## Scope

"The journey started integrating infotainment and cluster functionalities in one device. Features are continuously added (e.g., cameras, …)"




### Function List

- Cluster
- Infotainment
  - Radio
  - Media
  - Navigation
  - Phone
  - Connectivity
- Audio, Sound, Speech
- Augmented Reality
  - Head-up Display
  - Display
- Entertainment
  - Co-Driver Entertainment
  - Rear-Seat Entertainment
  - E-Travel Companion
- Diver and Cabin Sensing
- Human Vision
  - 360 deg View
  - Digital Mirror
- Machine Vision

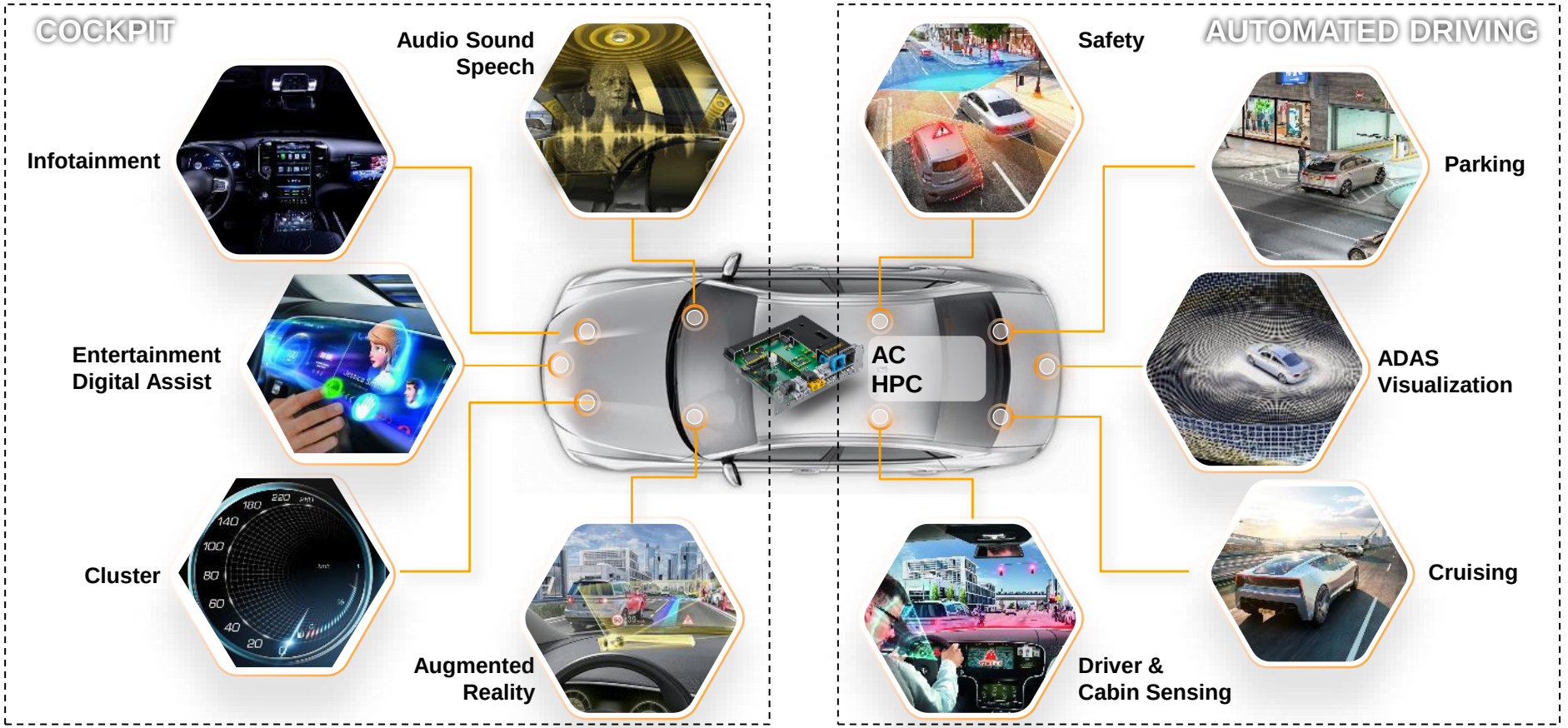
# Smart Cockpit HPC Demo Car
## In Collaboration With Google Cloud


- Powerful processor of the Telechips Dolphin family
- Pre-integrated functions for cluster, infotainment and visualization of Advanced Driver Assistance Systems
- Cost-optimized and with a short development time

# Cross-Domain High-Performance Computer

## Combining ADAS and Cockpit Functionality (AC HPC)

> “The journey started integrating cabin sensing into the cockpit HPC. Other functions of automated driving are continuously added.”




### Function List

**Cockpit**

- Cluster
- Entertainment & Digital Assist
  - Co-Driver Entertainment
  - Rear-Seat Entertainment
- Infotainment
  - Radio, Media
  - Navigation, Connectivity
- Audio, Sound, Speech
- Augmented Reality

**Automated Driving**

- Diver and Cabin Sensing
- Cruising
  - Traffic Jam Chauffeur
- ADAS Visualization
- Parking
  - Valet Parking
- Safety
  - Lane Departure Warning

