MBSE & Virtualization approach to achieve shorter time to market

Presenter: Raigon Ignatius

IBM DASSAULT SYSTEMES Capella VIETSOL BLUEKEI SOLUTIONS

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Introduction

Raigon Ignatius
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AN Engineering APAC

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Experience

- *Hod of A Arch. & Networking Systems Engineering APAC Since 2022*
- *Hod of A Arch. & Networking Systems Engineering Singapore (2019-2022)*
- *Software Team leader, Continental Automotive Singapore,(2015-2019).*
- *Software Project lead, Continental Automotive Singapore,(2013-2015).*
- *Software Engineer, AMD Singapore, (May12 – Dec12).*
- *Software Engineer, Continental Automotive/Siemens VDO (Apr07-Apr12)*
- *System engineer, Siemens Information Systems India, Sep04 - Apr07).*

Education

- *PG Diploma in Embedded system design from C-DAC Bangalore, India*
- *Bachelor of technology in Biomedical Engineering (Model Engineering college, Cochin university of science and technology), India*

Personal

- *Married with 2 daughters*
- *Hobbies: Marathoner since 2011, hiking, cycling, volleyball*

History of Continental

1871-1900

Spirit of Optimism

October 8, 1871: Continental-Caoutchouc- und Gutta-Percha-Compagnie is founded in Hanover.

- Rubberized fabrics
- Solid tires for carriages
- Soft rubber products

1901-1930

Inventive Spirit

Merger with major companies of the German rubber industry to form Continental Gummi-Werke AG.

- Invention of the detachable rim
- Automobile tires with patterned tread

1931-1960

Racing Success

Vehicles with Continental tires win numerous international races.

- Engine mounts
- Conveyor belts
- Air springs

1961-1990

Internationalization

Business is expanded in Europe and America with acquisitions and the establishment of international joint ventures.

1991-2024

Automotive Supplier

One of the top five in the global automotive supplier industry since 2007.

- Key technologies for hybrid and pure electric vehicles

Continental Group

Leading the Way for Your Mobility

~200,000 talented and
dedicated employees

Group Sector Tires

Industry-benchmark
in **tires**

Group Sector Automotive

Leading technology provider and
systems integrator of choice
for the **software-defined**
vehicle

Group Sector ContiTech

Material expertise for
industry solutions

Automotive Group Sector

Safe. Exciting. Connected. Autonomous.

- Together we innovate **mobility solutions for a safer, more exciting, connected and autonomous** world, focusing on **safety and motion, autonomous mobility and user experience**.
- Our expertise in **software and systems integration** as well as architecture and networking completes our portfolio.
- We are **THE technology provider and systems integrator** of choice for the software-defined vehicle.

€ 20.3 billion in **sales**

102,413 employees

As of Dec. 31, 2023

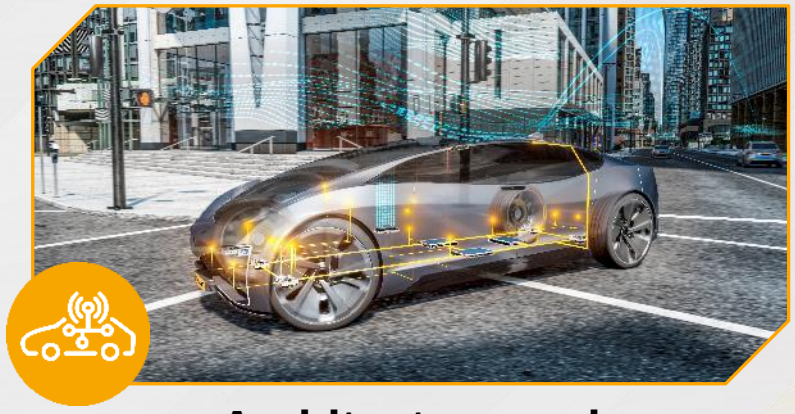
Continental Automotive Group Sector

Our Structure

Safety and Motion

Autonomous Mobility

User Experience



Architecture and Networking Solutions

Aftermarket

Software and Central Technologies

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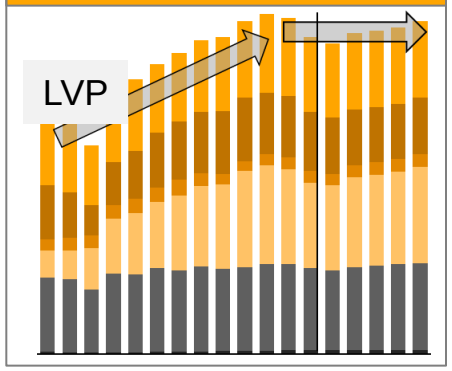
The Transformation in Automotive Industry ...

Rapid Change of Market Environment

Economic Situation

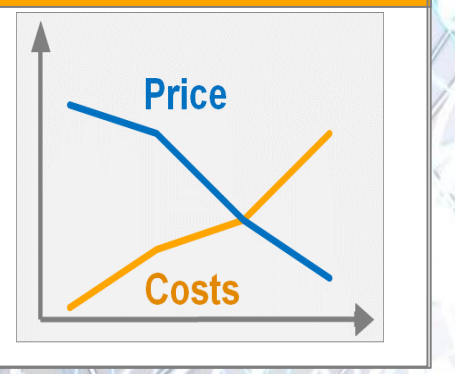


Technological Change

Digital Transformation

Regulatory Changes

Competitive Environment



MARKET CHANGE

Portfolio and Competition

- Technologies of strategic importance lead to high competition and new market players
- New functions are introduced to vehicles
- **'The world' is not requesting more cars, but different technologies !**

The Transformation in Automotive Industry ...

Technology trends revolutionizing the automotive industry

Automated Driving

Cloud Services

Internet of Things

UX Applications

Shared Mobility

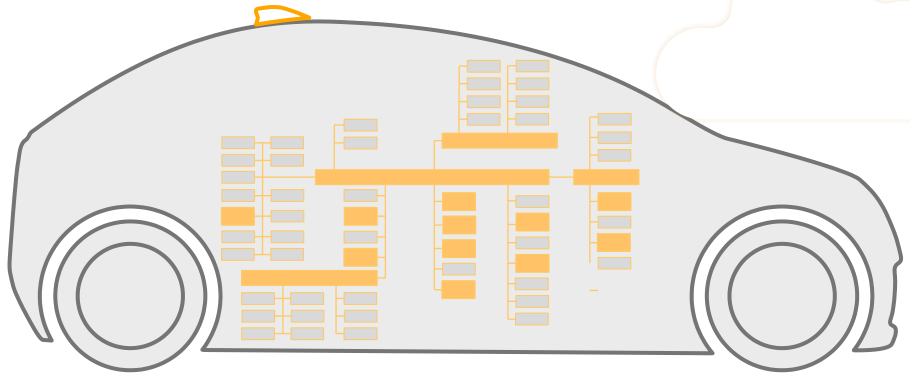
The Transformation in Automotive Industry ...

