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Pune, 05th Oct 2023

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Prepared for

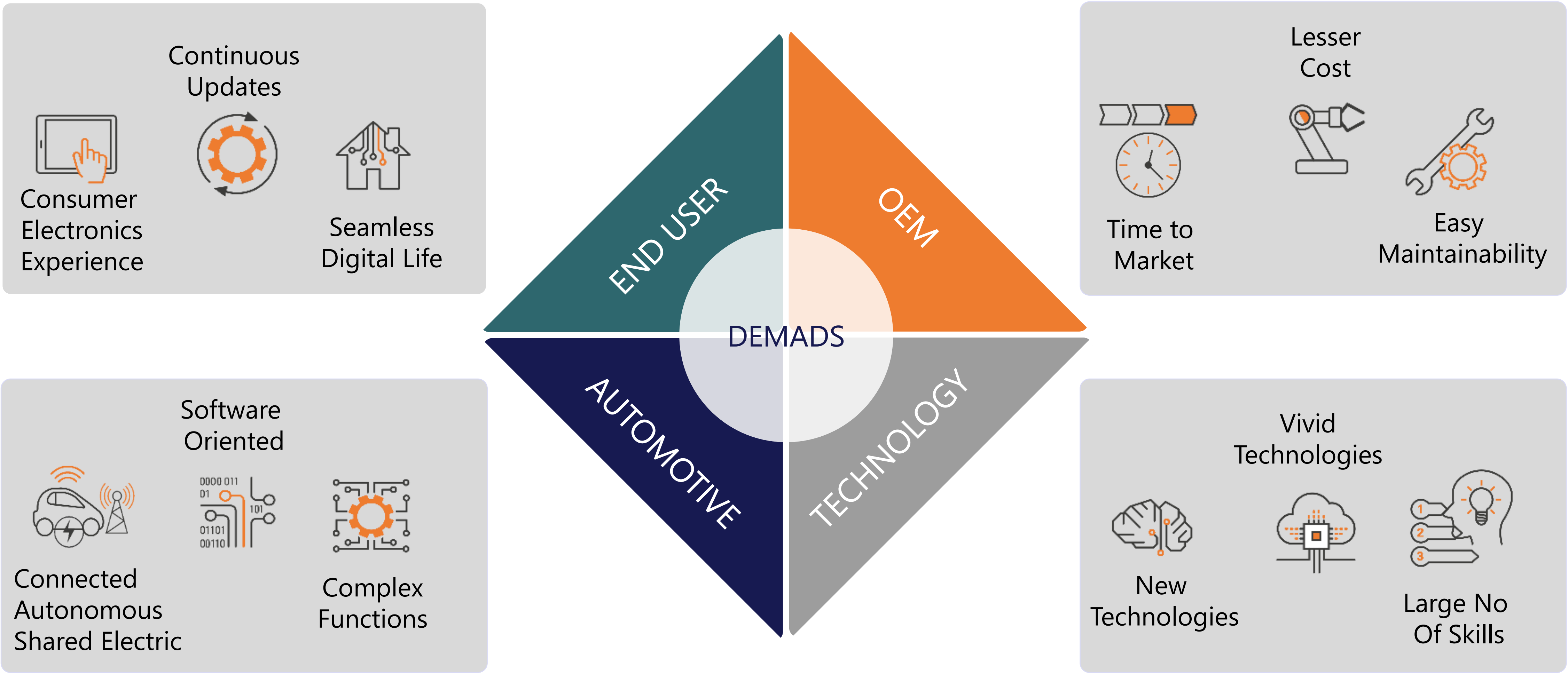
MathWorks AUTOMOTIVE CONFERENCE 2023 India

MathWorks®

Developing Vehicle Features for SDV with Cross-Domain Computing

Next-Gen E/E Architecture

Automotive industry is currently driven by CAUSE
Demands are being raised in 4 dimensions



While addressing 4-dimensional demands solution must include important growing challenges within Automotive industry

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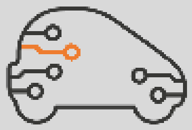
WIDE RANGE OF MOBILITY

Passenger | Commercial

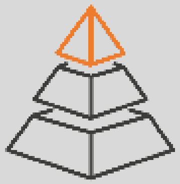
High | Mid | Low (Variant)