# Cross-Domain HPC Technology Car

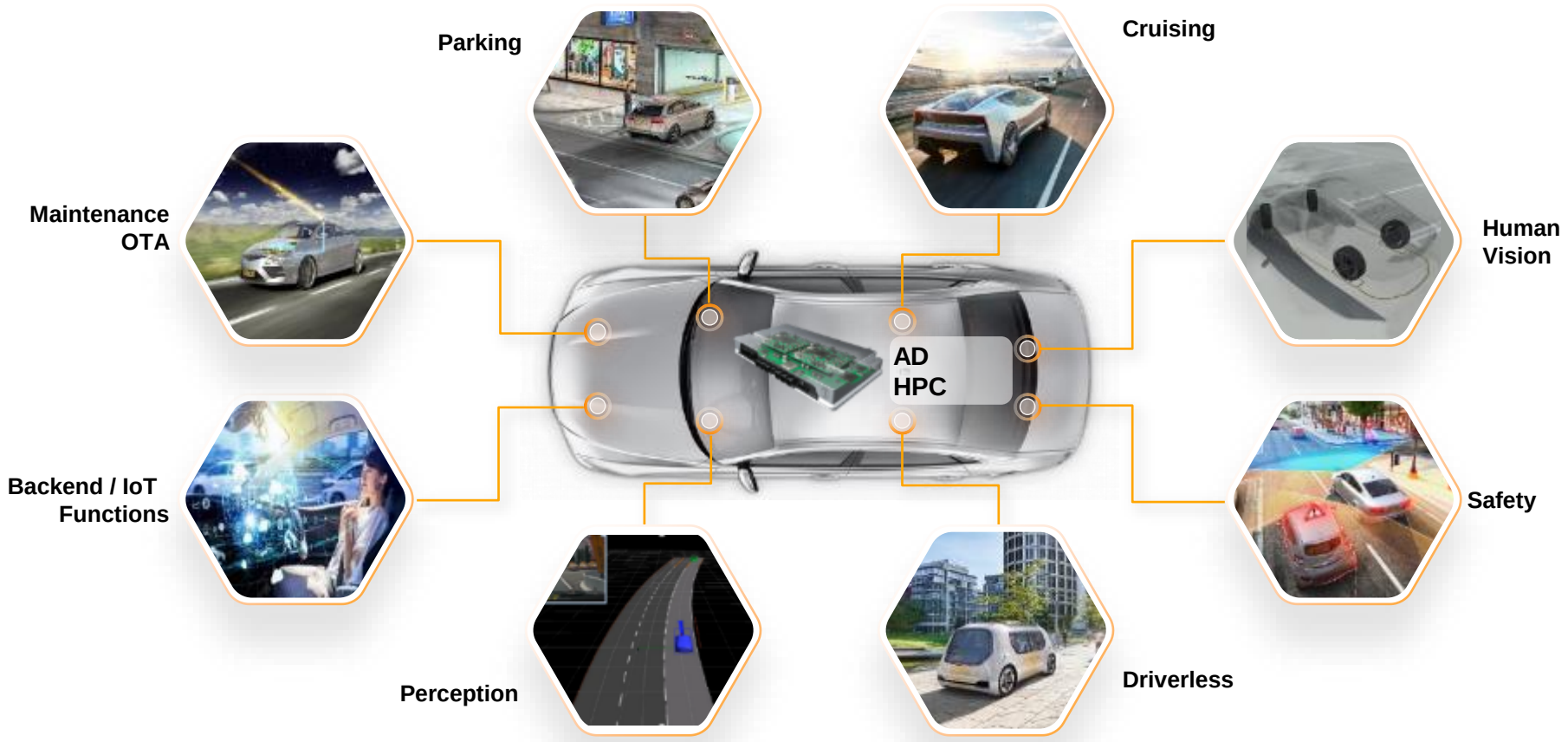
## Combination of Cockpit and ADAS

- First driving vehicle with a cross-domain AC HPC
- Combining cockpit and advanced driver assistance features on one chip
- Milestone on the path towards full domain integration

# Automated Driving HPC

## Integration of Assisted and Automated Driving Functions Into One Device

**“ADAS functions such as visualization, parking, driving from L2+, and combinations of these functions can be hosted on one device”**




### Function List

- **Parking, e.g.**
  - Automated Parking
  - Valet Parking
- **Cruising, e.g.**
  - Driver Montoring
  - Traffic Jam Chauffeur
- **Human Vision, e.g.**
  - Surround View
  - Transparent Hood
- **Safety, e.g.**
  - Lane Departure Warning
  - Blind Spot Monitoring
- **Perception**
- **Backend Functions e.g.**
  - Big Data
- **Maintenance / OTA**