Industry Trends in architecture

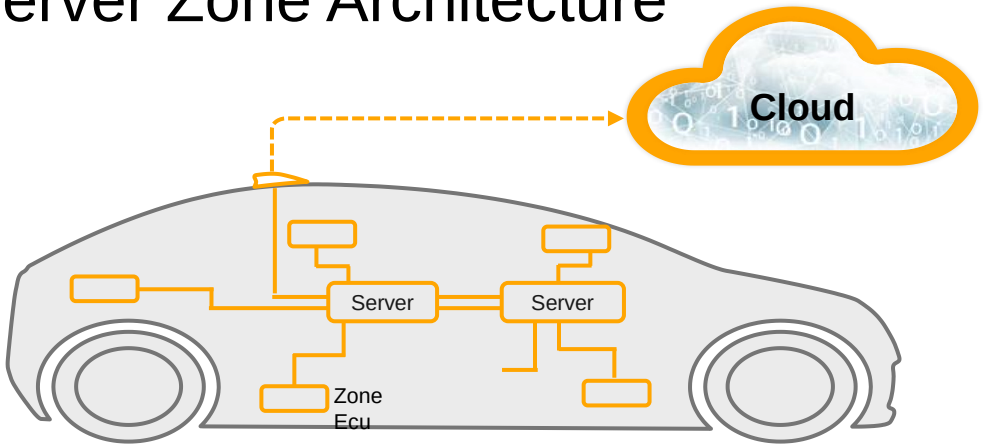
Current

Going forward

Distributed Architecture



Server Zone Architecture



COMPLEXITY CHANGE

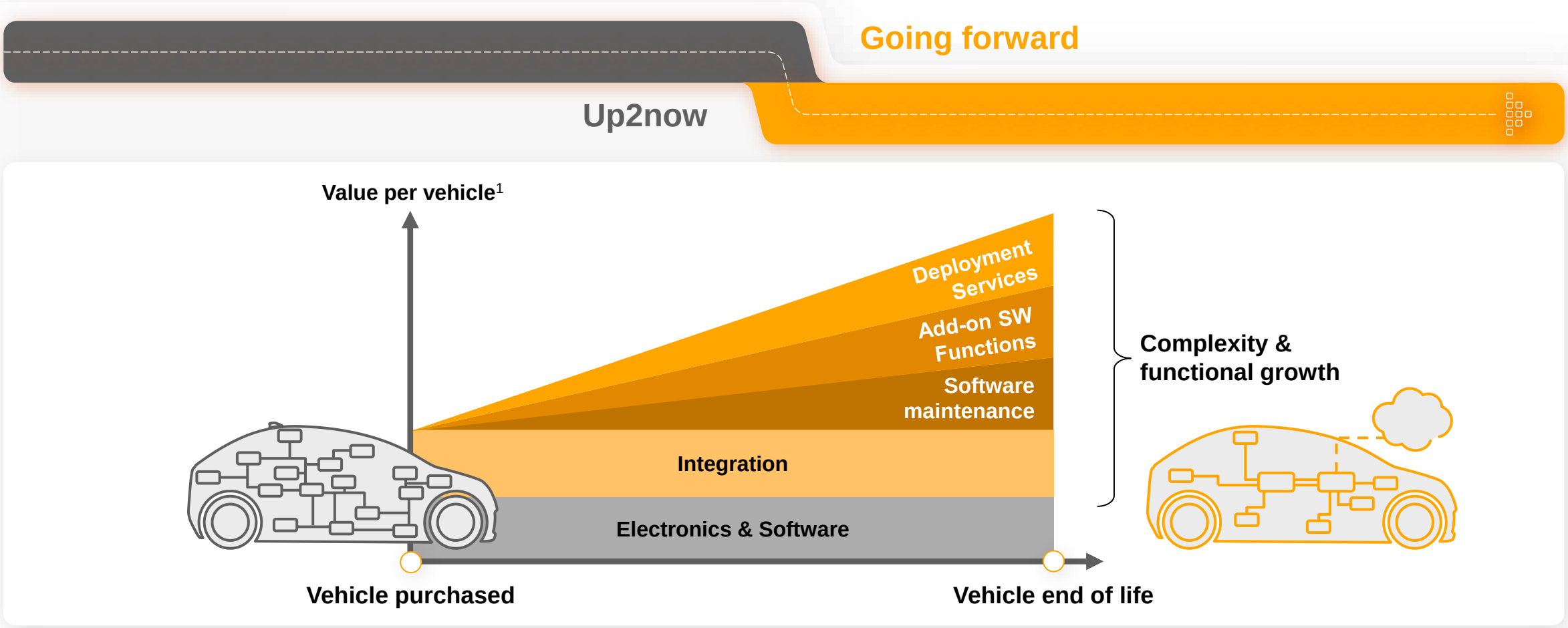
- New architectures including high performance processors in vehicles
- Function and service oriented approaches, mainly based on software

MOBILITY CHANGE

- Connected solutions enable improved functions
- Open-up new opportunities with new customers like fleets and cities

Software Defined Vehicle

New value streams across lifecycle



[1] Not to scale; for illustrative purposes only

Summary : Transformation

The need for fast time to market

Changes in product portfolio

Ever-increasing complexity

Large development programs Short development times

- While complexity increased significantly, the product development time has been decreasing
- With Chinese OEMs taking lead, the eCU development time has comedown to 12-16 months in Asia
- This forces Automotive suppliers to adapt new approach to deliver products in shorter time.

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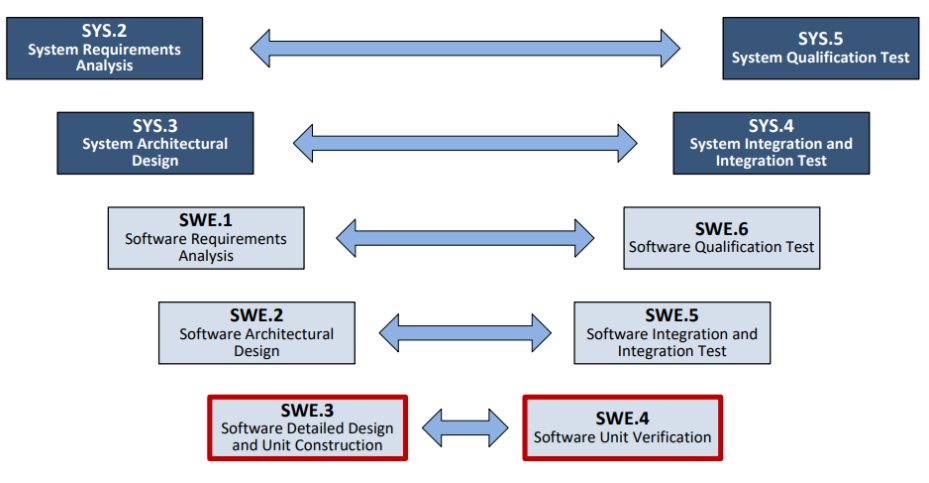
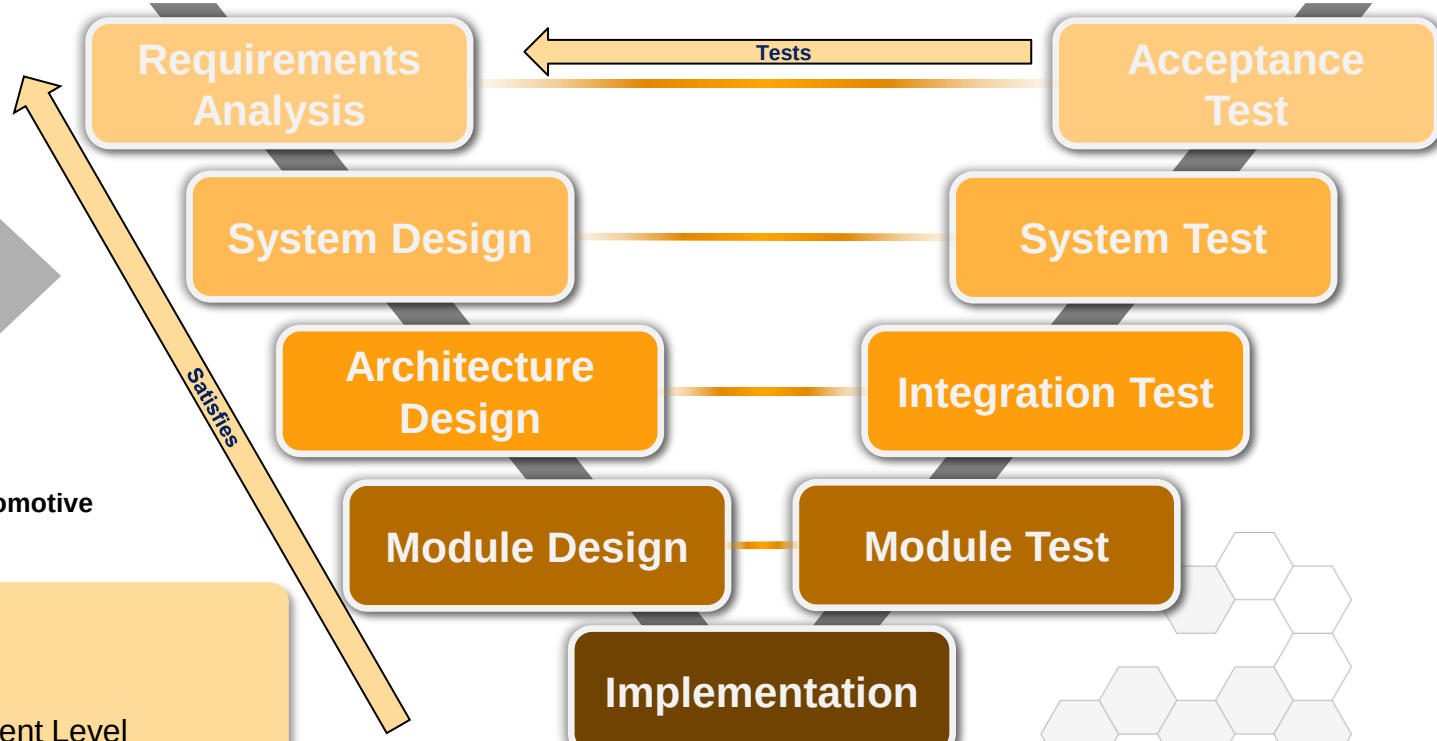
Automotive Ecu development process



