Mission Critical – The importance of clear problem statements for Innovation Engineering

Andreas Aal
MaaS / TaaS HW/SW Development

Commercial Vehicles

What do we want?

Shaping the future of autonomous mobility SW-Driven-BMs

Configurable, flexible platform for SW based services fully compliant to the digital IoT ecosystem

Autonomous Driving

Level 5
Fully automated

Level 4
Highly automated

In ODD

Level 3
Partially automated

Level 2
Today's driver assistance systems

Level 1
Base level assistance systems

Level 0
Driver only

Mobility-as-a-Service

Digital Urban Mobility

- Door-to-door, efficient & safe
- Shared mobility vs. ownership
- Traffic relief through pooling

Transport-as-a-Service

Goods Transport of Tomorrow:

- Efficiency gains in the last mile
- Response to driver shortage
- Flexible use 24/7, 365 days/year

semi

SEMICON® EUROPA 50 YEARS

MaaS/TaaS vehicles operate fully autonomous
in a limited Operational Design Domain (ODD)

L2+/L3 private-use		L4 AD MaaS/ TaaS
Limitation to **specific road classes** → fragmented ODD	VS	Continuous operations with the ODD
Handover to driver to cover system limits	VS	Remote guidance in rare unclear traffic situations
Mainly highway	VS	Urban focus

Modular solutions tailored to customer needs

- cities, service operators, logistic firms ...

Layer 1

Layer 2

Layer 3

Layer 4

DIGITAL DRIVER

SMART AUTONOMOUS VEHICLE

FLEET MANAGEMENT

MOBILITY SERVICE

Full Stack

Fleet-as-a-Service

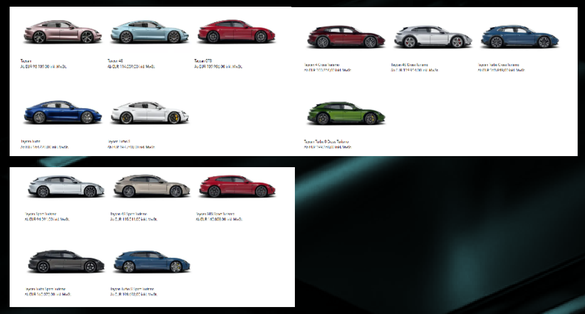
eVehicle-as-a-Service

semi

SEMICON® EUROPA 50 YEARS

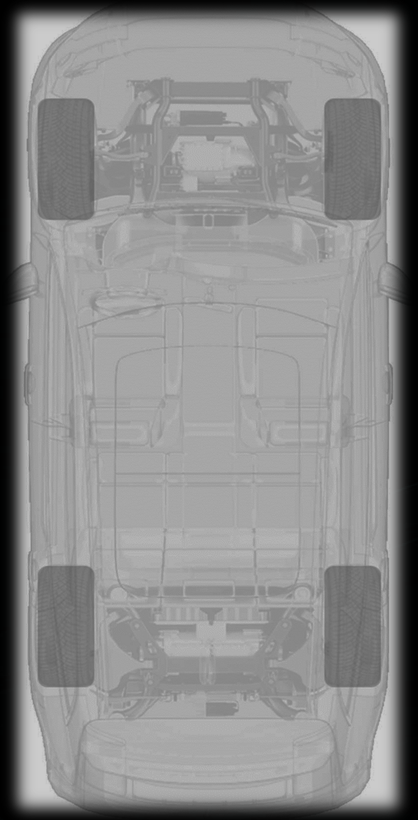
Where do we come from?

Automotive – many semiconductors & high product complexity

	Apple iPhone 15	SONY PlayStation 5	Porsche Taycan
			
Number of main variants[1]	4	2	14
Units sold per year	~ 225.000.000	~ 19.000.000	~ 44.000
Number of semiconductors	Approx. 35[1]	Approx. 130[1]	Approx. 8.000[1]

1: based on Porsche Consulting teardown

Automotive – product complexity & tech node capacity competition



NODE SIZE	2022	2026	CAGR*		TREND**
			Demand	Capacity	
> 250 nm	●●●	●●●	+2.4%	+0.0%	↘
> 180 nm	●	●●	+3.3%	-0.7%	↘
> 130 nm	●	●	+3.4%	-0.7%	↘
> 90 nm	●	●●	+3.1%	-1.4%	↘
> 45 nm	●	●	-1.3%	+3.7%	↗
> 28 nm	●	●	+7.3%	+3.1%	→
> 16 nm	●	●	-10.7%	-7.0%	→
> 10 nm	●	●	+8.4%	+5.7%	↘
≤ 10 nm	●	●	+18.3%	+16.6%	→

● No shortage ● Minor shortage ●● Medium shortage ●●● Major shortage

* Compound annual growth rate 2022–2026 |
** Based on development 2022–2026, subject to creation of further new capacities