GROWING INFLUENCERS

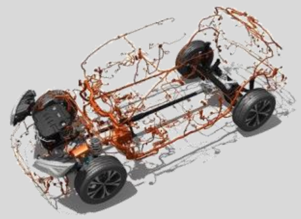
EE Architecture



Complexity

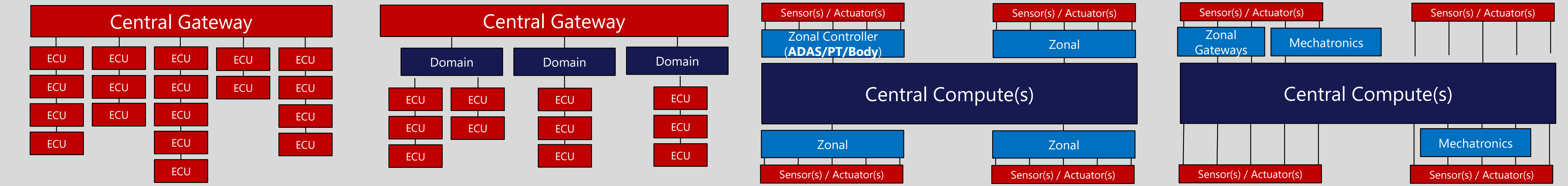


Wiring



EVOLVING EE ARCHITECTURE

Distributed | Domain | Zonal | Central



One SOLUTION for all multi-dimensional requirements **SOFTWARE DEFINED VEHICLE**

Realizing SDV Architecture for future automotive requirements

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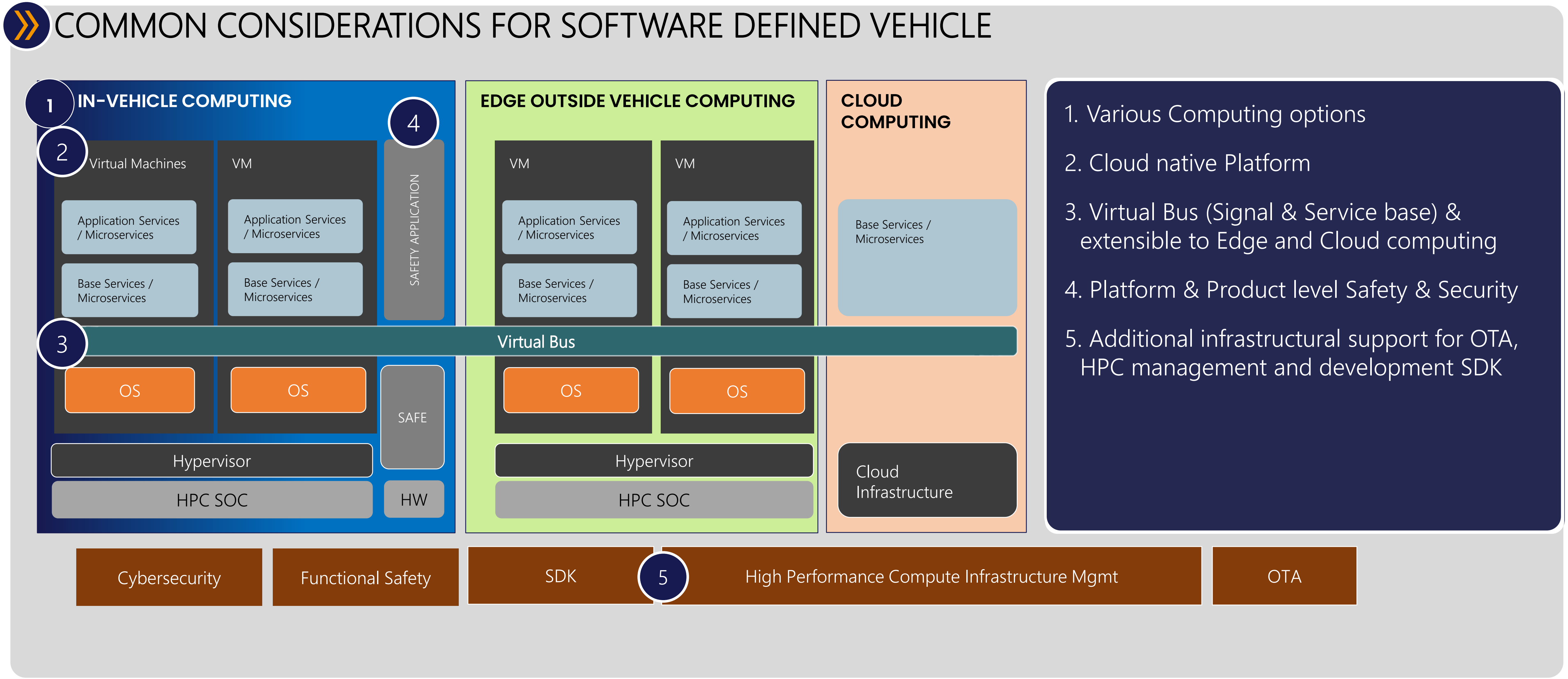

OTA: Over the Air, SDK: Software Development Kit,, SOC: System on chip; SOA: Service oriented architecture; VM: Virtual machine; HPC: High Performance Computer;

FEV Software Defined Vehicle Architecture and Development Methodology extends to Edge and Cloud as a scalable platform