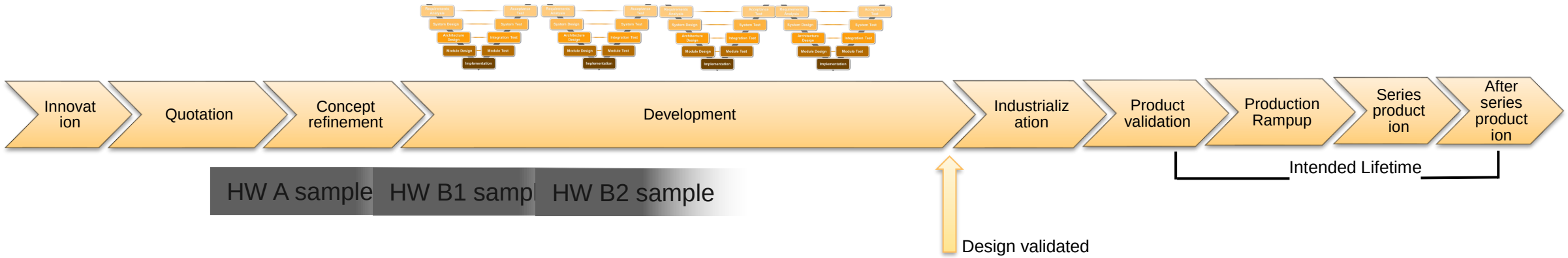


ASPICE (Automotive SPICE) is a process assessment and improvement model for the **automotive industry**.

Virtualizing the V-Cycle… is key in improving efficiency

- Start with **Functions**
- Focus on System (**SYS)** & Software(**SW)** including Vehicle and Environment Level
  - **Code generation**
  - **Test automation**
- **Reduce** test efforts **on final Hardware (HW)**
- Delivered via **automated system delivery pipelines**
- Not only reduce time but to **increase** product **quality, reuse, reactivity**
- Also to meet **customer requests** for Virtualization

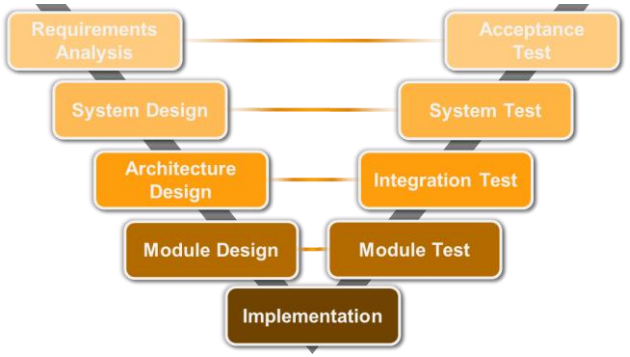
Automotive Ecu development process



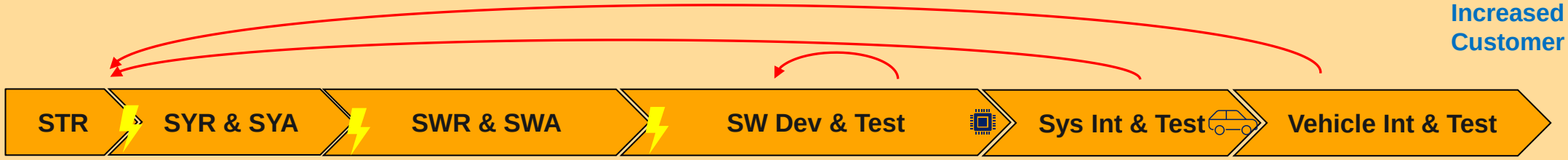
- There are in-fact multiple V-cycle in the development cycle
- The availability of Hardware sample has significant impact on the development time
- Achieving significant reduction in development time needs to consider decoupling software development from h/w development