Source: omdia, Q3/2022 Silicon Market Trackers, Porsche Consulting Analysis

semi

SEMICON® EUROPA 50 YEARS

Automotive – product complexity & tech node capacity competition

Classical proprietary

black box Tier1 ECU

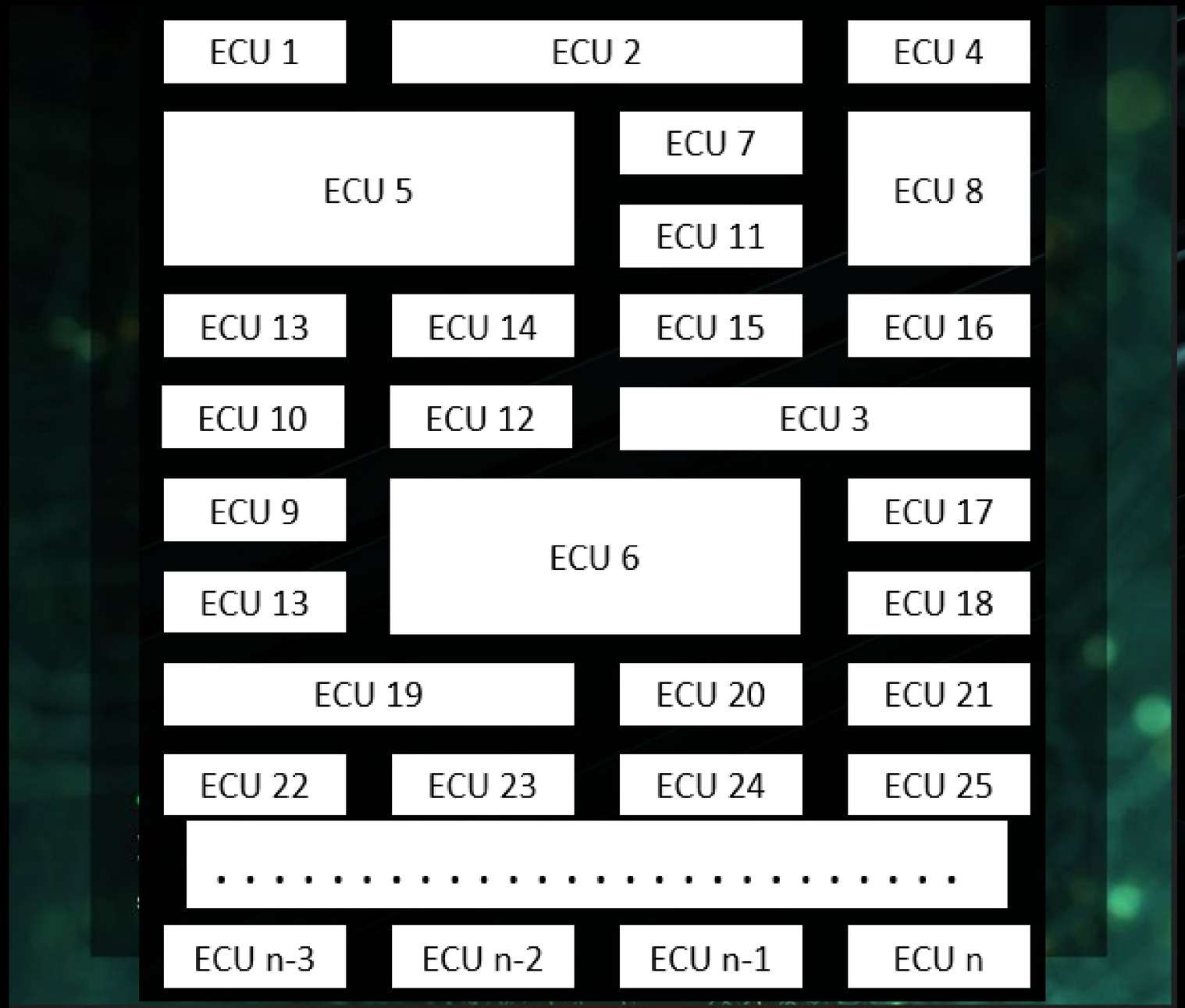
design mismatch

leads to **increased**

vulnerability during

supply chain

disruptions



semi

SEMICON EUROPA 50 YEARS

Selected automotive electronics shortages – flashback & outlook

LL: shortages are a regular part of the industry - are they managed sufficiently?

A. Aal, SEMICON EUROPA, FMF, 2022

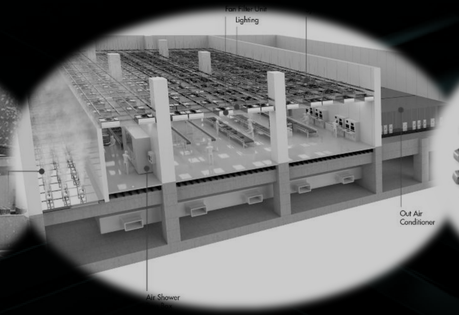
2010
Cause: environment
Eyjafjallajokull

2011
Thailand Flood
Cause: environment

2012/3
environment
Fokushima
Memory/Displays/PCBs

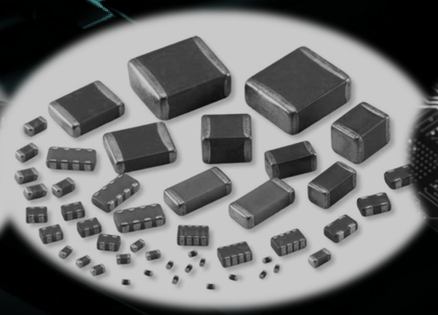
2012/3
Gold to Copper Wire Bonding
quality issues