# Aurora Truck
# Automated Driving HPC

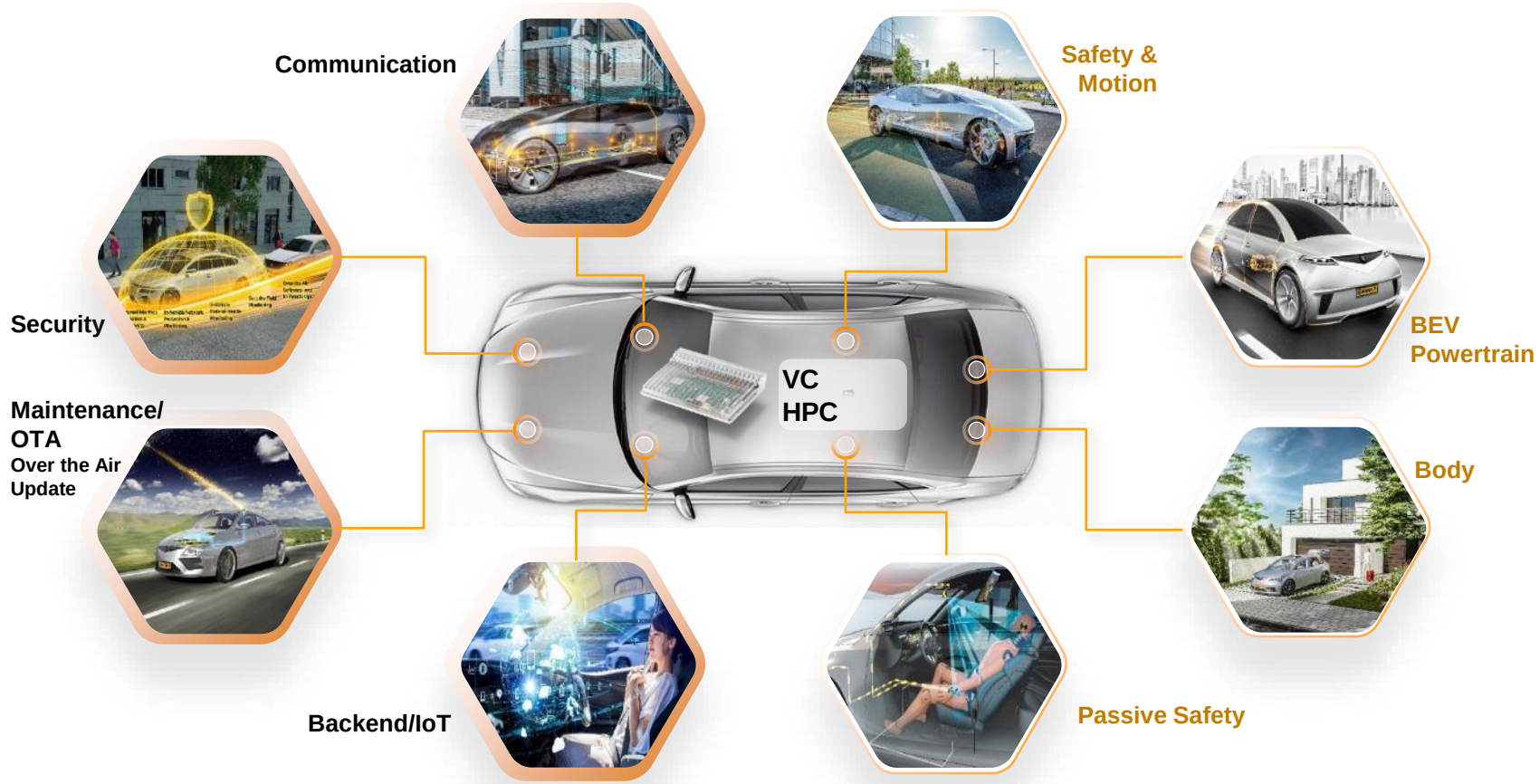

- AD HPC hardware for fully driverless (L4) operation of long-haul trucks
- ADCU for full-stack fallback-path
- Partnership with Ambarella - Software Stack for assisted and automated driving

# Vehicle Control (VC) HPC

## Host for Vehicle Control Core- and Cross-Domain Functions

**“We integrate vehicle infrastructure and cross-domain functionalities into one device… ”**

VC Core Functions | Hosted Functions




BEV = Battery Electrical Vehicle, OBD = On Board Diagnose

### Function List

- **Communication**
  - Routing, Gateway, …
- **Security**
  - Gateway, Key Management, ..
- **Maintenance / OTA**
  - OBD Diagnostic, SW Update, …
- **Backend/IoT**
  - Predictive Maintenance
  - Big Data (collection), …
- **Safety & Motion**
  - Holistic Motion Control (HMC), …
- **BEV Powertrain**
  - Powertrain: Electric
  - Charging Management, …
- **Body**
  - Exterior/Interior Light
  - Air Conditioning, Seat Control, …
- **Passive Safety**
  - Tire Pressure Monitoring
  - Driver Health Monitoring, …

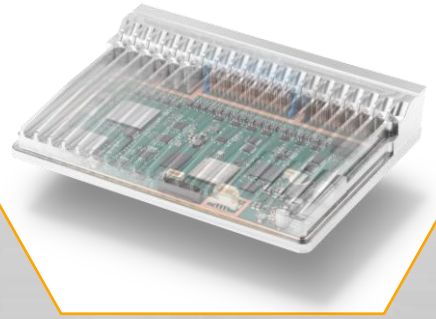
# Various VC HPC Platform and Series Products

## Vehicle Control High-Performance Computers

Source: https://insideevs.de

**GAC**

**VC HPC**
Base Platform



**Hybrid HPC**
(HPC/ZCU)

**Volkswagen ICAS1**
for ID.Series

- Integration host for vehicle control functions
- Central data and communication hub
- Master for over-the-air software update and upgrades
- Vehicle cyber security master

*ZCU = Zone Control Unit; ICAS1 = InCar Application Server

# Zone Control Units – The Next “Layer” Below the HPC

## Essential Components to Realize the SDV

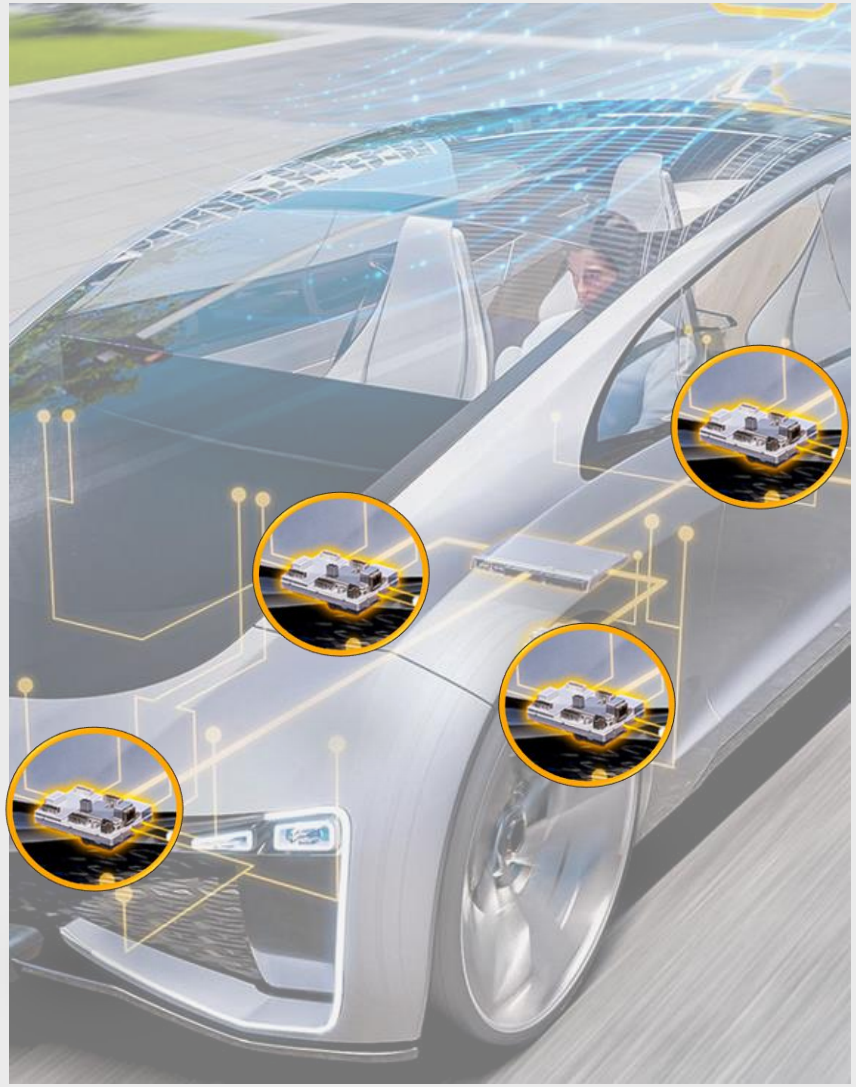
**Manage complexity** +
Reduce total vehicle system cost

**Consolidate I/Os** and reduce ECUs

**Optimize** power & signal management

Low effort **Variant Management** / **fast time to market**

**SOA Introduction** - “Place” for Real Time Functions and StS* conversation



**ZCU allows x-domain zonal management of signals, data & power!**

### Input/Output Control

- **Standardized** data/service interfaces
- **Signal-to-service** conversion between sensors/actuators & HPC
- Hosting **time critical real-time** functions