Motivation

Frontloaded SW & SYS Integration & Test

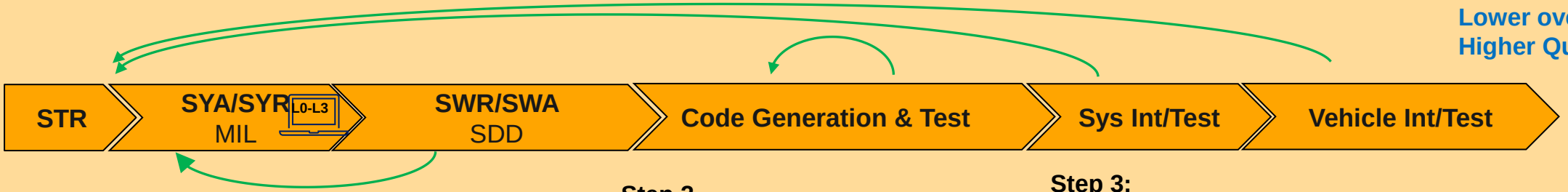


w/o Virtualization → Late Target HW availability



Many late changes
Increased cost
Customer dissatisfaction

with Virtualization → Enables early virtual SW & SYS integration & Test



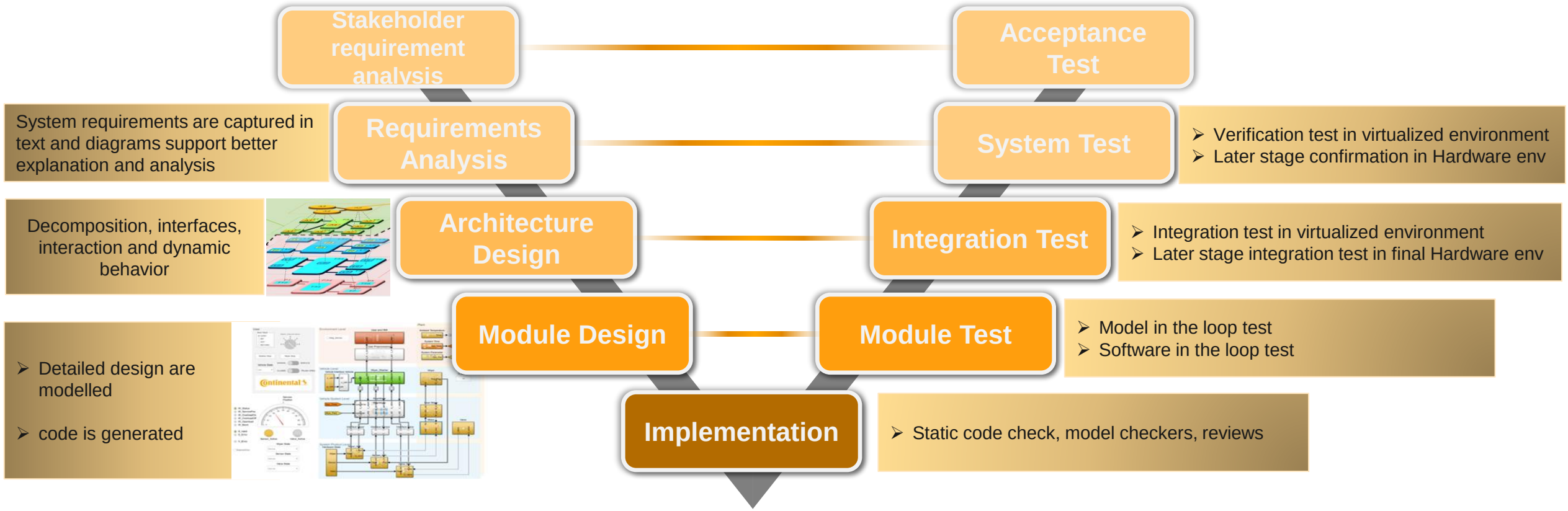
Fewer late changes
Lower overall Costs
Higher Quality

Step 1
Model In The Loop (L0-MIL)
→ Better Requirements & Design

Step 2
Code generation from Model
→ Saves efforts, reduces complexity

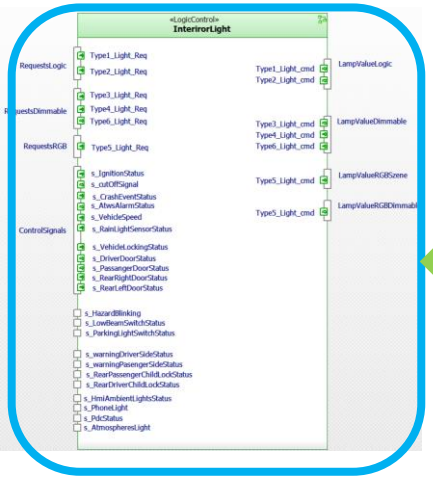
Step 3:
Virtual SW Integration and Test
Virtual System Integration and Test
Prepares for Target HW Integration
→ Saves effort, increases Quality

Current MBSE approach

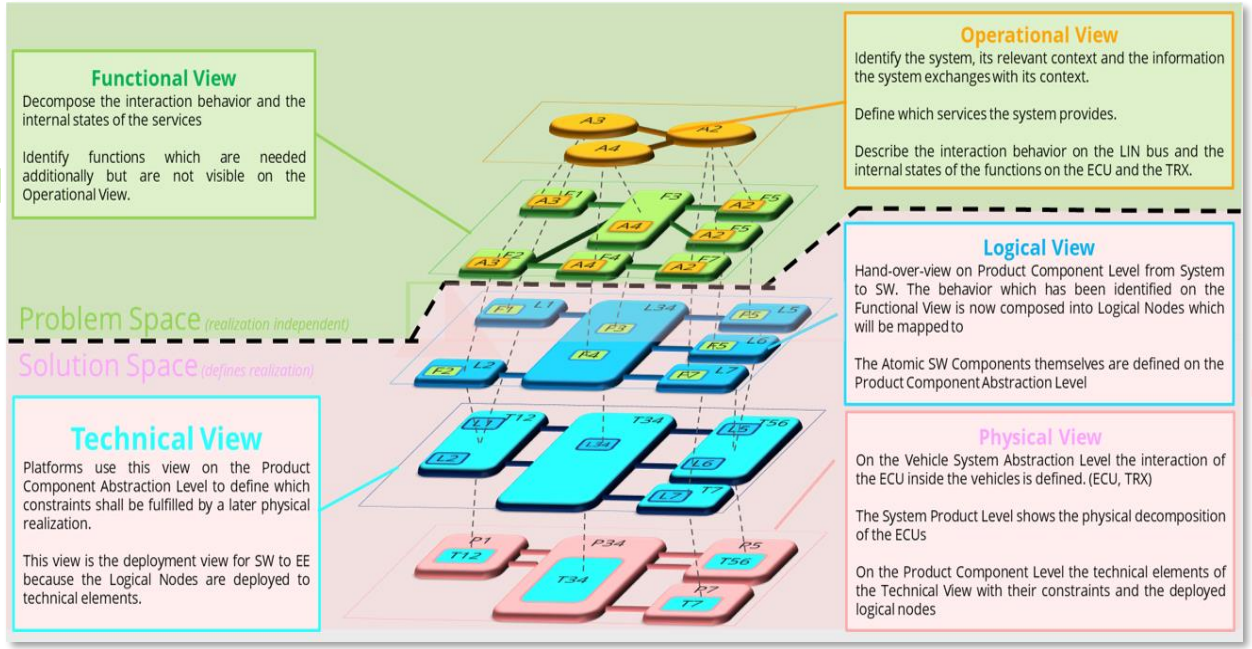


Architecture

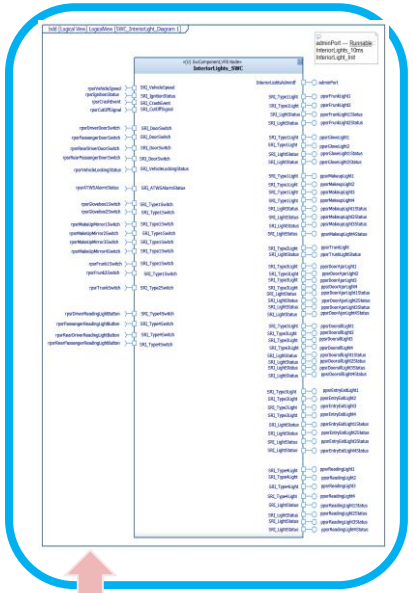
SYA Functional View Generic



Maps onto Model in the Loop (MIL – L0)

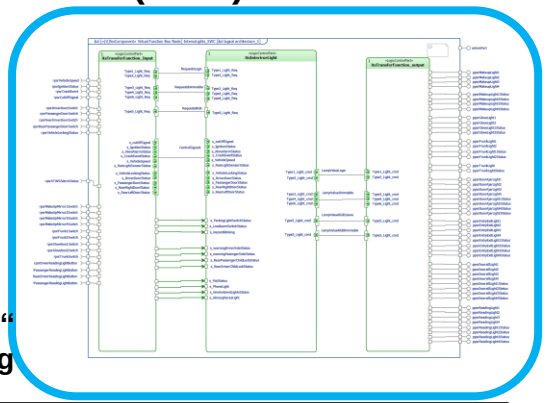


SWA Logical View Specific



Interfaces specification Maps onto Integratio Model for Code Generation

Software component design in models(SWC)