2014/5/6
market consolidation
Fab Relocations
Buffer stocks too low

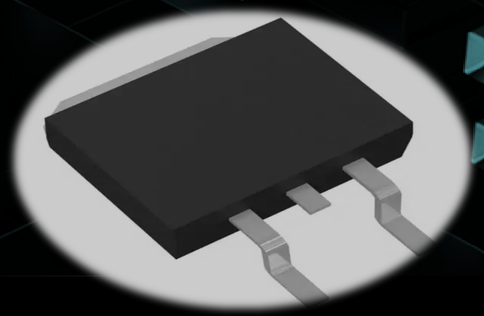


2014/5/6
Semiconductor PTNs ↑
market consolidation

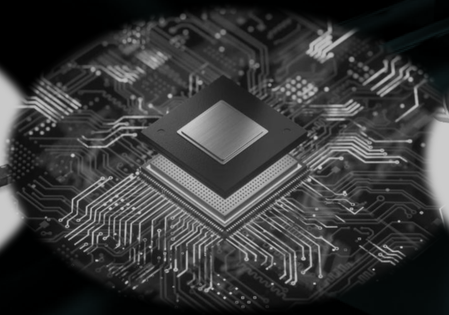
2017/18
market consolidation
MLCC shortage



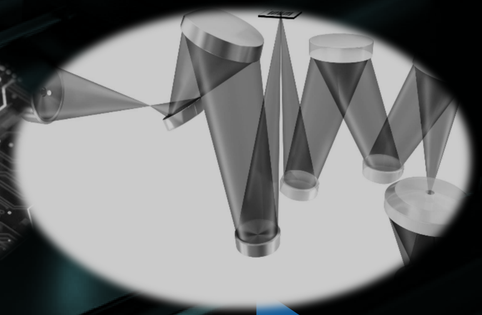
2018/2019
MosFet 15-20% prices ↑
demand vs 6/8 inch capacity gap