### Communication Gateway

- **Ethernet** backbone connection **to HPC**
- CAN, CAN-FD, LIN, 10MBit Ethernet for **zonal network**
- **Translation** between service-oriented and signal-oriented ECUs

### Smart Power Distribution

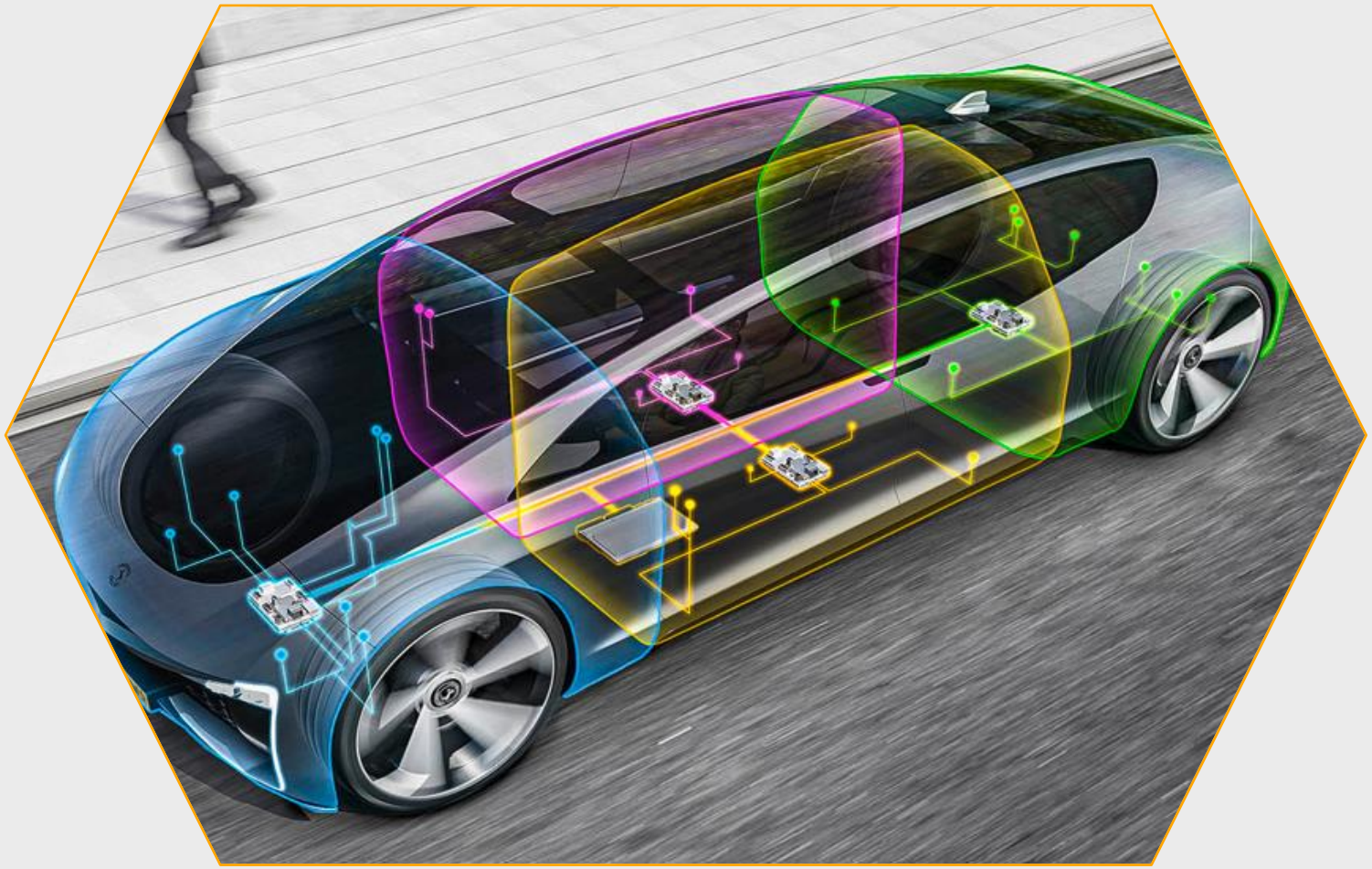
- Intelligent **power distribution** and diagnosis
- **Smart fusing**/switching up to 40A
- **Redundancy** (support ASIL-rated power distribution)

StS: Signal to Service

# Zone Control Units - Consolidation in Physical Zones

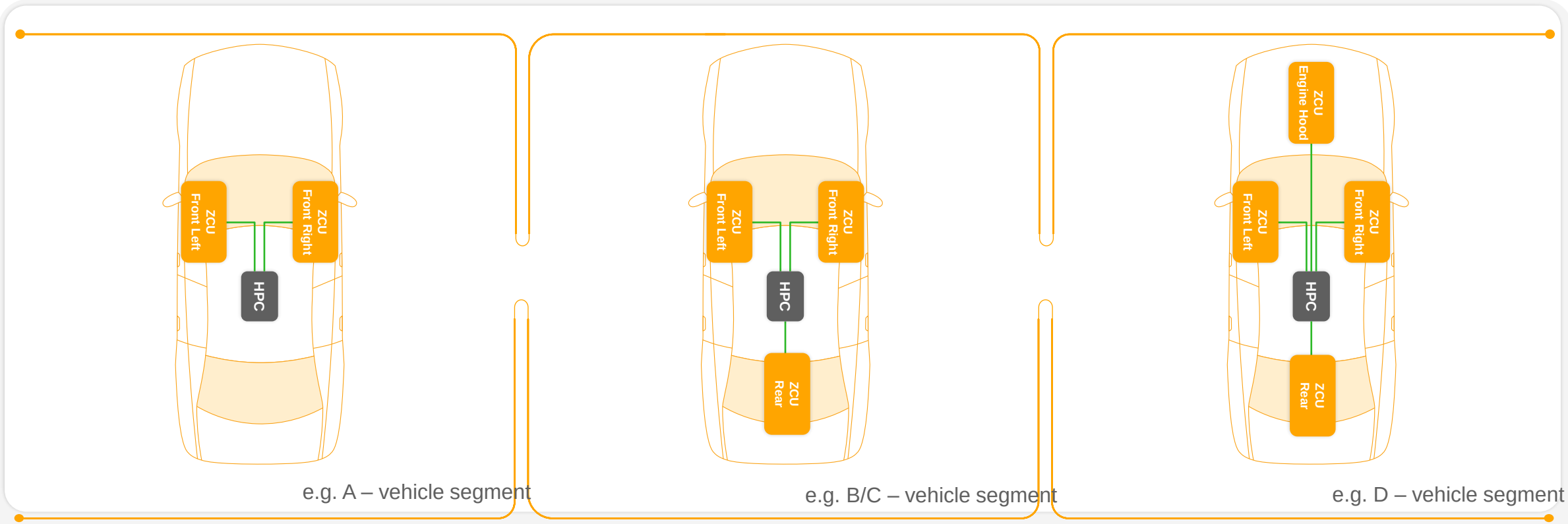
## Real X-Domain Hub Enabling Service-Oriented Architectures