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Containerize

BUSINESS SERVICES

DIGITAL TWIN

IN-CAR SERVICES

VEHICLE TO VEHICLE

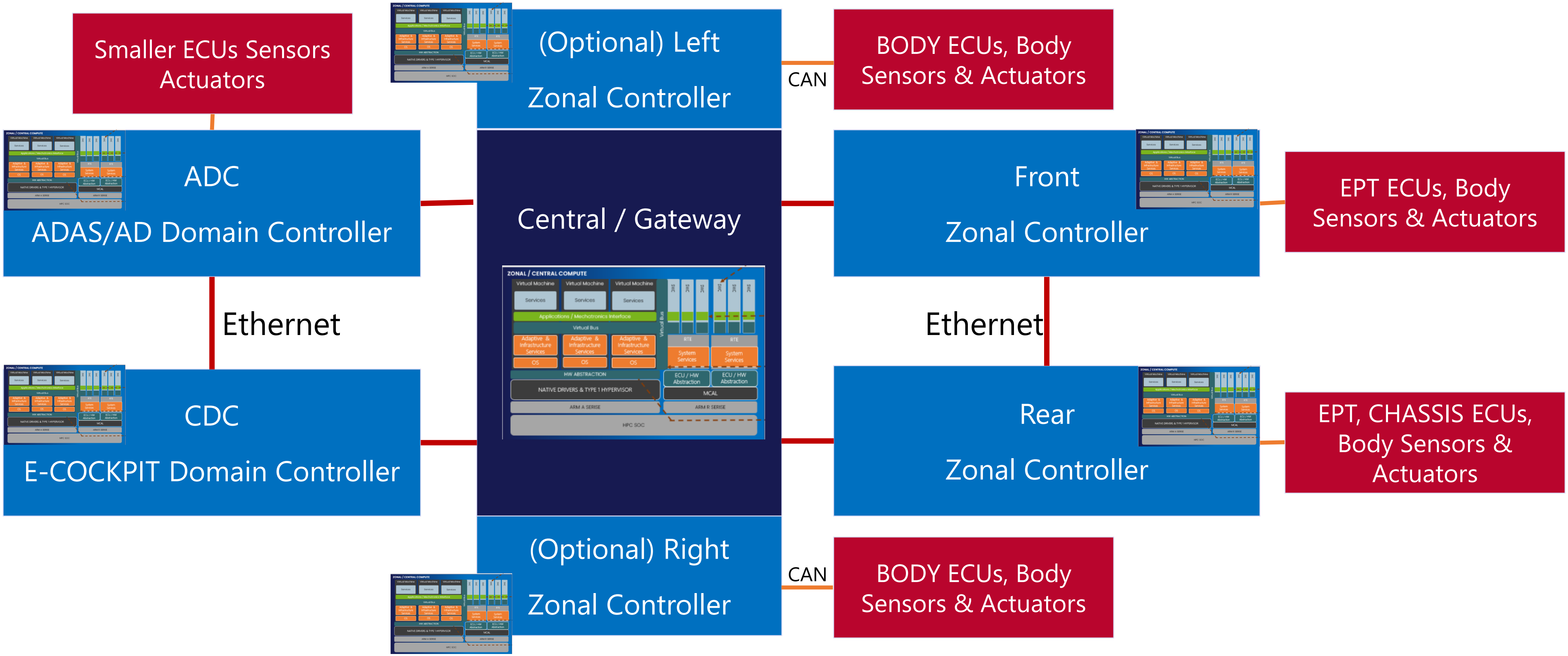
VEHICLE TO INFRA

SDK | Cyber Security | Functional Safety | HPC INFRA MGMT | OTA

OTA: Over the Air, SDK: Software Development Kit,, SOC: System on chip; SOA: Service oriented architecture; VM: Virtual machine; HPC: High Performance Computer;

MOVING TO CENTRAL & ZONAL ARCHITECTURE

Typical EE Architecture by various OEMs for 2024 to 2026



System & Software Architecture to be design as reusable services

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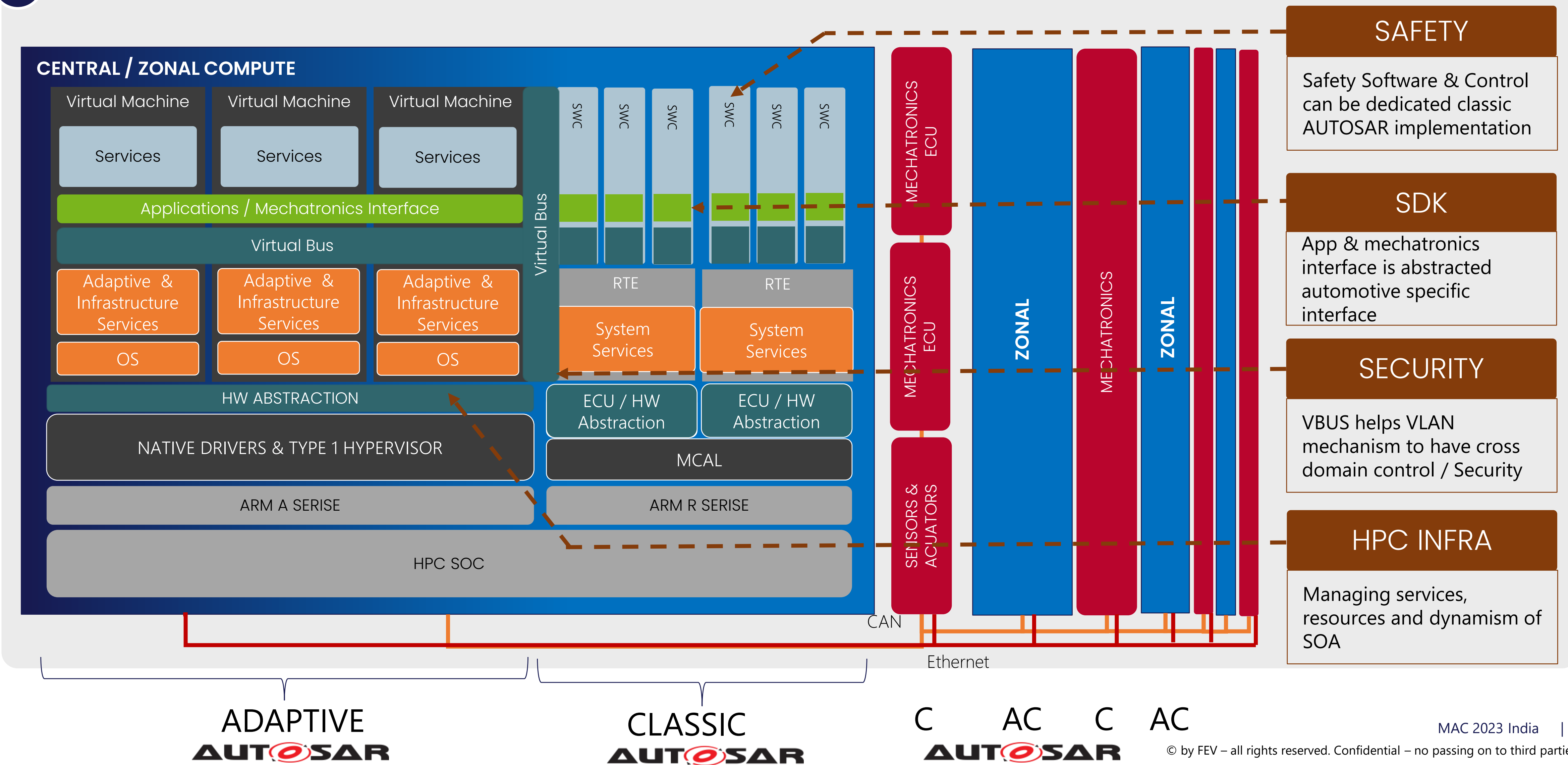
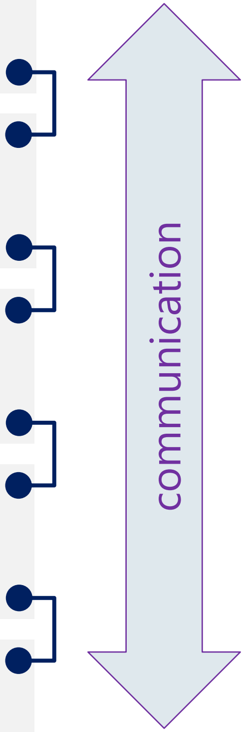
UNIFIED SYSTEM & SOFTWARE ARCHITECTURE