2020/21/22
Covid-19 after-wave
global chip shortage



24/25
Geopolitical instabilities
Tool / process gas (Neon) shortage

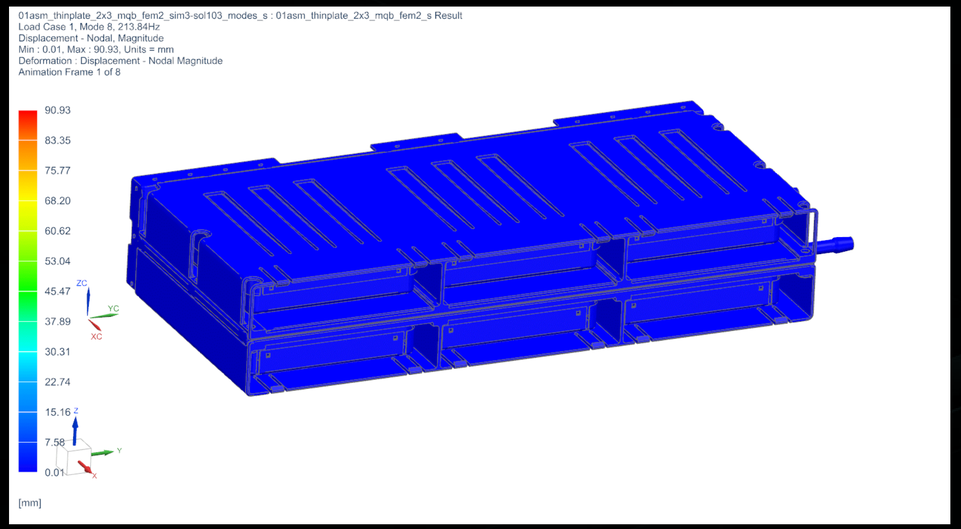


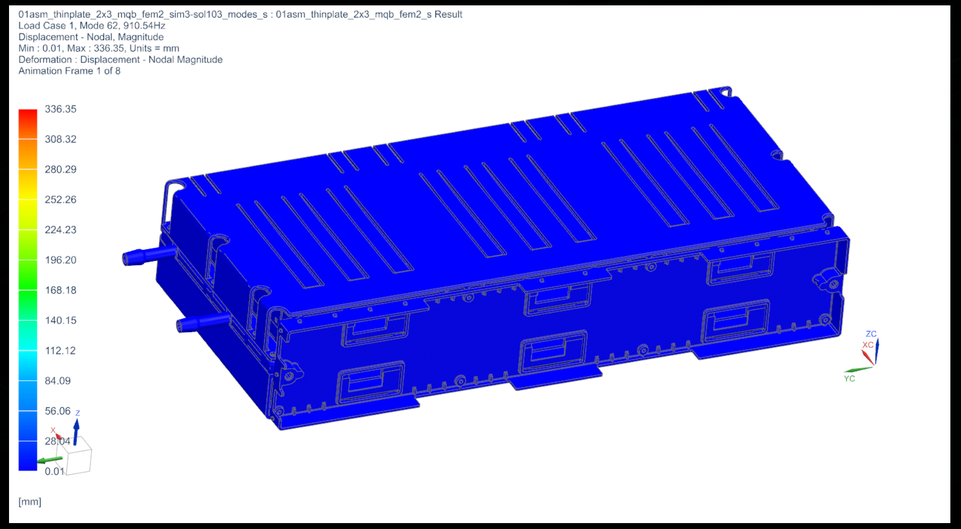
24/25
Drought Probability ↑
environment

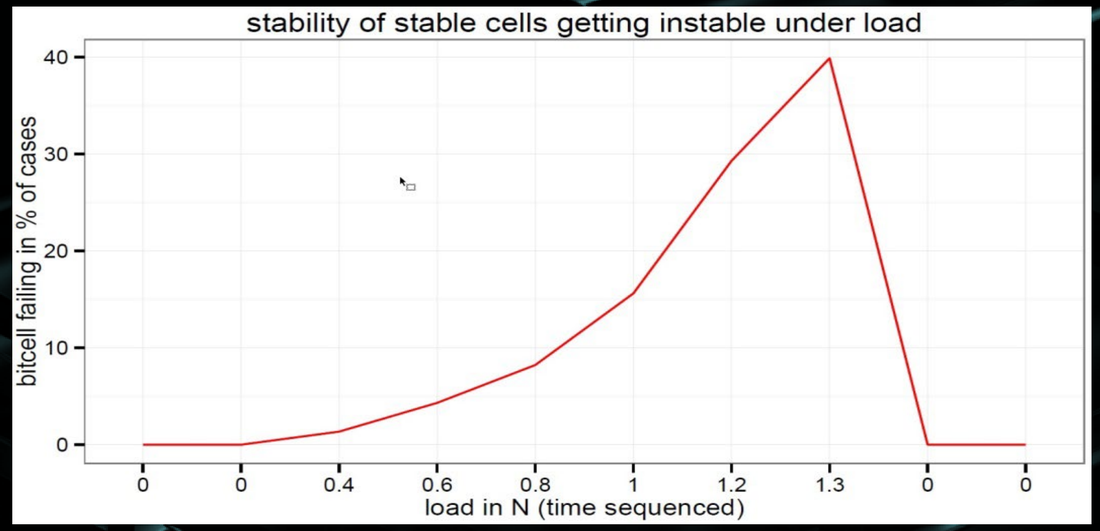
Automotive – Integration complexity

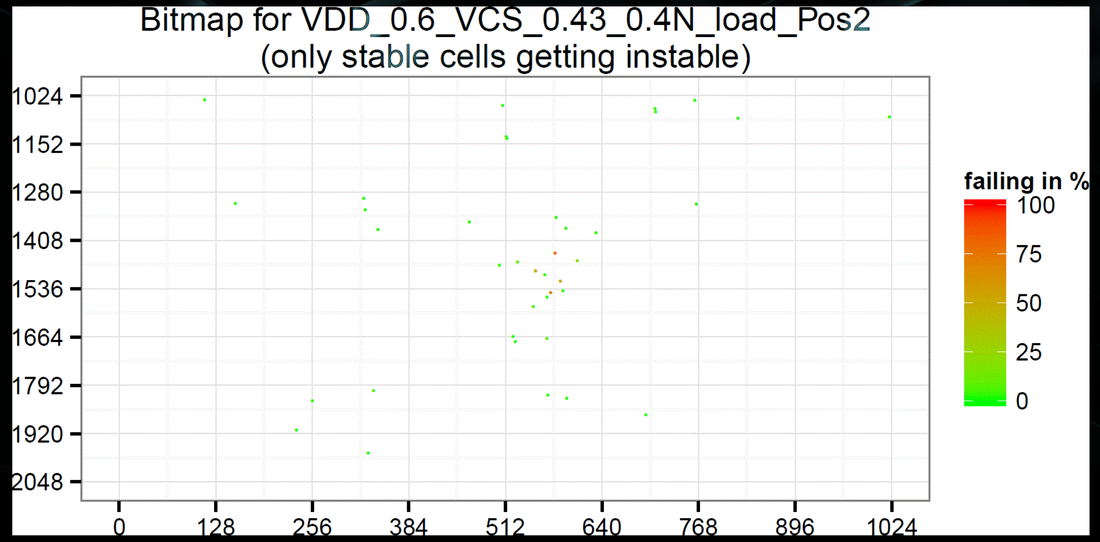
- SRAM read disturb due to mechanical stress

A. Aal et. al., Reliability & Stress-Related Phenomena in Nano-electronics 2016









What we do? – inferring requirements and designing architectures

Automotive Digital Business Models

... force a change of the E/E architecture towards **SDVs**

A. Aal, CENEX, UK, 2023

Market Expectations

- Autonomous Driving
- Smart Infotainment
- Seamless Multimedia
- Augmented Reality
- Digital Business Models
- Environ. Compliance

