Middleware is Lubricant and Glue of SDV E/E Architecture

AutoSAR is Cornerstone of Automotive Middleware

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CSSDC @ Continental China

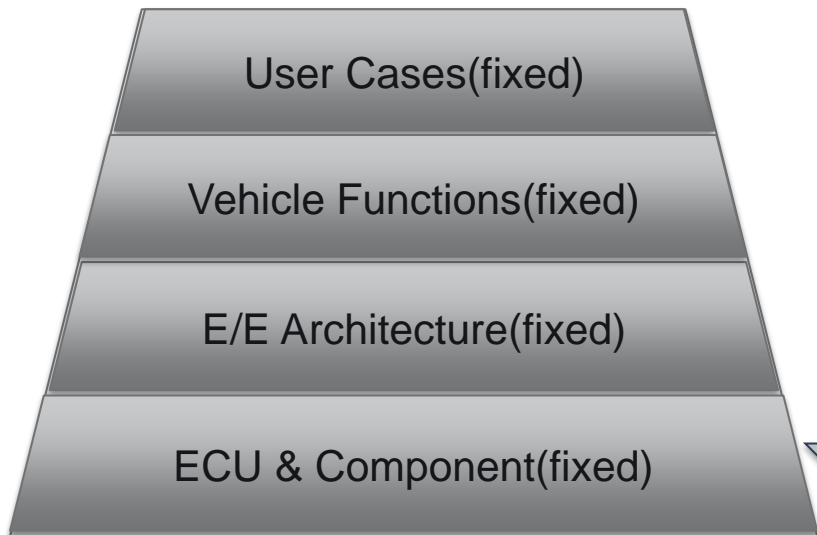16 Mar 2023   AutoSAR China Day 2023 @ Shanghai

China Software and System Development Center(CSSDC)

Moving Toward Excellence in System & Software Engineering

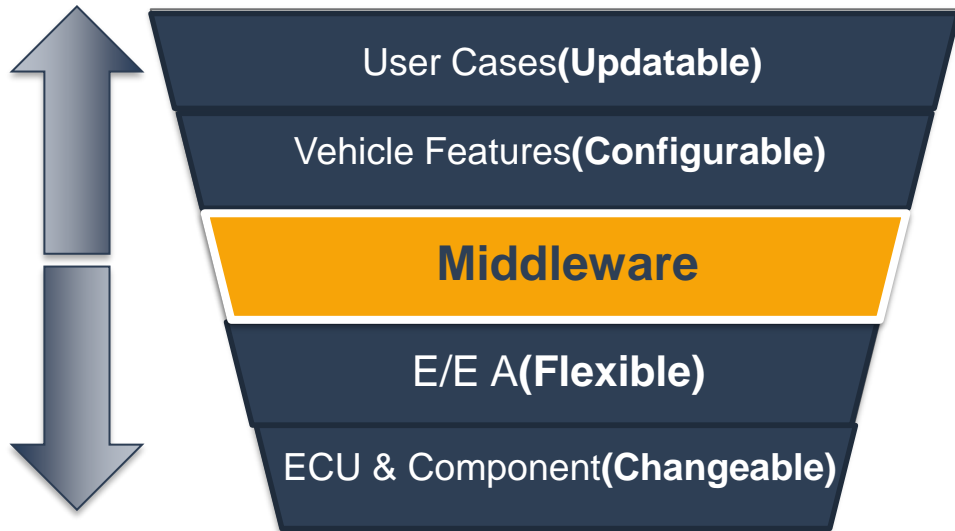# Middleware Transforming E/E A System Engineering
Middleware is from Thin to Thick and will be partial E/E A in the future

E/E A System Design Top-Down

- User Cases(fixed)
- Vehicle Functions(fixed)
- E/E Architecture(fixed)
- ECU & Component(fixed)

Before

E/E A System Design Bottom-Up

- User Cases**(Updatable)**
- Vehicle Features**(Configurable)**
- **Middleware**
- E/E A**(Flexible)**
- ECU & Component**(Changeable)**