Hierarchy levels in modern E/E architecture
How functions can be distributed across computational options

	Function	Computation	Communication	Updating / Change
Cloud	complex / fleet-oriented functions	fully scalable, cloud-native	Internet Protocols	frequent and continuous update
Central Compute*	in-vehicle centralized high-level functions	limited scalability. high performance	Internet Protocols	high update / change
Zone Controller	spatially boxed multi-domain functions, I/O concentration	Restricted/medium performance	Internet Protocols, classic automotive (CAN (FD), LIN, ...)	low update / change
Local Controllers	specific & local single task control	restricted performance	classic automotive	No/low update / change
Sensors & Actuators	highly specific	low-level	classic automotive	no update / change



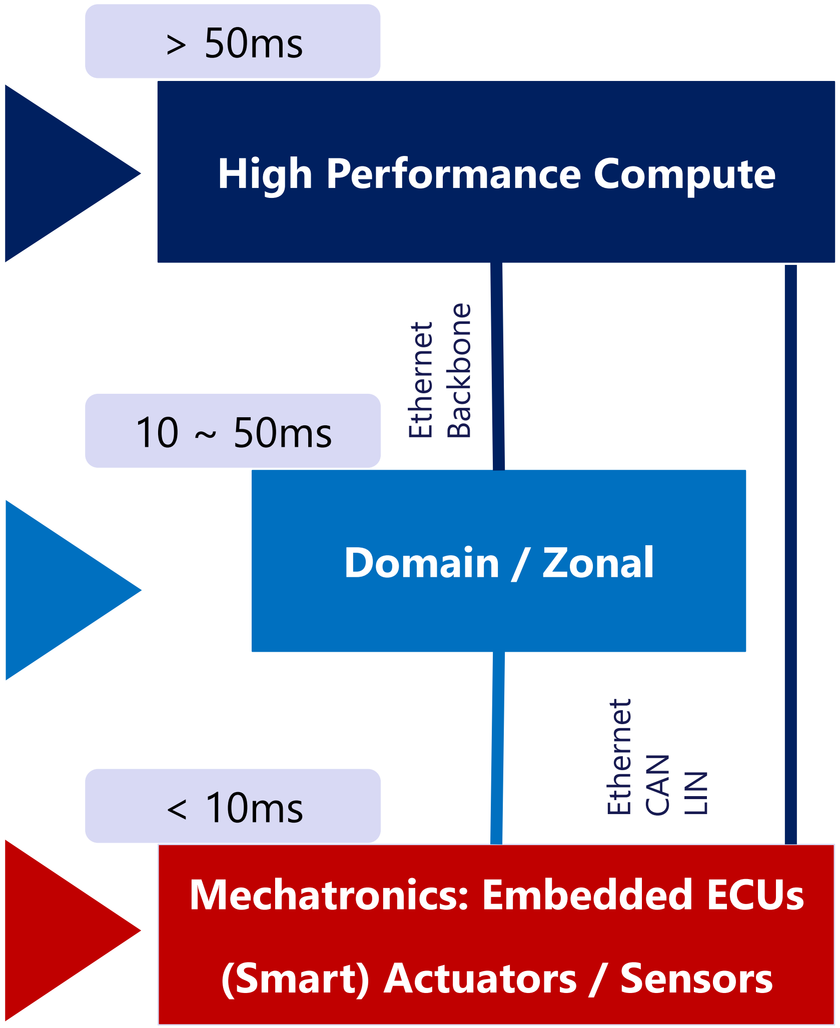
*) not necessarily means one single computing instance ("vehicle computer")