New in-vehicle compute system enables
Software-Driven Business Models

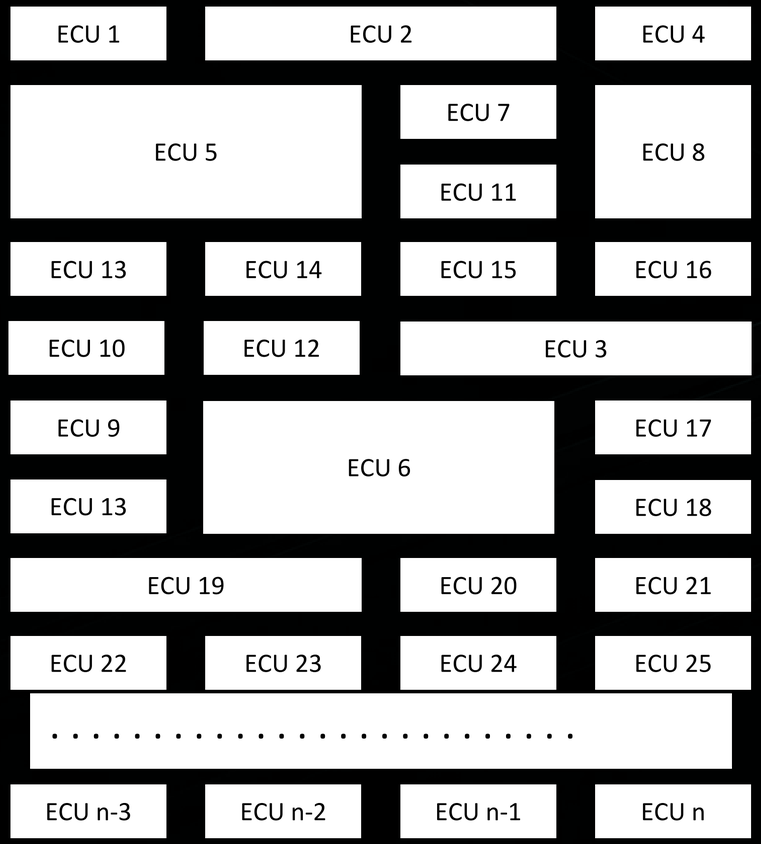
Require

- ✓ *Safety / Reliability*
- ✓ *Cyber Security*
- ✓ Software Updates
- ✓ Hardware Upgrades
- ✓ Short Time-to-Market
- ✓ Best Cost/Performance

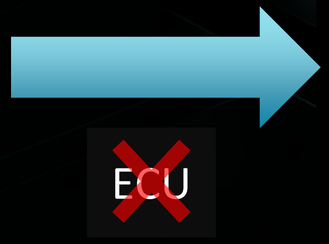
Target offer – flexible & securely encapsulated customer platform for SW based services