- Main ECU of a **physical vehicle zone**
- Located in the vicinity of the sensors/actuators and peripheral devices
- **Hub for x-domain zonal management** of signals, data and power



# Server-Zone Architecture

## Scalability Enables X-Carline Vehicle




e.g. A – vehicle segment

e.g. B/C – vehicle segment

e.g. D – vehicle segment

**Remarks**

Beyond the above shown star topology an optional CAN ring topology can be applied, too.
Any other vehicle architecture with e.g., up to 8 ZCUs can be supported due to modularity and scalability.

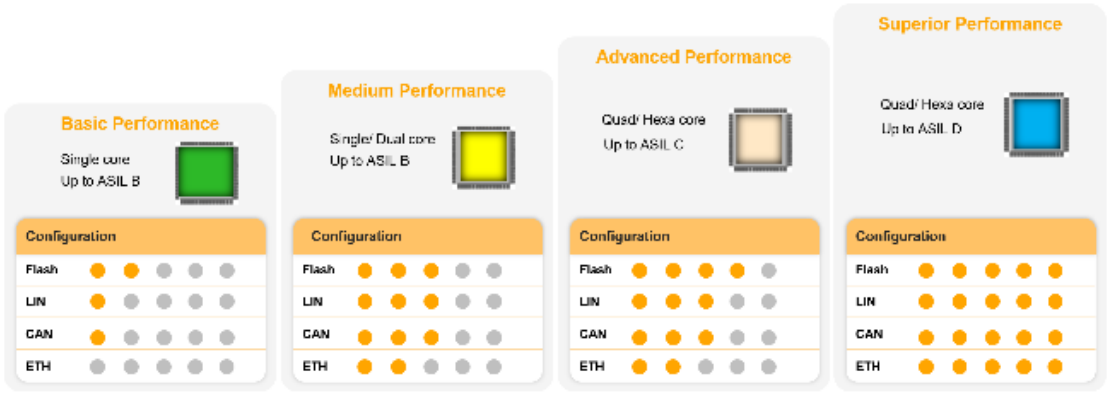
ZCU = Zone Control Unit.

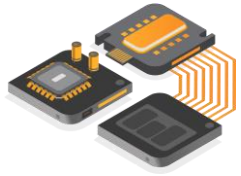
# Zone Control Unit Platform
## Scalability and Modularity

**Continental's Zone Control Unit Platform supports the market needed variety with a well-defined scalability and modularity concept**

### Scalability

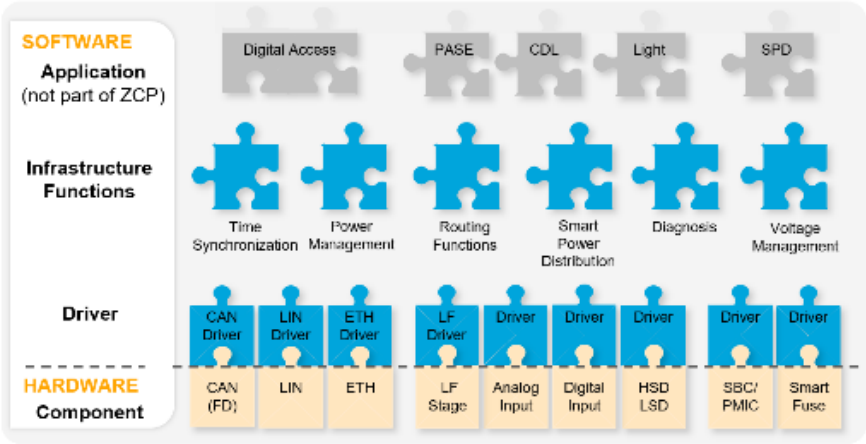
Ability to support lower and higher-level requirements (µC performance, amount of IOs, interfaces,…)