Next Generation In-Vehicle EE Architecture combines Central, Zonal, Domain and Legacy Controls

- Features/functions with high demand for
  - Computing power, on-chip accelerators
  - Updateability / Upgradeability
  - Data exchange
- Virtualized cross-domain Application SW independent from HW
  - Mixed criticality: safety and non-safety functions
  - Service-Oriented Architecture

- Dedicated domain controller with specific requirements (e.g. AD, VMC)
- Local cross-domain features/functions on zonal controller
- Simplified / reduced wiring harness
- Transfer zone between service- and signal-orientation

- Legacy sub-systems & ECU (cost, availability, eco-system)
- Smart mechatronics with high demand for
  - Safety
  - Hard real-time, start-up time
- Signal-based



SOFTWARE DEFINED VEHICLE FEV DEMONSTRATION

FEV runs a technology initiative for core platform development meeting the SDV targets

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KEY VALUES

E/E Consolidation

Feature Increase

Automotive Fit

CORE TECHONOLGIES

PROJECT TARGETS

Manage System Complexity
Via consistent SE for SW & EE design

Increase Software excellence
Usage of Cloud native design principles, app abstraction, virtualization and new SW frameworks to run cross domain applications
(Re)- Engineer of (legacy) features from different domains into SOA architecture

Create E2E understanding of the dataflow
Buildup of cloud backend, middleware (on-/offboard) and virtual bus

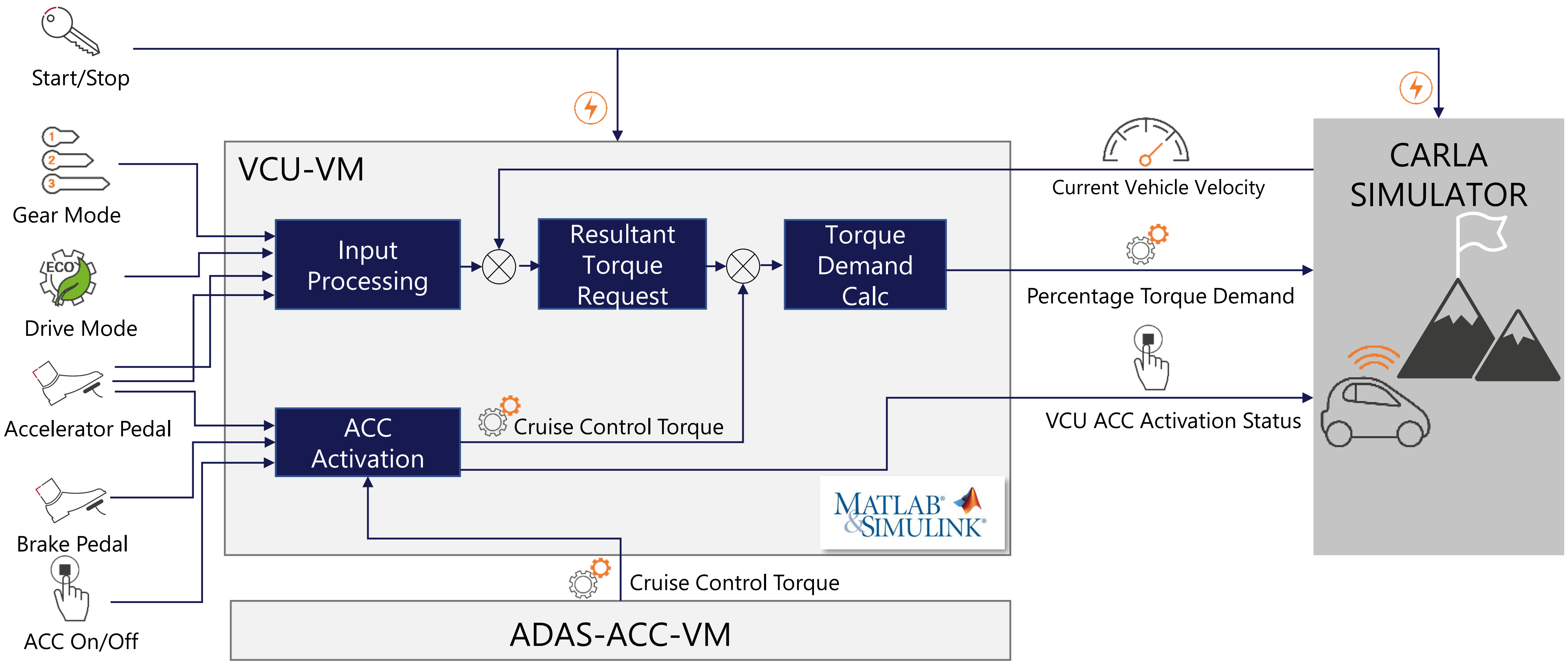
Extend skills in automotive grade development
Analysis and Implementation of safety & security mechanism

SDV Demonstrator

Scalable, modular demonstrator to test, improve and showcase the project objectives

- Demonstrate mix criticality load on HPC
- Redesign legacy functions into SOA Architecture
- Create virtual bus for maximal abstraction of SW

Migration of Legacy Function to SoA: *E-Drive Torque Path Arbitration*



Integration of vehicle function in VCU Cluster on HPC with Autosar Adaptive for SOA architectural design

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Legacy to SOA architecture approach:

SYSTEM DESIGN

- Use Cases elaboration
- Features definition
- Requirements derivation
- System design