SDV – SHIFT FROM MULTI ECU

- TOWARDS CENTRALIZED OR DOMAIN COMPUTE PLATFORMS – DISRUPTIVE TRANSFORMATION –



- **Open** Blackboxes
- **Control** Value Chain
- **Drive** Innovation



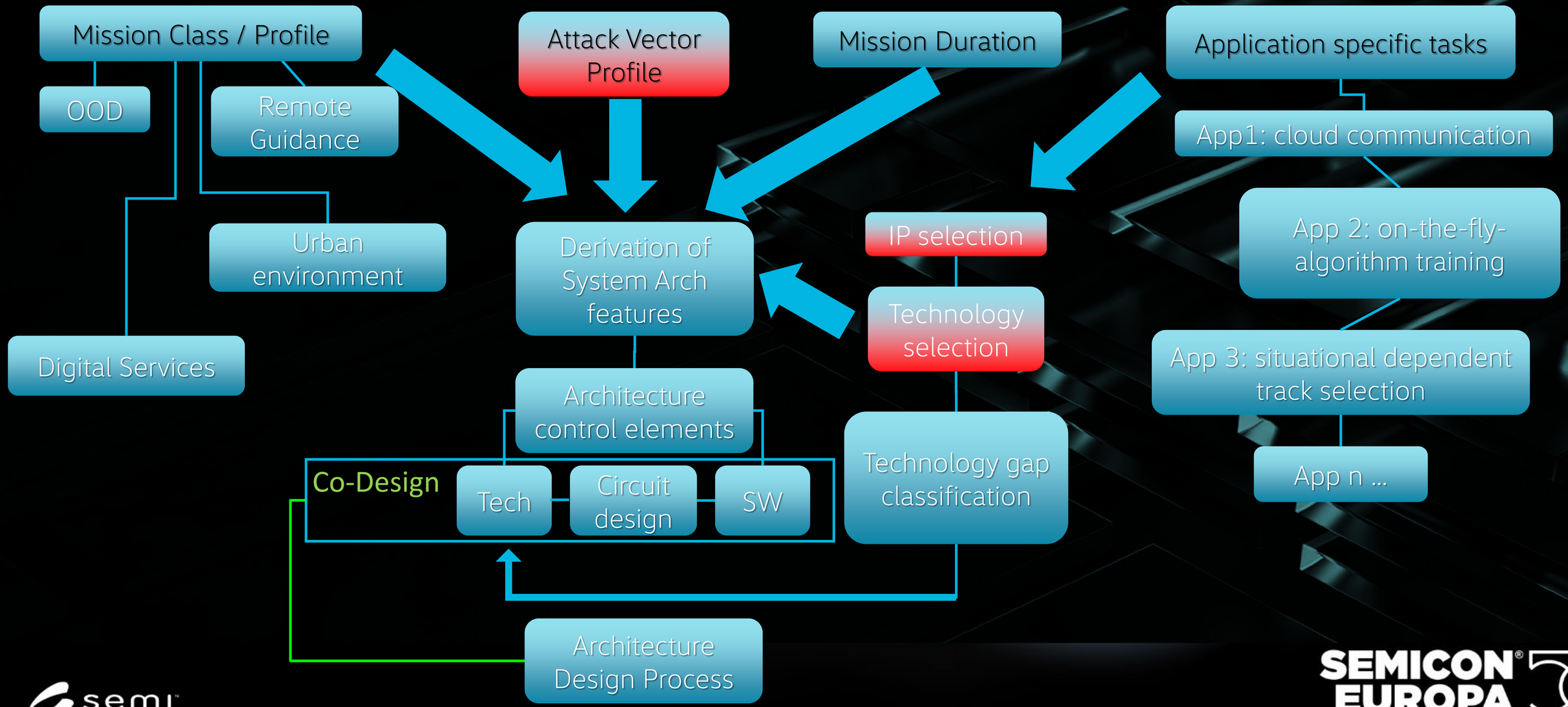
Compute Platform

SDK for Car Backend		SDK for HMI		SDK for Autonomous Driving
RTOS	Linux + Preempt RT	Linux	Android	Linux + Preempt RT
Central Compute & Control System Safety Controller Primary Root of Trust Communication Bus				ADAS / AD Compute Module
Car Backend API	Sensor / Actuator API	Car Frontend API		Steer by Wire API
Car Backend	Sensor / Actuator Hubs	Car Frontend		Steer by Wire Controls

semi

SEMICON® EUROPA 50 YEARS

SDV ARCH ADAPTION – CHIPLETS CAN ONLY COMPLEMENT, HERE !!! – TARGET DEFINITION –
THE “EIERLEGENDE WOLLMILCHSAU (GERMAN), WHY?”



SYSTEMS ENGINEERING GUIDED ARCHITECTURE CHANGE

– HPC & AI ARCH REQUIREMENTS –

High level (AI) compute architecture requirements for SDVs*):

- Modular, re-configurable to train algorithms
- Predictable & time constrained (safety, real time)
- Reliable / fault tolerant
- Flexible: Neural Network algorithm agnostic
- Fail safe towards surrounding systems
- Resource / energy efficient

*SDV: Software Defined Vehicles (SDV) build a subclass of Software Defined Systems (SDS)

- designed following a development methodology where SW & HW are malleable & defined in parallel
- along with connectivity to iteratively ensure the platform under development meets system-aware requirements
- optimal solution measured by flexibility, performance, cost, manufacturability, reliability, safety

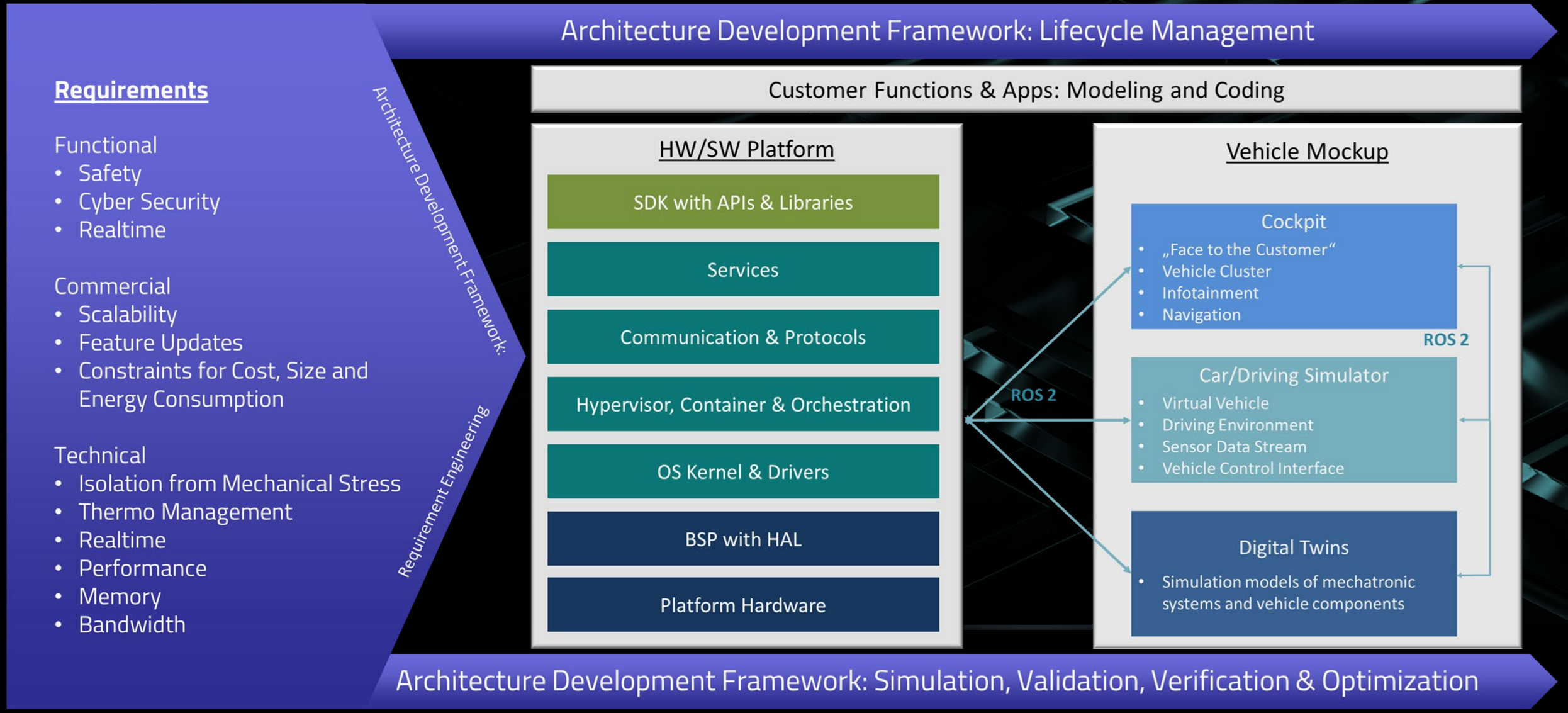
Note: System design for Inference ≠ design for training