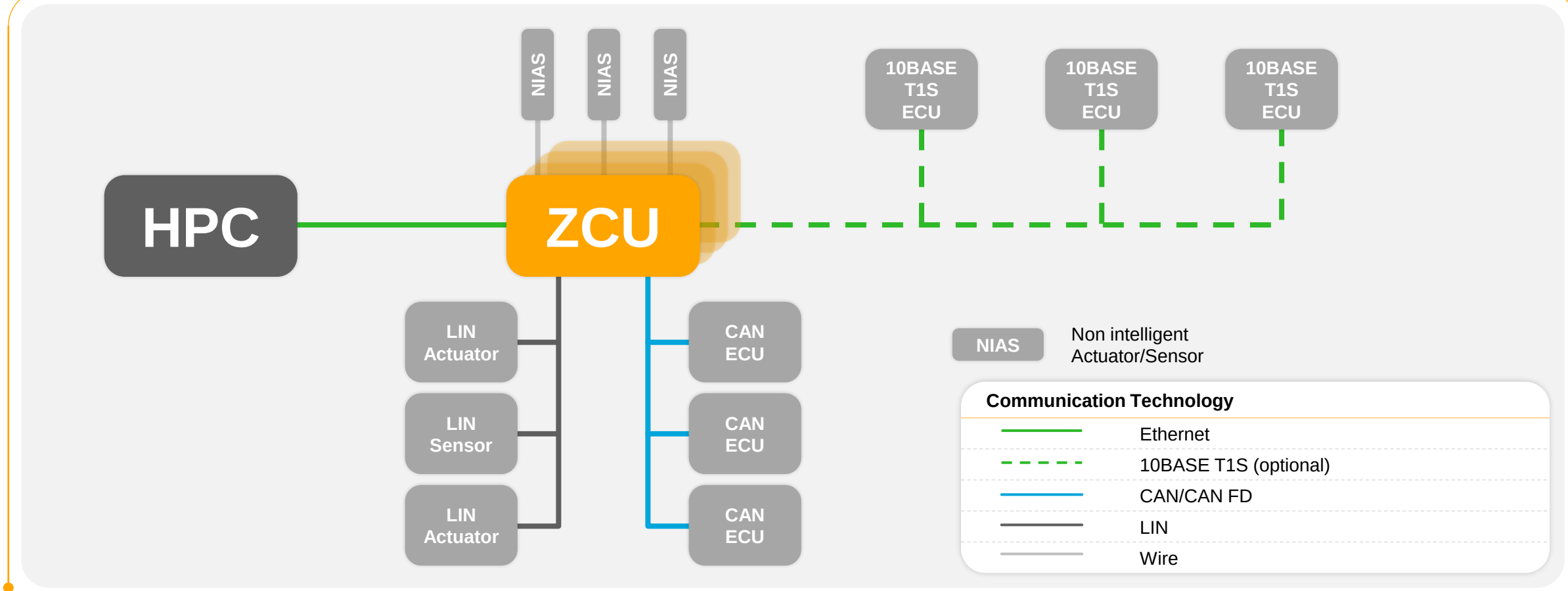
### Modularity

Exchangeability of solutions to cover the specific needs of the OEMs



# Server-Zone Architecture

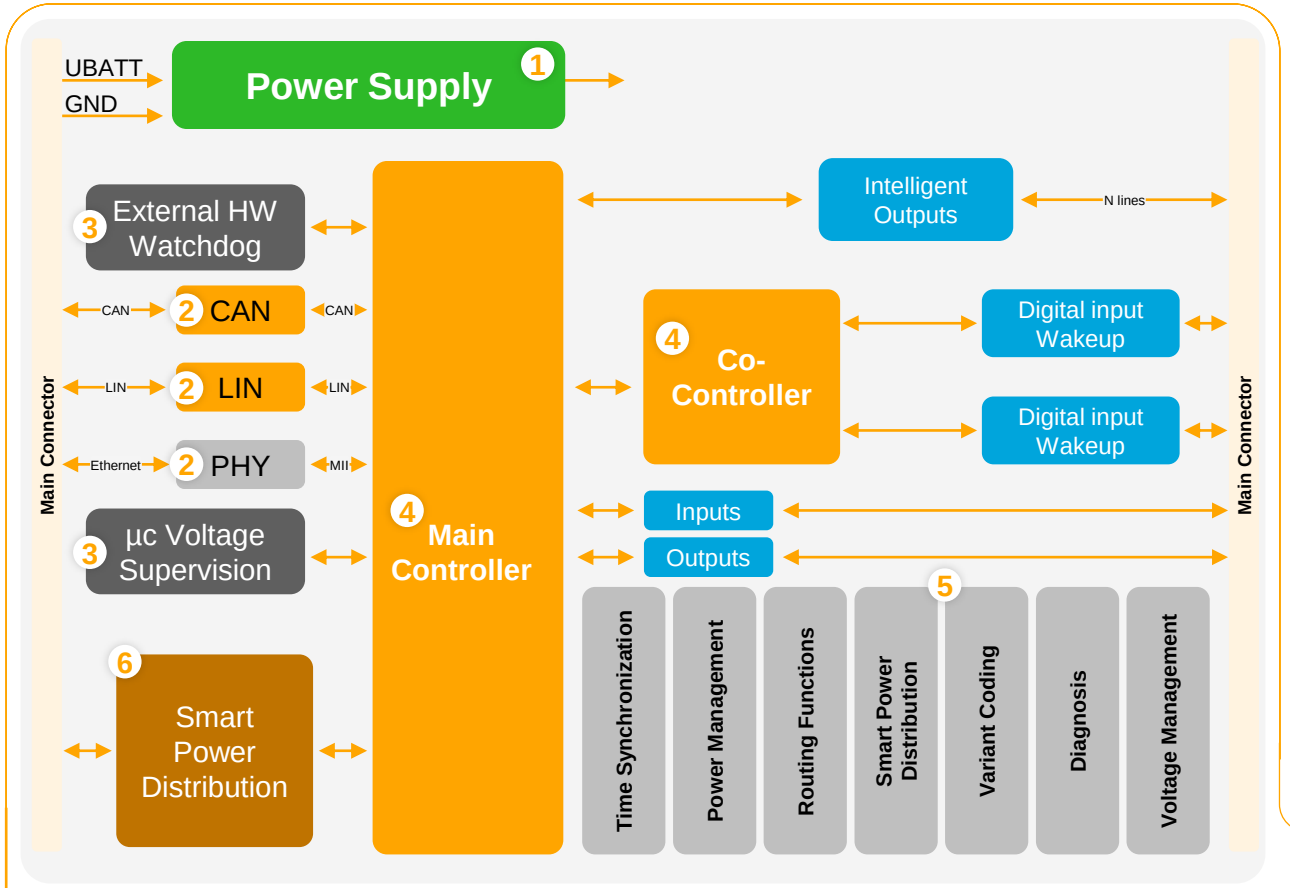
## Main Interconnection Scheme for Zone Control Unit

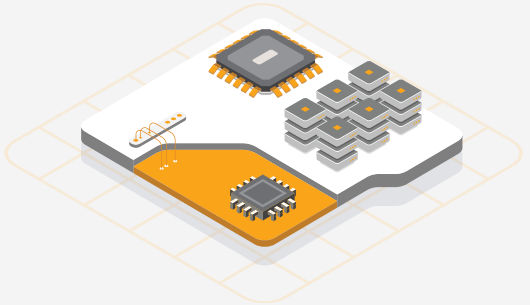



ZCU = Zone Control Unit; HPC = High Performance Computer; LIN = Local Interconnect Network; CAN = Controller Area Network; CAN FD = Controller Area Network Flexible Data Rate; 10BASE T1S = 10 MBps Multidrop Ethernet via twisted pair copper wire; NIAS = Non-Intelligent Actuator Sensor

# Zone Control Unit Platform

## Backbone - Content



### Backbone Elements

1. Power supply (scalable in relation to ASIL level)
2. Communication interfaces (modular and scalable)
3. Microcontroller supervision (scalable in relation to ASIL level)
4. Microcontroller topology (Co-controller is optional)
5. Infrastructure functions (modular, partly optional)
6. Smart Power Distribution (SPD)