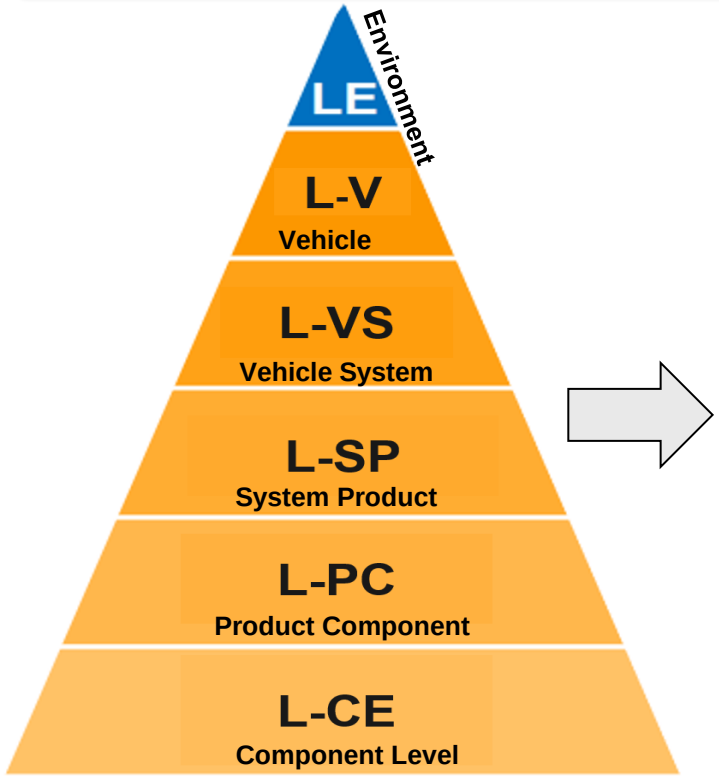


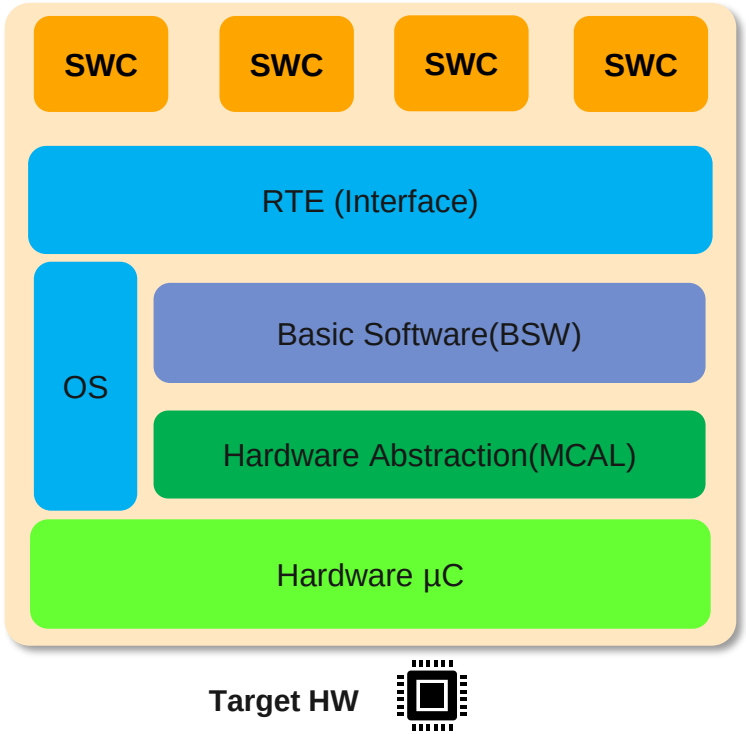
Connecting „Generic“ with „Specific“ Functionalities modelled in modelling tool

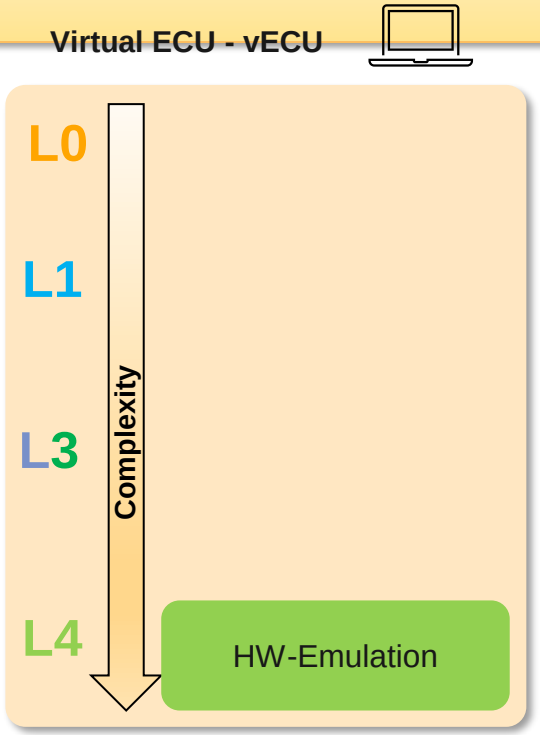
Virtualizing ECUs

vECU virtualization Levels and System Classifications

- Virtual development of ECU involves the simulation, modeling, and software tools ecosystem to design, test, and validate ECUs without the need for actual ecu Hardware.
- This allows efficient development testing and integration of complex ECUs.





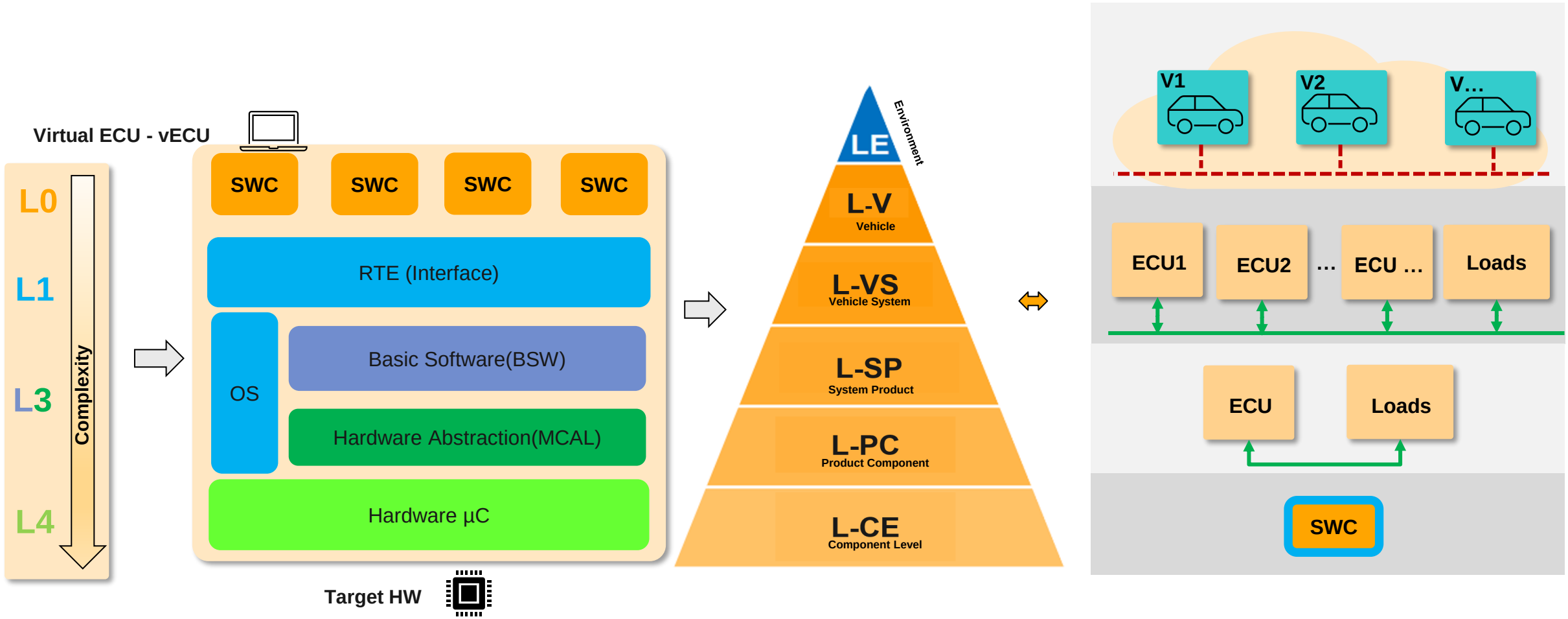


AUTOSAR (AUTomotive Open System ARchitecture) is a global partnership of automotive companies aimed at establishing a standardized software architecture for automotive systems.