Today

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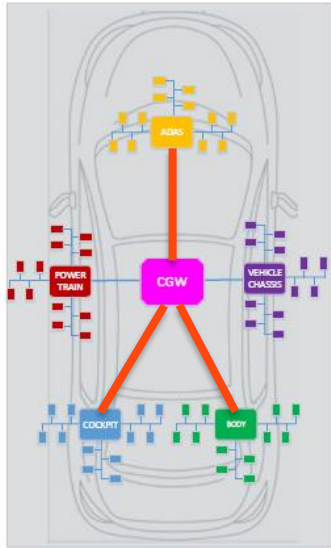
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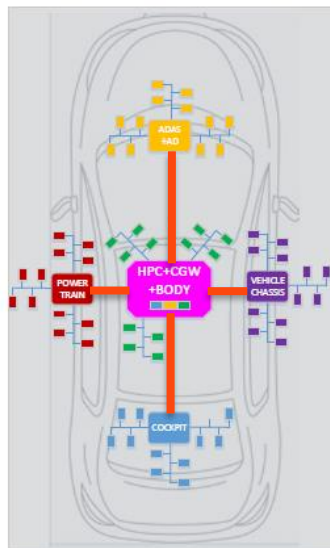
Middleware on Ethernet In-Vehicle Enabling SOA
Ethernet is Dominating Communication in Vehicle
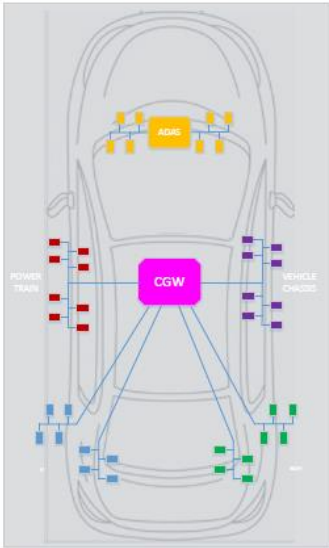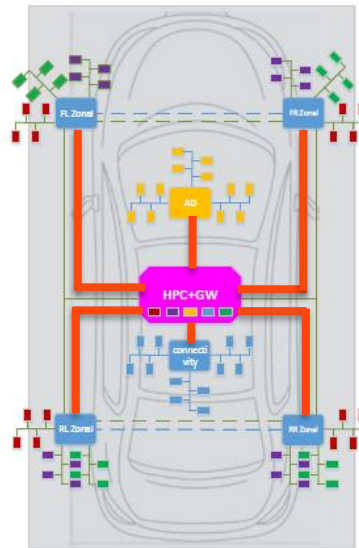

CAN BUS
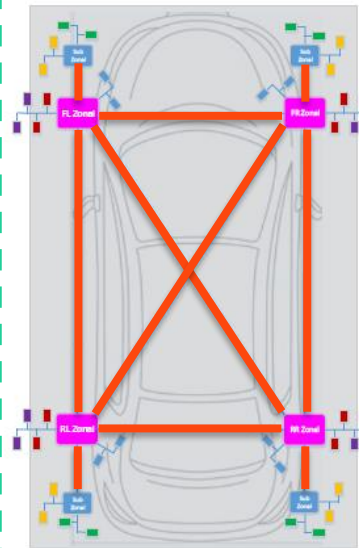
Domain

Domain(Some SOA)

Zonal（Star or Ring network）

Distributed Zonal

>100M Ethernet

2015 -- 2025

>1G Ethernet

2020 -- 2030

>10G Ethernet

2025 -- 2040

AutoSAR is Becoming the Foundation of Automotive Middleware
Automotive is Widely Recognized and Used by COEM and Suppliers