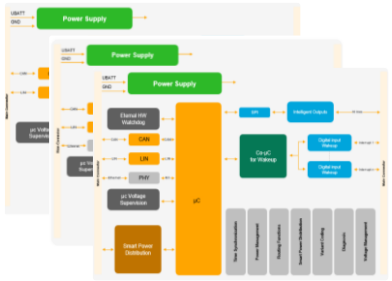
**Security and safety measures are pre-integrated in all backbone variants!**

µC = Microcontroller, PHY = physical layer, SPI = Serial peripheral interface

# Zone Control Unit Platform

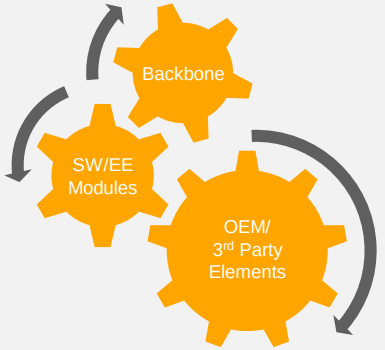
## Flexible Integration Process

### Platform Backbone Selection

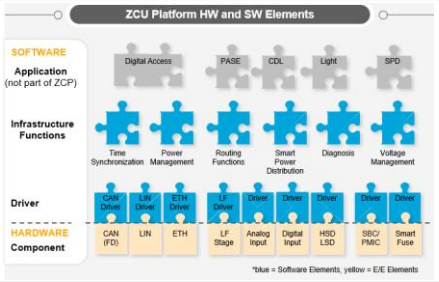



### Customer/ 3rd Party Supplier interface

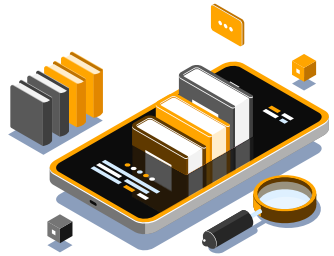

### Integration Process




### Platform Modules Selection




### Continental Function Library




**Advanced integration process ensures efficient application development!**

# Agenda

# Full Scale Solution Provider for the SDV

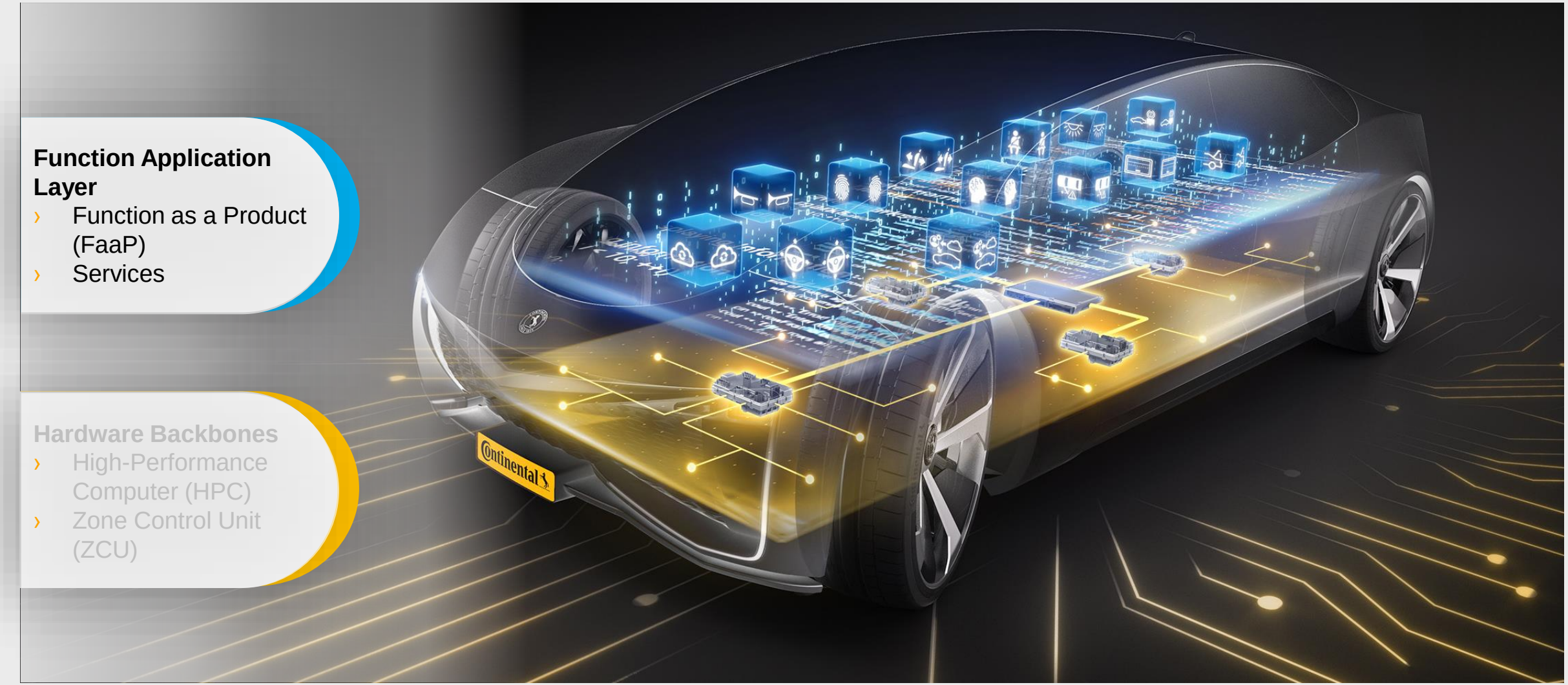
## Function Application Layer / HW Backbone Provider

**Function Application Layer**

- Function as a Product (FaaP)
- Services

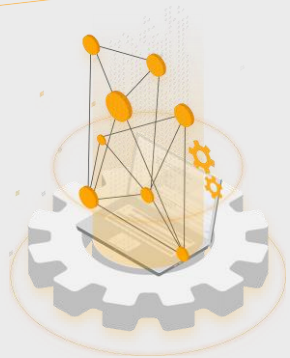
**Hardware Backbones**

- High-Performance Computer (HPC)
- Zone Control Unit (ZCU)