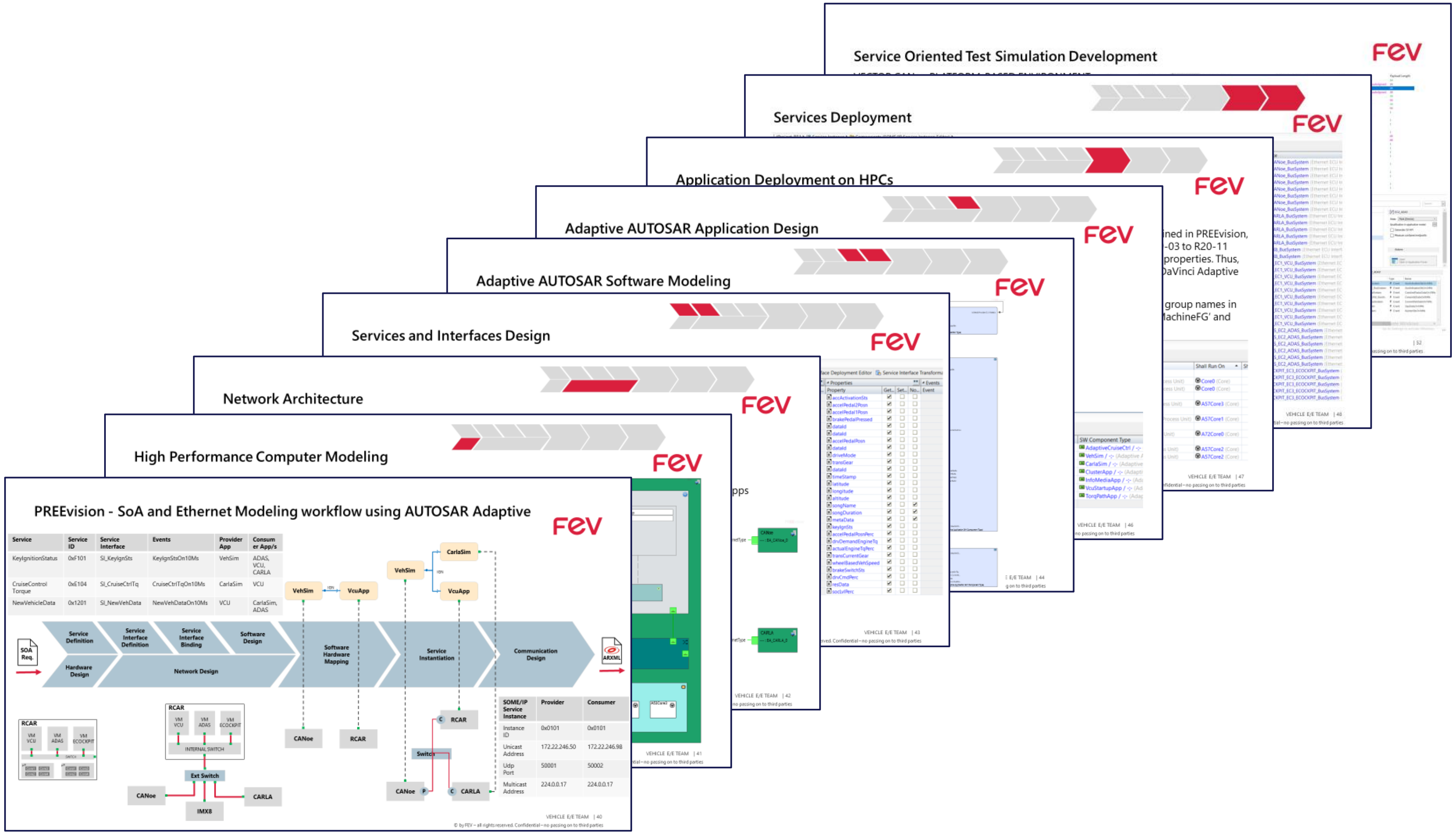
SOFTWARE DESIGN

- Service Architecture Definition
- Application Design in MATLAB/Simulink
- Signal Modeling including timing req. analysis
- Deployment configuration of Autosar Adaptive stack

INTEGRATION:

- Application implementation
- Integration with Vector Adaptive Stack
- Deployment of QNX OS and Hypervisor
- Set up of HIL Demo

Continuous improvement along the entire workflow via consequent monitoring of best practices and lessons learned