Legend:
- Hypervisor
- Adaptive Platform
- Classic Platform
- Third Party Platform
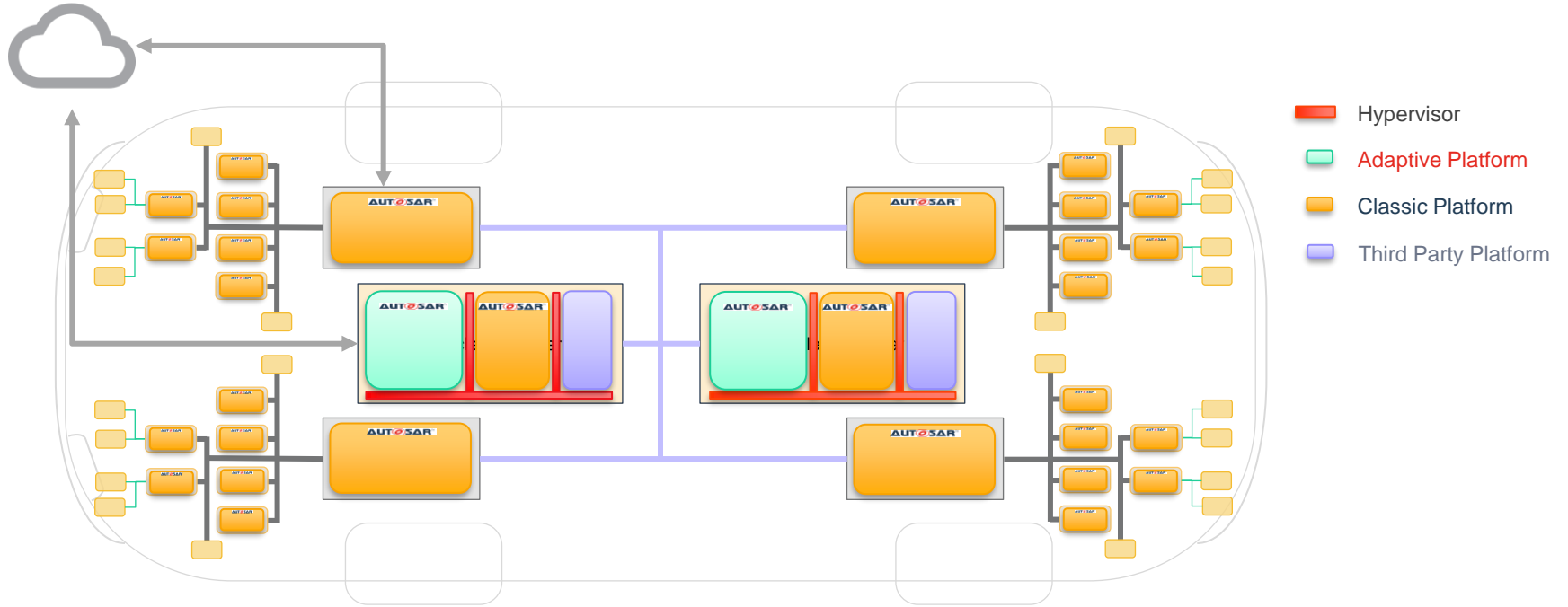
Control-by-Wire is Control-by-Middleware
Control-by-Wire System leads to decoupling Vehicle Body and Chassis

Skateboard Chassis

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A-Core (Performance)

R-Core (Safety & Realtime)

Software & Service Driven

Performance & Computation Functions

Cockpit HPC

Vehicle HPC

ADAS/AD HPC

VIU

VIU

PCU

EPS

ESC

VIU

VIU

VIU
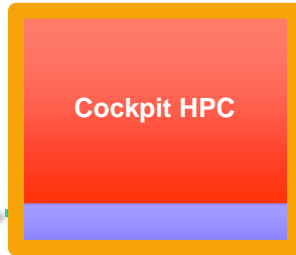
Hardware & Product Driven

Real-Time & Safety Functions
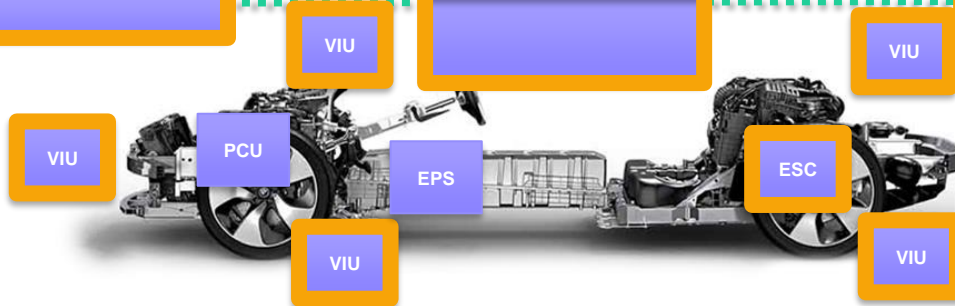
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Middleware Standardizing Data Sharing between Vehicle and Road
Smart Infrastructure Extending SDV User Cases
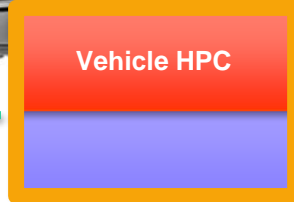