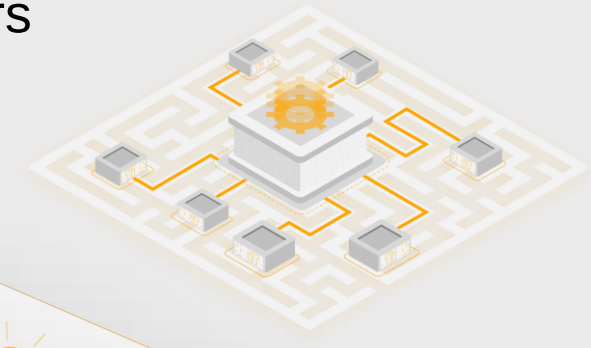


# Industry Challenges

1. Software complexity increases



2. Multiplication of software suppliers

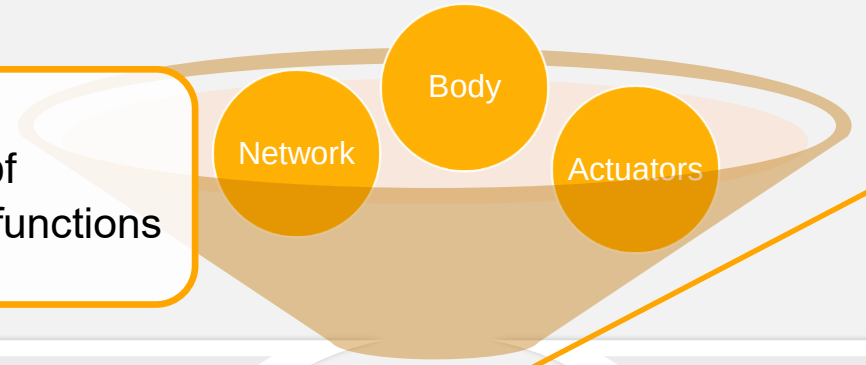


3. Limited resources

# Our Value Proposition: Function as a Product

## Function Application Layer Solutions

We target **100%** of products portfolio's functions




**Collaboration** needed between HYUNDAI MOTOR GROUP & Continental to ensure **Architecture fit.**

**Software Assets**

**Long term Maintenance**

**Collaboration Services**

HYUNDAI MOTOR GROUP

**SW Organization**

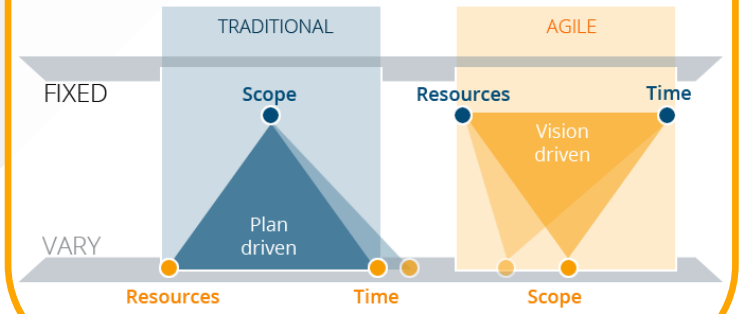
**Functions Parametrization**

**Integration services**

**Consulting & Training**

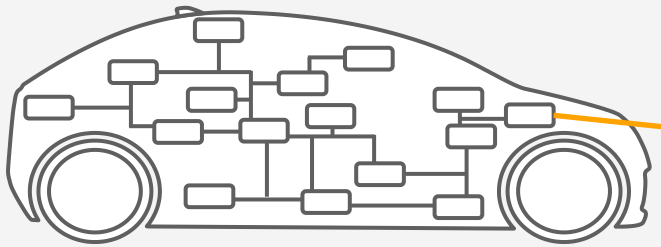
## Pricing models:

- **License** for **assets**
- **Agile Fixed Price** for **services**

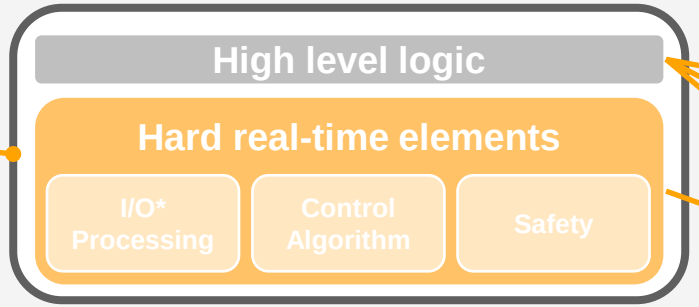


# What does it mean for our function's portfolio?

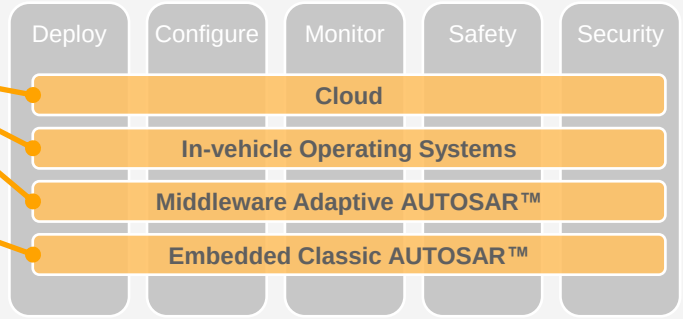
## OEM involvement needed right from the beginning



**Vehicle Function**




**HW/SW decoupling strategy**




**Software Defined Vehicle****

- Catalog of "**backbone**" functions with "**low differentiating capabilities**"
- **Market leader** with **classic** single **product** approach
- Support OEM to achieve a **timely** and **smooth transition** to **new E/E architecture**.

- **Separate** hard **real-time** elements from high level **logic**.
- Lower layer **focuses** on **I/O*** processing, **control** algorithm and **safety**.
- **Decoupled** artifacts shall **link into OEM architectures**.

- Need to **fit** with **OEM unified model** for **life cycle** management across **different** software **environments**
- **Complete automatization** and **standardization** will **take years**.
- **Need** for **expertise** and **knowledge** to execute these capabilities.

* I/O = input/output, ** Non-exhaustive capability model

# Function as a Product

## Key Take Away

- Function as a Product means software assets and the services around to ensure seamless integration and maintenance.
- Function as a Product serves every stage of the OEM Software-Defined vehicles transformation.
- Function as a Product targets at first the backbone functions of the vehicle.

# Agenda

# Road to Cloud Ecosystem

## Enable. Develop. Integrate.

With our expertise across the entire ecosystem, we are able to connect all the dots and provide dedicated solutions to support our customers, realize their vision.