ADAPTIVE AUTOSAR

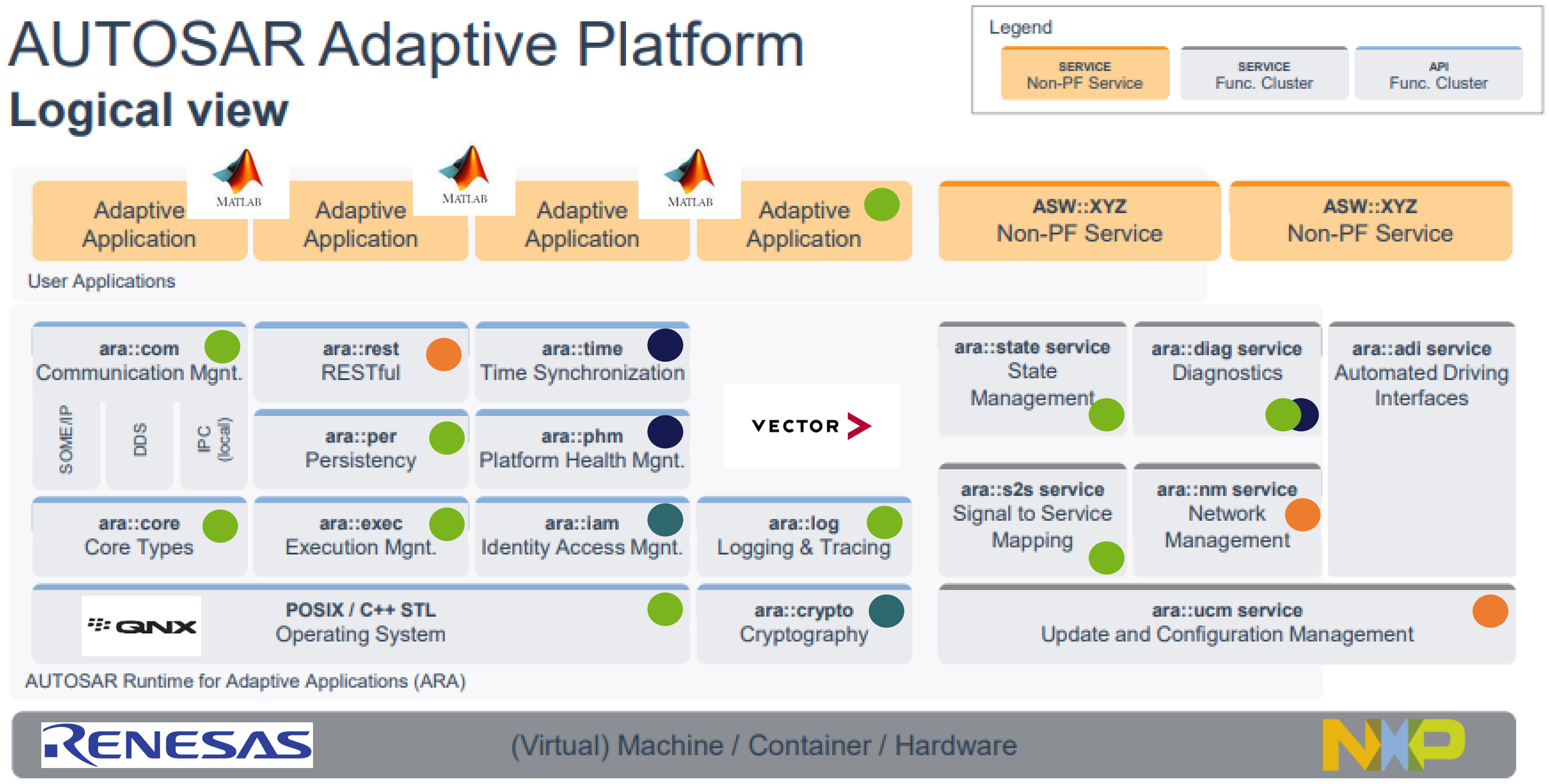
Adaptive AUTOSAR: FEV Partnership Landscape

BASE PLATFORM

SCALABLE APPROACH

EXPLOITATION ROADMAP

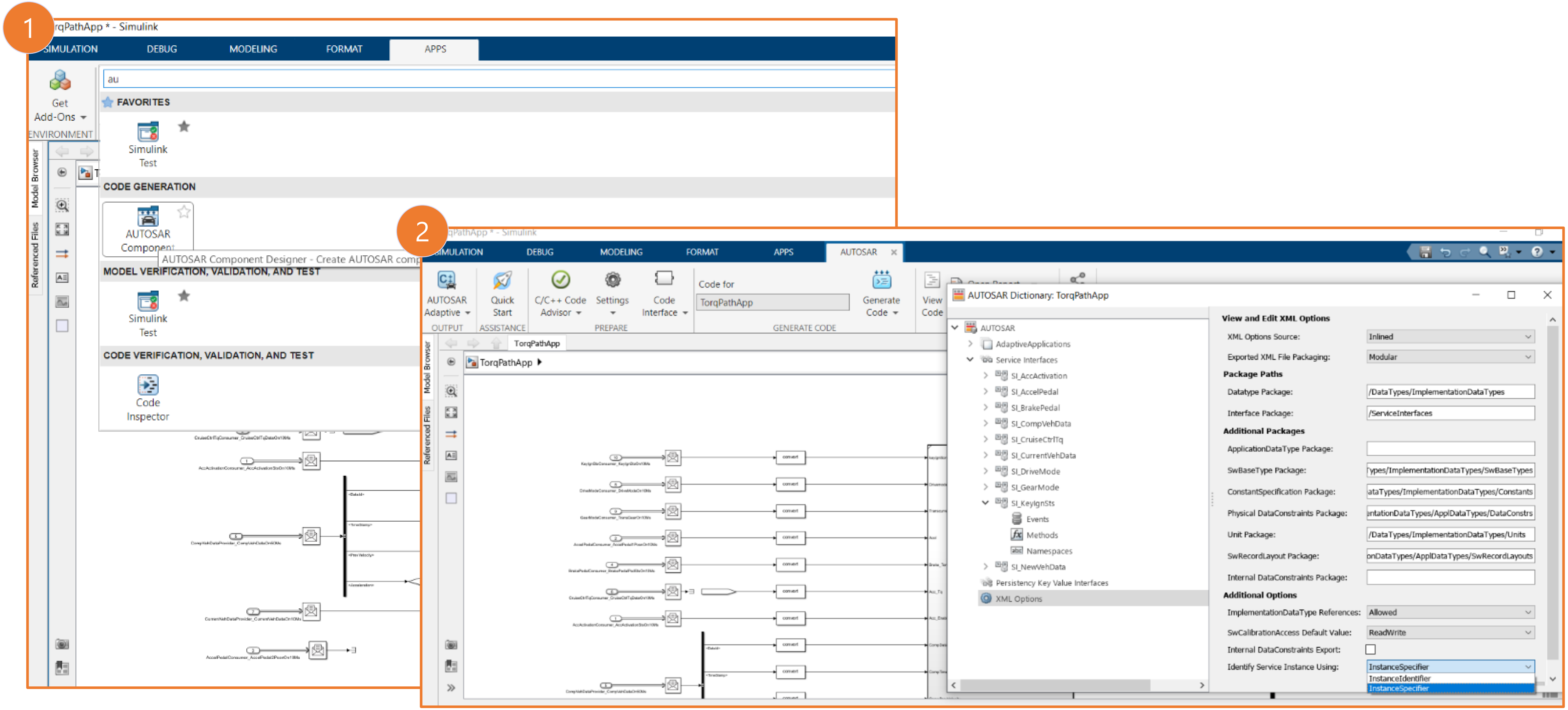
	2023	2024
Base Platform	High	High
Functional Safety	Mid	High
Cyber Security	Low	Mid
Over The Air Update	Mid	High