Road Side | Edge Computation | Central Cloud

Road Facilities & Engineering

Government & Partners

Edge Computing Platform

cBox

Radar Camera

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RSU

Sensing

Computing

Application Software & System Integration

MEC Application Server

C-V2X Central Application Server Cloud

Conti & Partners & OEM

Road Infrastructure Mobility Application

5G & C-V2X

5G & C-V2X

Safety Intersection **Smart Highway** **Traffic Efficiency** **Smart Public Bus** **Mobility as a Service** **Smart Street Light**

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Performance ECU(HPC) SW Architecture Overview
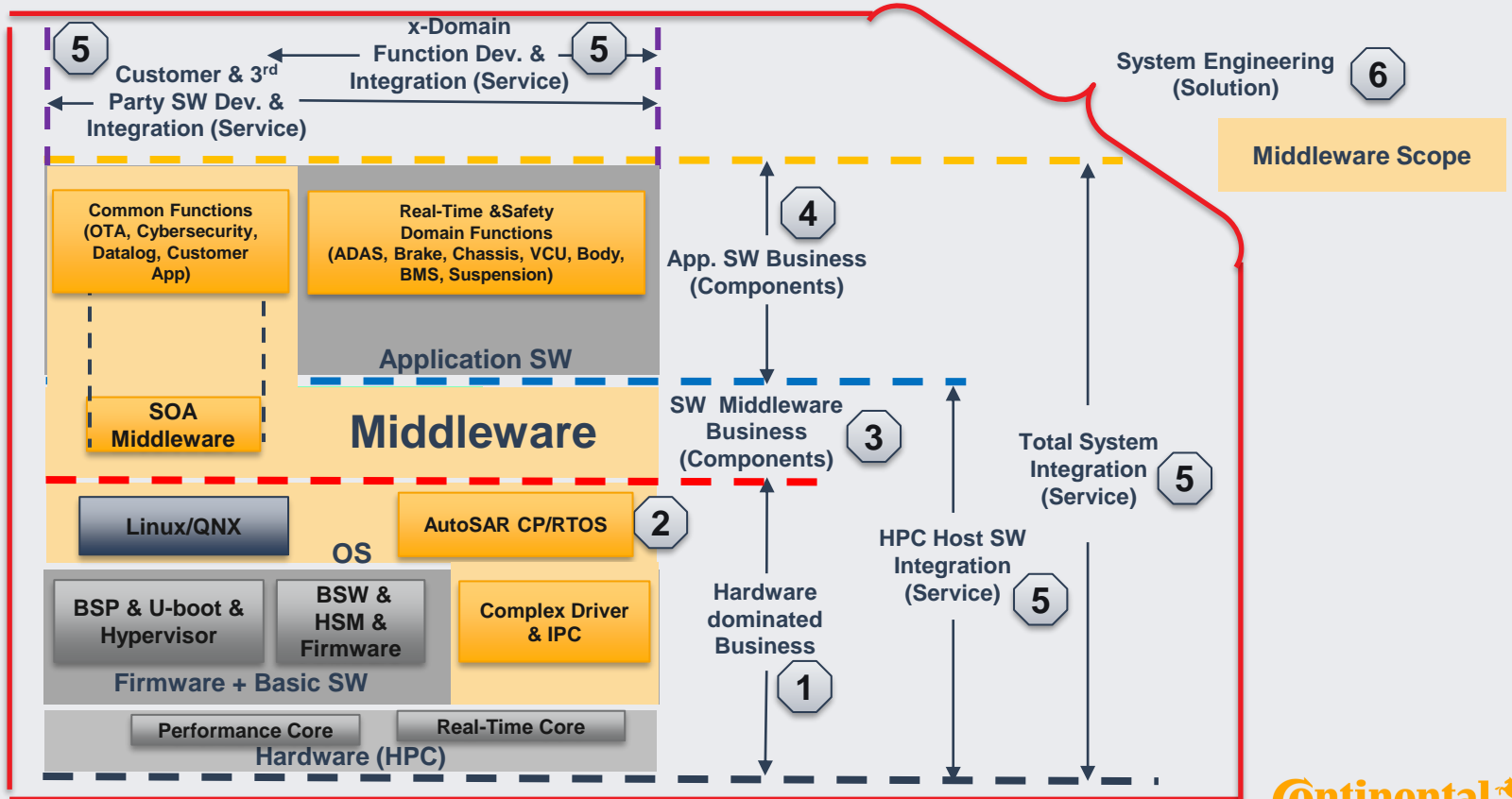
Safety & Realtime ECU SW Architecture Overview
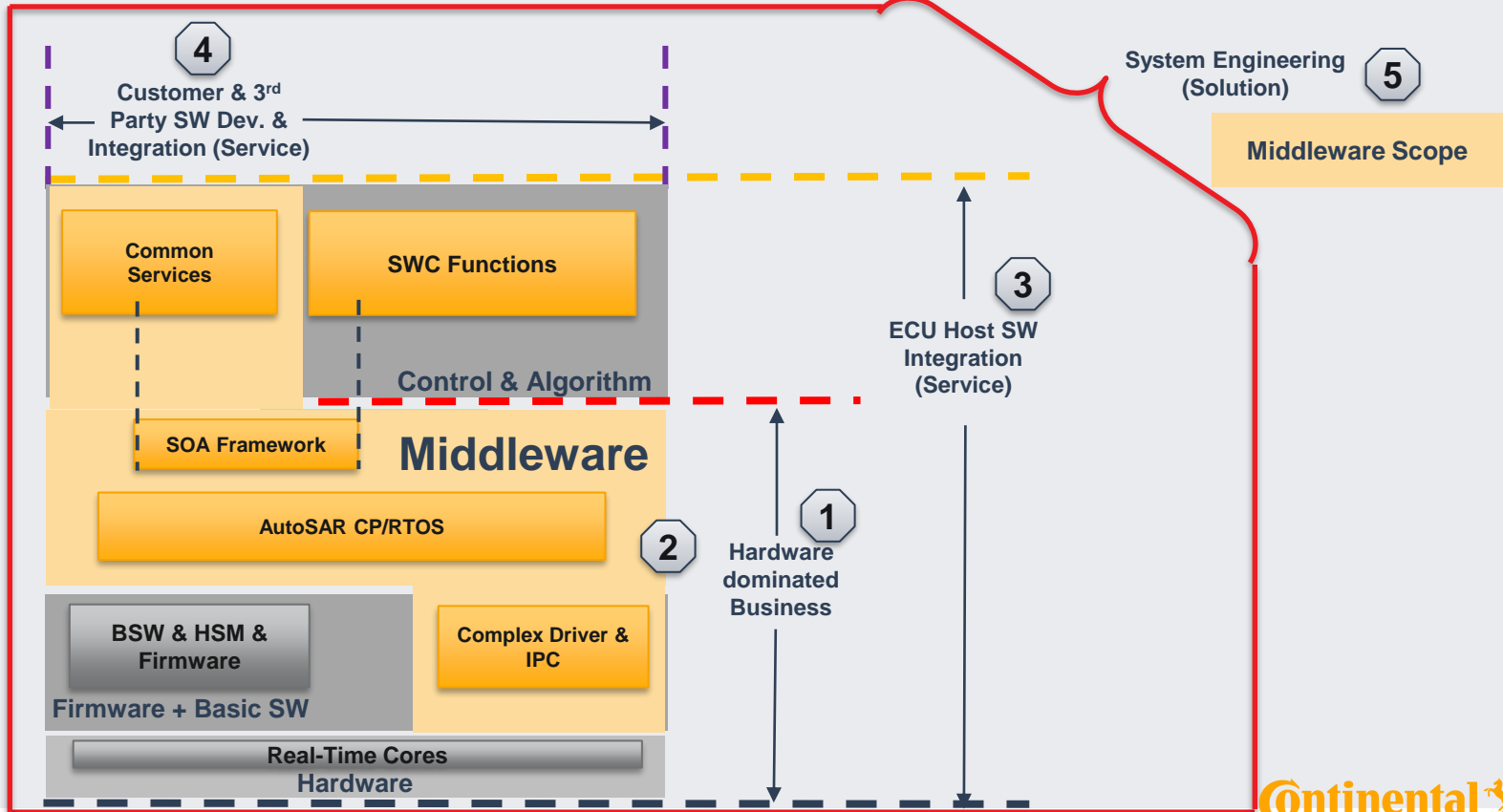
Middleware Enhancing SWC Reusability and Portability
Cross SoC/APU/MCU and Project
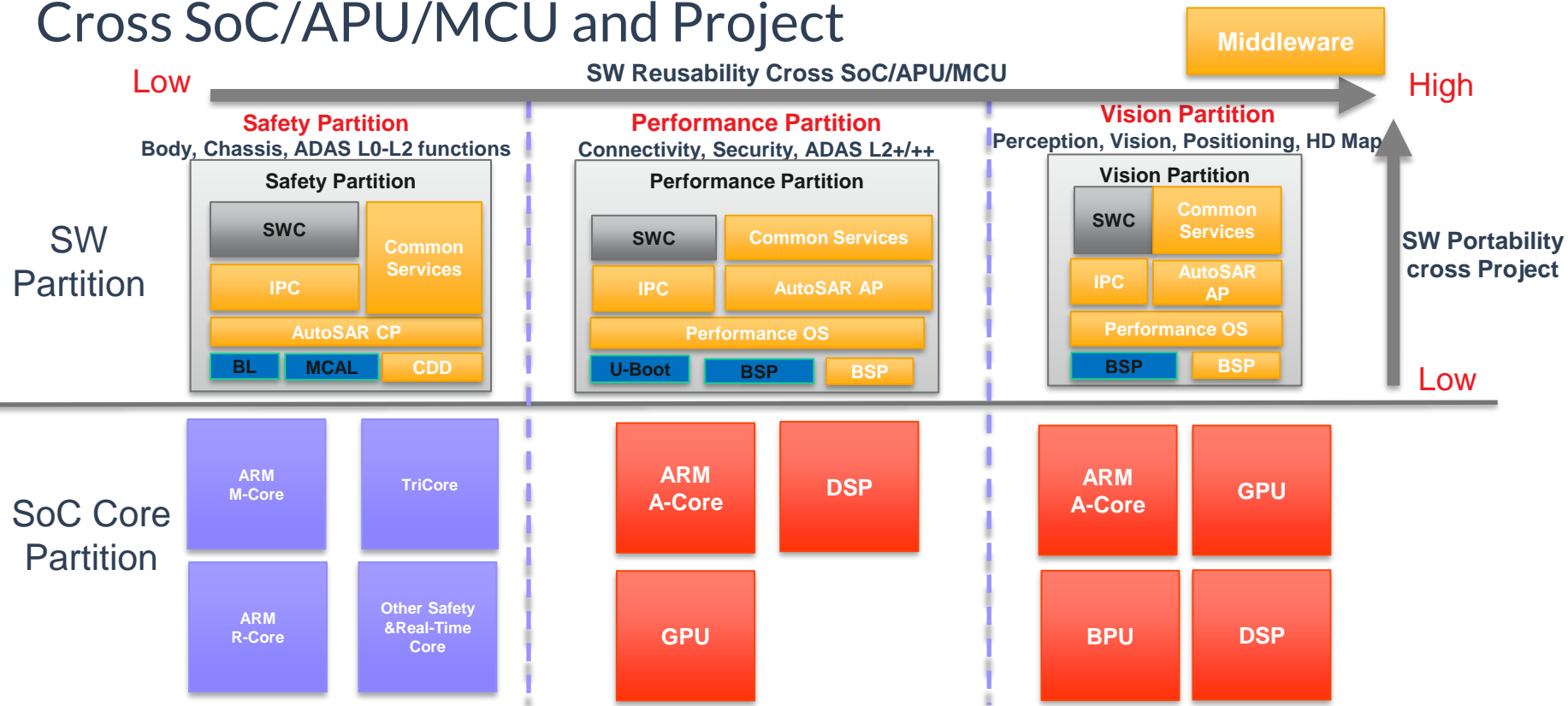
Middleware Enhancing SWC Reusability and Portability
Body HPC Case Overview