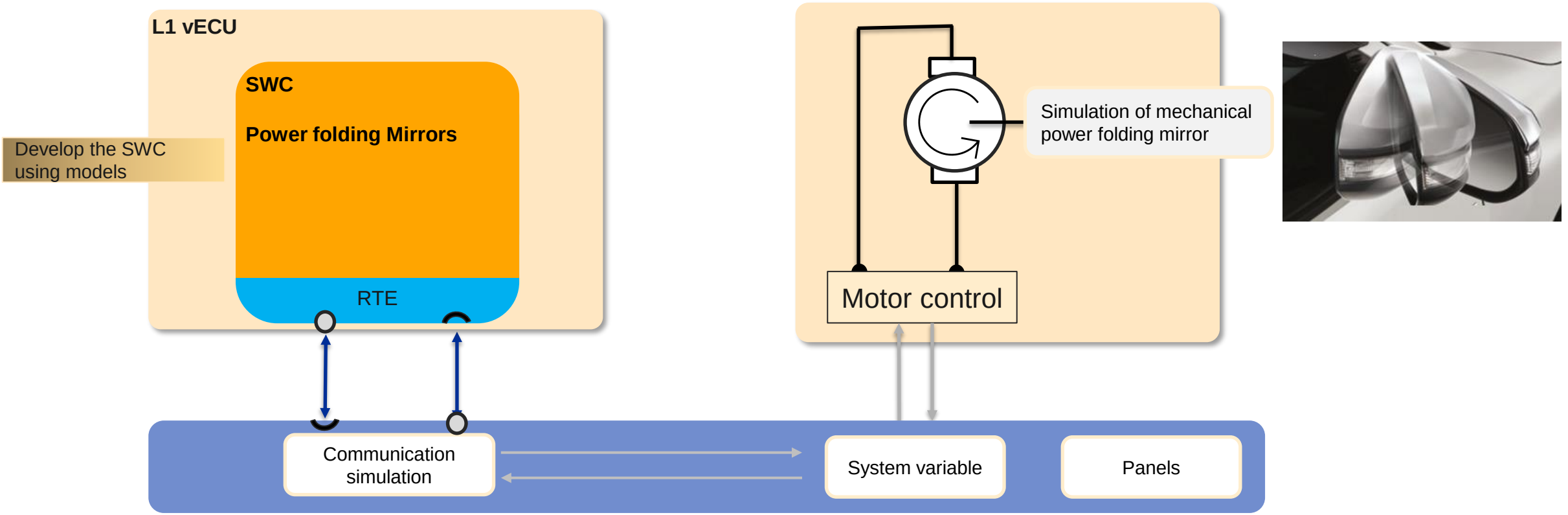
Notes:
- L1 enables Function or software as a product development
- Achieving L3 enables virtual system setup

Virtualizing ECUs

vECU virtualization Levels and System Classifications



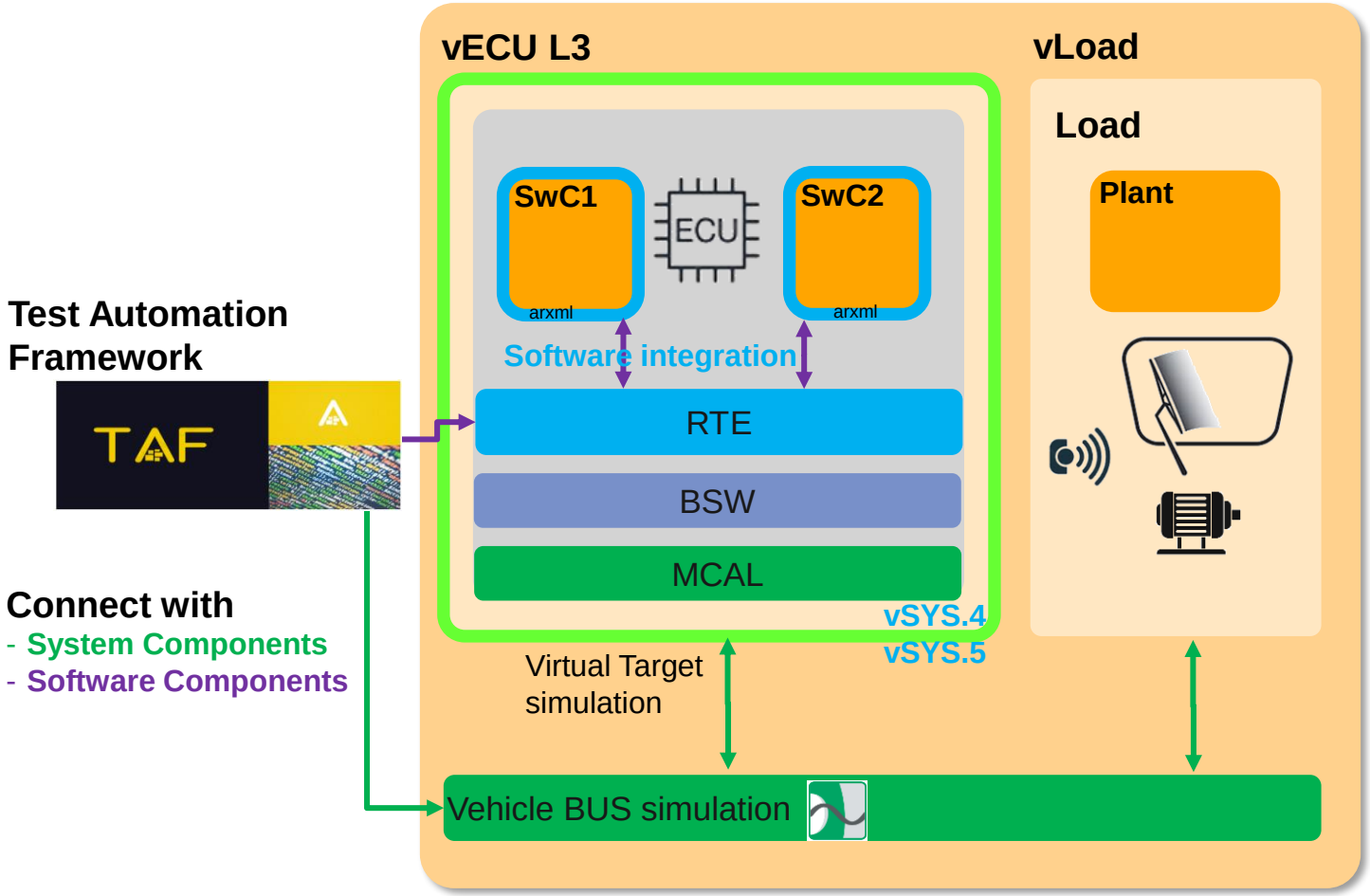
L1 vECU : Virtualizing SWC



Notes:
- Software component and interface layer(RTE) is reused
- Communication and loads are simulated

L3 – vECU connected with Loads

System Product Level



System Components:

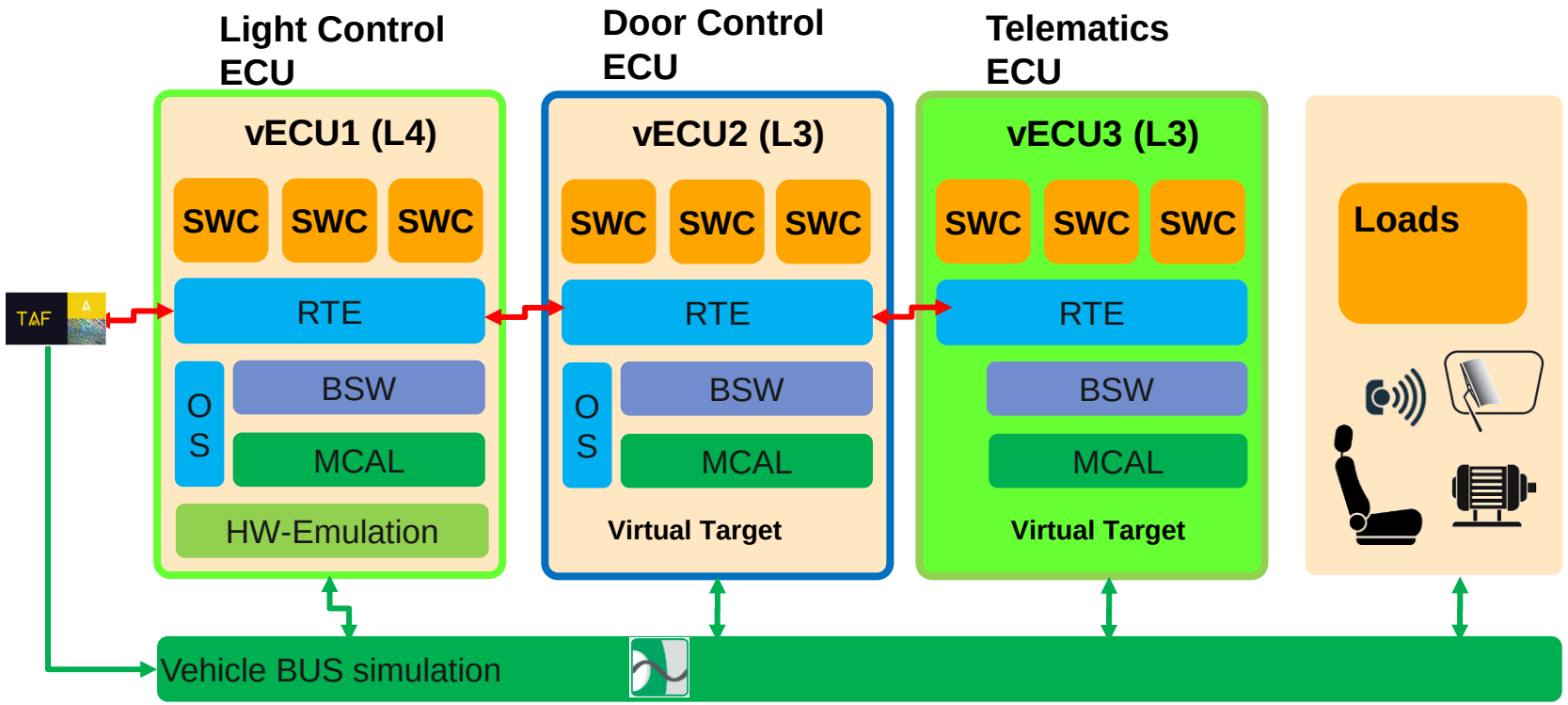
1) L3-vECU with Software Components
2) Virtual Loads simulating behavior of the environment
3) Vehicle BUS communication is simulated

Interfaces

- System Level (e.g. CAN-Bus, Ethernet)
- Software Level (e.g. RTE Sender/Receiver)
- Connection to test automation for SYS & SW Testing

Multiple connected vECUs

Vehicle Level System



System Components:

1) Several vECUs with different realism levels and SW Stacks
2) Virtual Loads simulating behavior of the environment
3) Simulates different types of Vehicle Buses

Interfaces

- on System Level (e.g. CAN-Bus)
- and Software Level (e.g. RTE Sender/Receiver)
- Connection for SYS & SW Testing

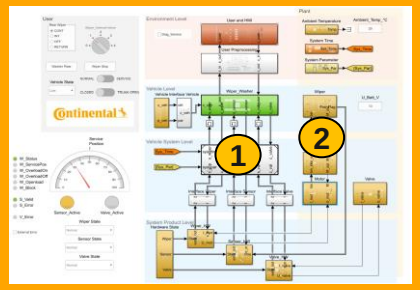
Current level:

- **Increasing the Functions coverage step by step**
- **Provide virtualization as a service to end customers**

Integration of building Models

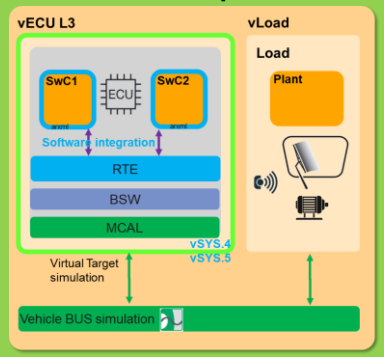
MIL → vSYS – L3 → Target HW

Model in the Loop MIL (L0)



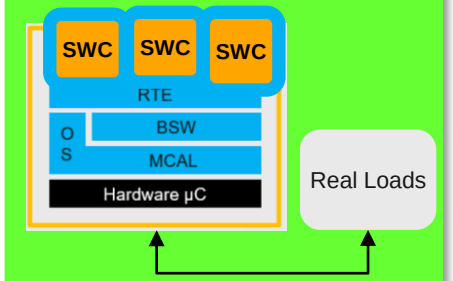
- **System Level Simulation**
- Focus on functional closed loop performance based on Usecases / Userstories under **virtual loads**. (1)
- **Refine requirements.**
- **Create SW detailed design.**
- No comprehensive SYS & SW Tests yet.

L3-vECU in the Loop



- **System Level Simulation**
- Code generated from Model
- Integrated in Autosar Basic SW stack
- SYA defined
- SW Interface defined at SWA
- Comprehensive SW and SYS closed loop Tests with virtual ECU (**L3**) and **virtual Loads**.

Target HW



- **Target System Integration**
- SW Integration and Test with other Functions on real target with full Basic SW-Stack
- System Integration and test with target SYA and **real loads**
- E.g Rear Wiper, Seat Control

Model in the Loop

→ Requirements Elicitation

→ Initial design

→ **Concept Established**

L3-vECU in the Loop

→ Virtual Integration and Qualification tests

Target System

→ Integration and Qualification test in final Architecture

Summary: Key aspects of our approach

Our Approach

- Assemble virtual Systems from **existing Solutions ➔ low effort**
- Integrate **model-based Functions** into the virtual System
- Supports commonly used autosar stack based virtual ECUs (**vECU**)
- Integrate **vECUs** into **Systems**
- Integrate virtual **Loads** into the Systems
- Test on **SW** and **SYS level** via our internal standardized approach
- Integrate into an automated system delivery pipeline
- Utilize containerization and parallelization to execute large amounts of test cases

AUTOSAR (AUTomotive Open System ARchitecture) is a global partnership of automotive companies aimed at establishing a standardized software architecture for automotive systems.