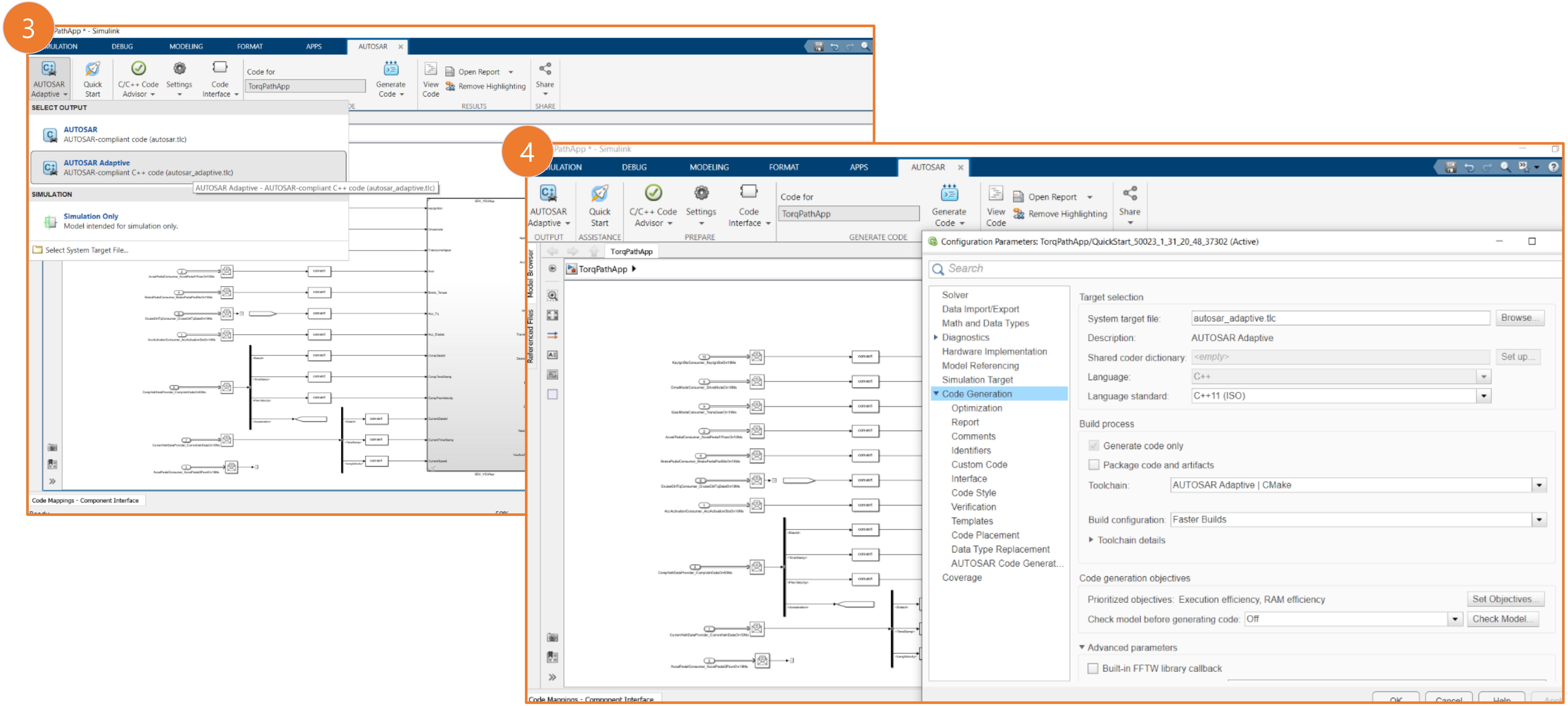
SOVD (Service Oriented Vehicle Diagnostics) -> Currently creating production specification

Ref: autosar.org

Realizing the Legacy Functions as Adaptive SWC in Simulink



Adaptive AUTOSAR compliant C++ Code Generation in Simulink




THANK YOU

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