Body HPC(Example)

Middleware

Safety Partition

| Body & GW (Conti) | VCU & Body $ Thermal (OEM) | Common Services |

| IPC | AutoSAR CP |
| BL | MCAL | CDD |

Performance Partition

| Connectivity (OEM) | SOA App (OEM) | Common Services |

| IPC | AutoSAR AP |
| Linux |
| U-Boot | BSP | BSP |

ARM M-Core

ARM M-Core

ARM A-Core

ARM A-Core
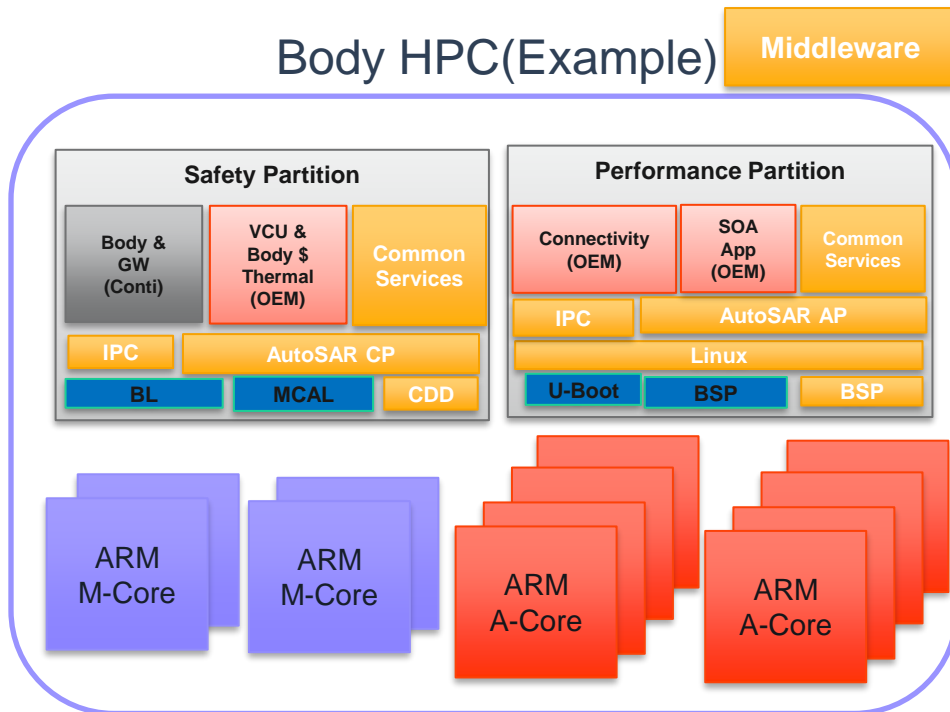
- **With Anchored Middleware**
  - ✓ SWCs could be reusable among different vehicle lines or models by SW adaption work
  - ✓ New SWCs could be add-on easily under middleware framework
  - ✓ New SWCs doesn't need to change E/EA due to SWC decoupling from actual HW via middleware
  - ✓ SoC could be further updated with better performance by middleware SW adaption
  - ✓ Bring flexibility and extensibility to E/E A during car-line lifetime

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Middleware Enhancing SWC Reusability and Portability
ADAS HPC Overview

ADAS HPC(Example)

Middleware

Safety Partition
- Safety Functions SWC
- IPC | Common Services
- AutoSAR CP
- BL | MCAL | CDD

Performance Partition
- Performance Functions SWC | Common Services
- IPC | AutoSAR AP
- Performance OS
- U-Boot | BSP | BSP

Vision Partition
- SWC | Common Services
- IPC | AutoSAR AP
- Performance OS
- BSP | BSP