- 1 bit flip ➔ 100 x failure in the AI model
- AI training can cause load mission profiles similar to row hammer attacks ➔ CS

THE SUM OF ALL CO-DEVELOPMENT IS THE PRODUCT

- ΣΠ FRAMEWORK

Digital Twinning



NEW SDV ARCHITECTURE APPROACH

– ADVANCE ACCELERATION LOGIC – IMPLEMENTABLE THROUGH MODULE AND/OR CHIPLET MODULES

- New architecture combination of NoC & multi-compute IP based engines
  - ASIL-D compliant
  - integrated compute cluster and newly integrated construction code (ICC – in car cloud) – energy efficient and super robust reimplementation of an edge-server for ISS (innovation solution services)
  - Spatial multi-redundant architecture that controls data flow by assigning data based on AI algorithm attributes to the most suitable IP + balancing CE (compute engine) workload for optimized performance and efficiency (longer lifetime, reduced hot spots, less cooling power) / minimal energy consumption
  - **MMHMRIOV** (managed multi host multi root IO virtualization implementation)
- Different types of CEs (CPU, GPU, NPU, DSP) – general purpose with high specialization option through configurability by main CE-fabric

- Read/write operations consume most power in AI algorithm deployment ➔ architecture task to reduce those

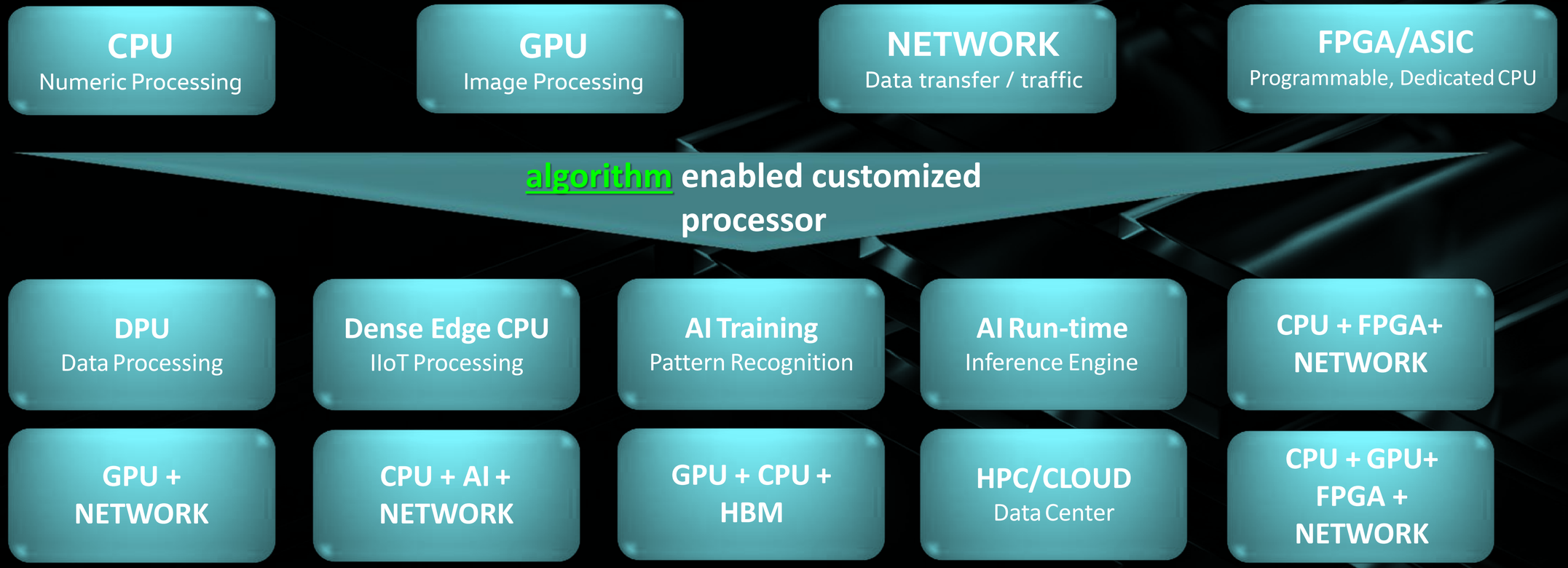
Principle of HW offloading extended to AI-SW algorithm offloading