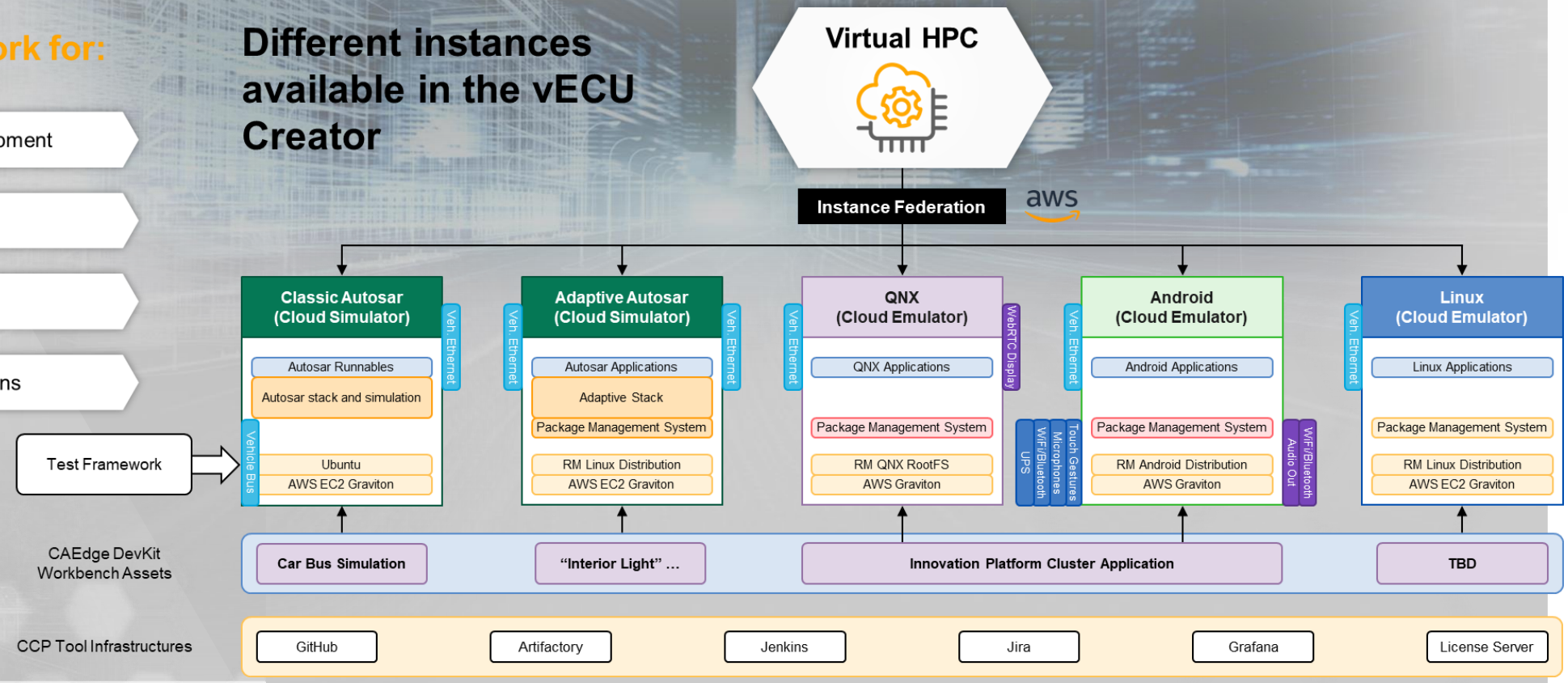
CAEdge Virtual ECU

Digital Twin of the Physical ECU

CAEdge
is a cloud-based framework for:

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

Different instances available in the vECU Creator



CAEdge

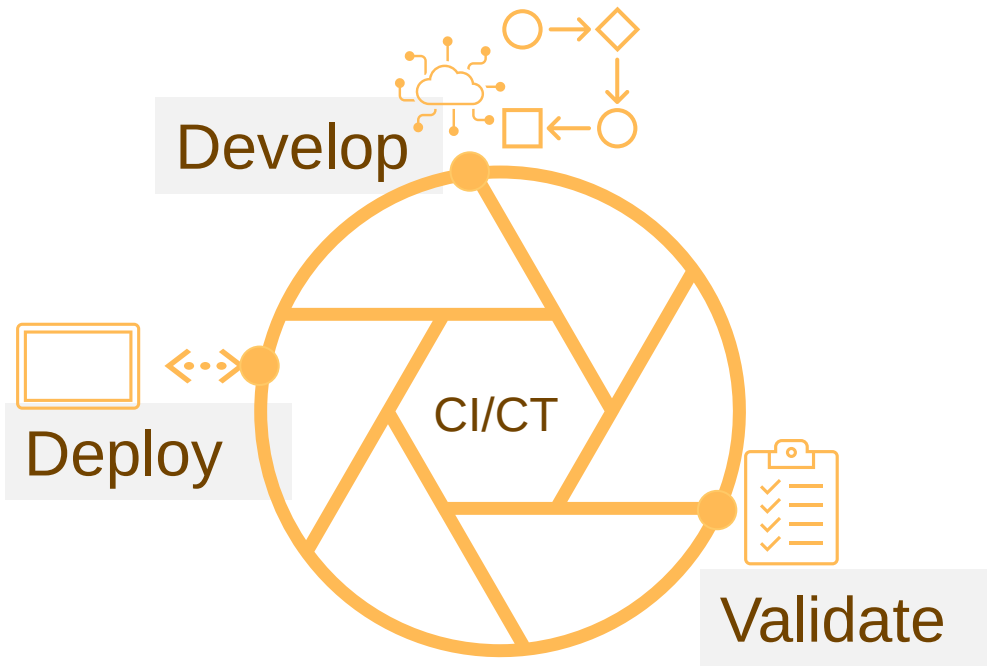
Continental Automotive Edge Framework

The Comprehensive Framework for Automotive Software Development

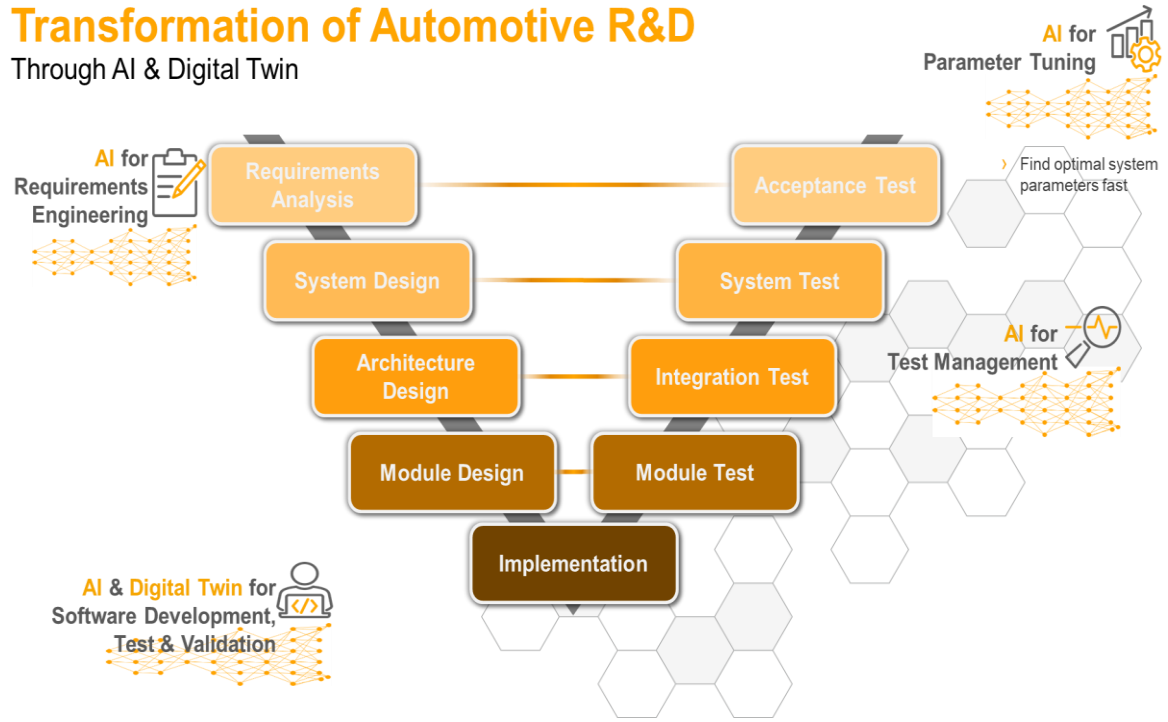
Summary: Faster development time

- MBSE and Virtualization are not the only means to achieve shorter development time
- CICT and AI are other areas that can help us to speed up the development time

CI/CT- Continuous integration and test delivery pipeline



Use of AI to support the engineers



Agenda