ARM R-Core
ARM R-Core
ARM M-Core
ARM A-Core
DSP
GPU
ARM A-Core
GPU
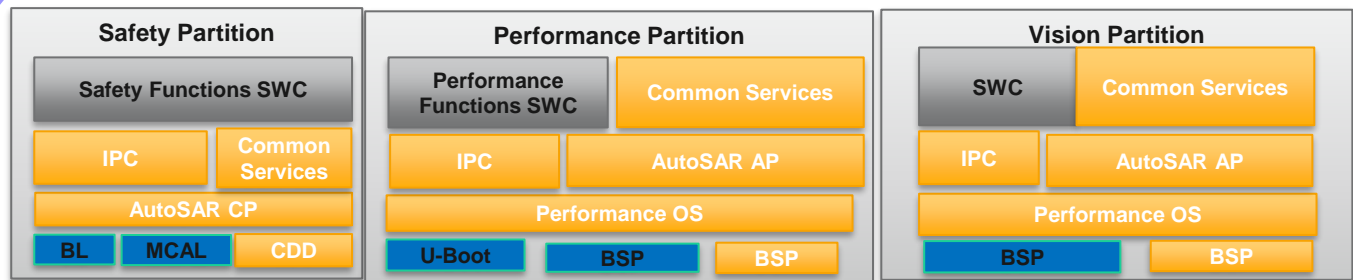
- **With Anchored Middleware**
  - ✓ OEM ADAS functions is easily deployed on AD HPC
  - ✓ OEM functions could be isolated from Supplier Driving Functions
  - ✓ Safety Driving Functions (like AEB) portability is highly enhanced
  - ✓ OEM Driving Fanions could be activated or updated when vehicle is sold to final user
  - ✓ Best balance between Driving Functions reusability and standardization cross project and even HW
  - ✓ Time reduction of HPC application project variant by variant once middleware is anchored in pilot project
  - ✓ High SW Synergy between different SoC

What Makes Middleware Excellent
Middleware is NOT Only Software Development

Advanced & System Engineering

- Project Management
- Requirement Engineering
- SW Architect Engineering
- Safety & Security Engineering
- Supplier/Partner Management
- CI/CT Solution
- SW System Testing Solution
- System Integration Solution
- Software Maintenance Solution
- SAFe Team and Process Excellence
- Customer Engineering Solution

Software Engineering

- SW Requirements
- SW High-level Design
- SW Low-level design and Coding
- SW Module Test
- SW Integration Test
- SW Validation Test
- SW Release Process

System Integration Engineering

- System Integration
- System Integration Test
- Vehicle Test
- Test Data Analysis
- Test Software Development

Customer Engineering

Excellence Middleware Release

Middleware Design   **Middleware Development**   **Middleware Deployment**
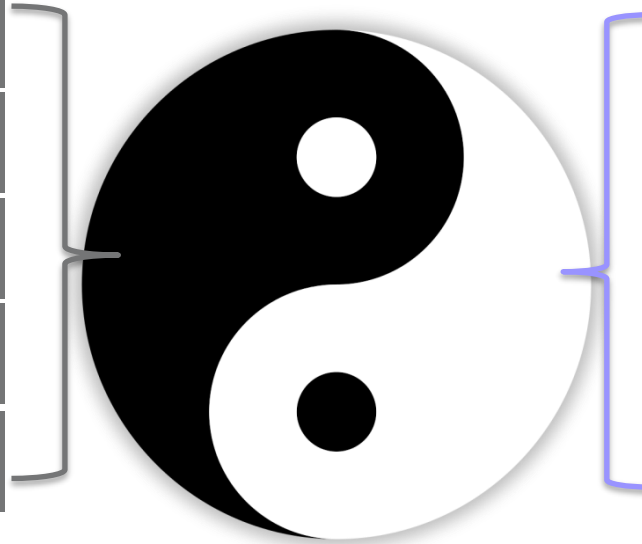
What Makes Middleware Success
Middleware is Lubricant and Glue of SDV E/E Architecture

Engineering Excellence

Lubricant

Hardware Independent
Flexible
Scalable
Compatible
Upgradable

Glue

High Performance
Safety
Security
Compliance
Robustness

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Takeaways

1 Unified Middleware deployed on HPC and ECU is highly increasing **portability and reusability** of application software module

2 Middleware is far beyond SW module with a single solution. More importantly, middleware is an elegant engineering process of **complex software system development, integration and delivery**

3 **Engineering Excellence** is magic code leading middleware to success

4 **AutoSAR** framework, both CP and AP, is **cornerstone of Automotive Middleware** which is key enabler of Software Defined Vehicle

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