Whom do we need? – a matching partner ecosystem

COLLABORATION

OPTIMIZED SDV ALGORITHM DECOMPOSITION

- PARALLEL PROCESSING @ MOST SUITABLE ACCELERATOR IP



SDV Architecture optimization potential through applying suitable Chiplet system architectures

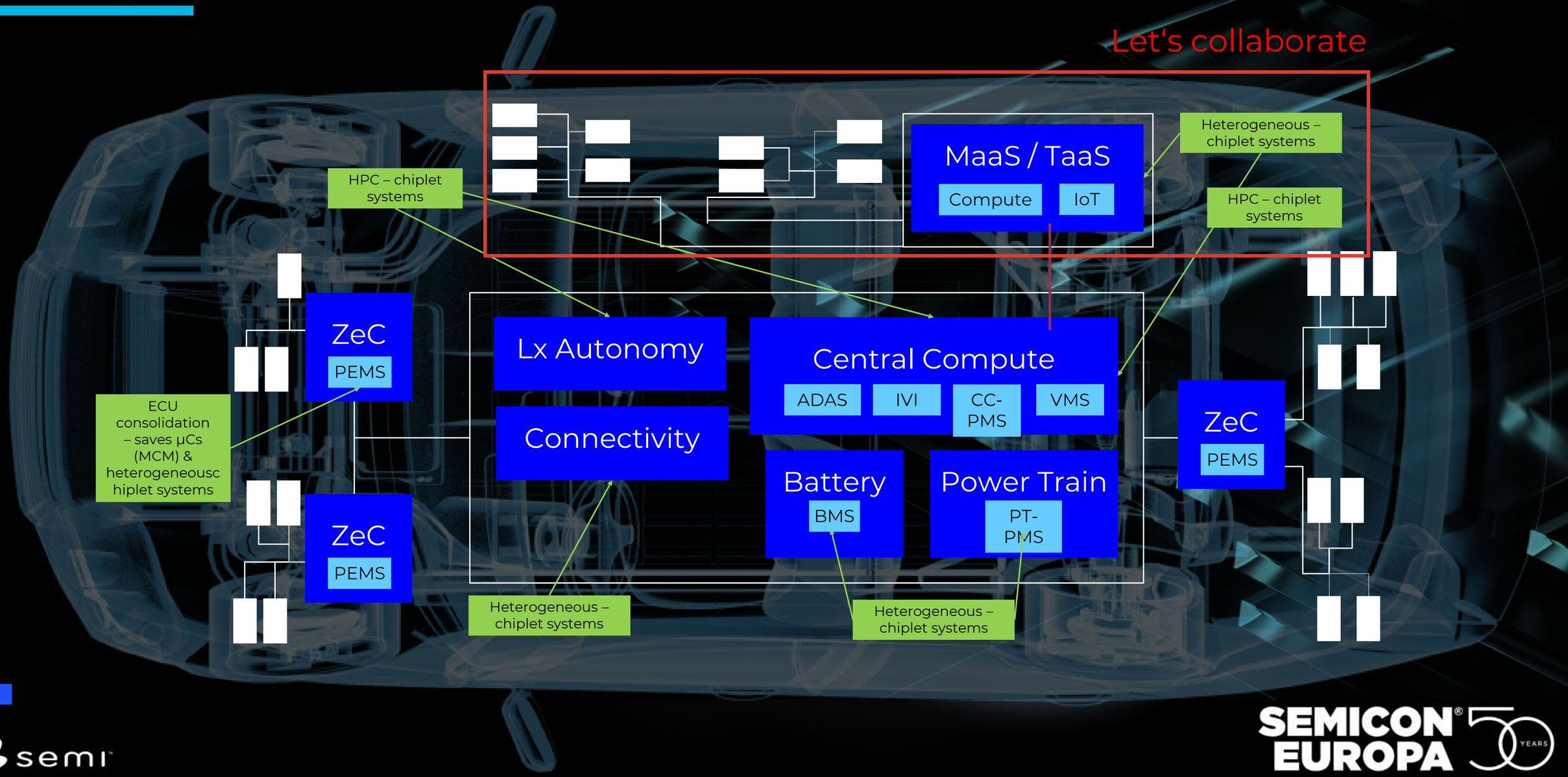
We are Looking for the right collaboration !!!

semi

SEMICON® EUROPA 50 YEARS

SYS-ENG OPTIMIZED CHIPLET USAGE IN AUTOMOTIVE

APPLICATION DOMAIN & ARCHITECTURE DOMAIN RELATED



semi

SEMICON® EUROPA 50 YEARS

Whom or whatever you need to transport – our future platform adjusts our vehicles to your business on any planet.

Commercial Vehicles

SEMICON® EUROPA 50 YEARS