

MathWorks
**AUTOMOTIVE
CONFERENCE 2023**
North America

Cloud-Native Development and Model-Based Approaches for Software-Defined Vehicles

Stefano Marzani, Amazon Web Services, Inc.



Agenda

- Trends driving Automotive Reinvention
- E/E Architecture and Software Development
- Cloud-Native Software Development
- Conclusion

Automotive Reinvention

Sustainability

An aerial photograph of a winding asphalt road that curves through a dense, lush green forest. The road has yellow lane markings and white dashed lines at the edges. Several cars are visible on the road, including a blue car, a black car, a white car, a red car, and another white car. The forest is thick with trees, and the overall scene is vibrant and natural.



Technology

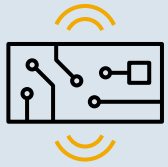
Connected
Autonomous
Shared
Electrification



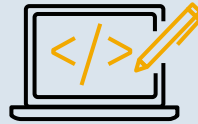
**Customer experience,
personalization, and AI**

Vehicle Software complexity is growing

Today's vehicles

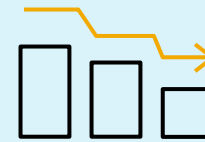


Number of ECUs
>100

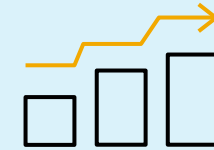


Lines of code
100–150M

Fully software-defined vehicles



Number of ECUs
Decreasing
with centralized compute
architectures in new
vehicle platforms



Lines of code
Increasing
due to new functionality,
highly automated and
autonomous driving

Software-defined vehicles journey

Key Challenges



HYPERSCALE

Thousands of cores of compute for development and validation. TBs of data to collect, ingest and store every day translates into PB scale data processing, storage and management problem.

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AGILITY & SPEED

Optimized software engineering to reduce development and validation costs and enable faster Time to Market. Future proof R&D cycles. Integrated and Agile to rapidly innovate.

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Safety of passengers and surroundings are top of mind of AWS, customers and vehicle end users. Decisions are moving from human to vehicle.

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ECOSYSTEM PLAY

Interoperability and seamless Integration of multiple first party and third party workload specific tools.

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E/E COMPLEXITY

Modern vehicles have several tens of Electronic Control Units, making the system hard to test and update.

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GLOBAL, SECURITY, DATA PRIVACY

Global fleet requires managed service for complex operations, attain data and security compliance across the globe.

Enter SDV: definition

SDV is a *vehicle* whose **functions** can be **updated, secured, and personalized** throughout its lifetime.

-

The insights generated from SDV improve **current and future** generation of **vehicles**.

Breaking down SDV



Hardware abstraction

Enabling a seamless experience between a developer's local environment, the cloud, and the vehicle



SW lifecycle management

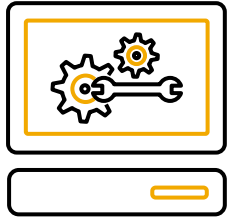
Auto DevOps Platform to increase SW quality, developer productivity, and provide better security and governance



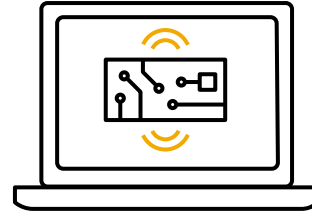
Vehicle data management

Enabling automotive customers to unlock enterprise-wide value from connected car data

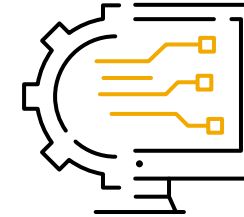
How cloud can help



Virtual
workbenches



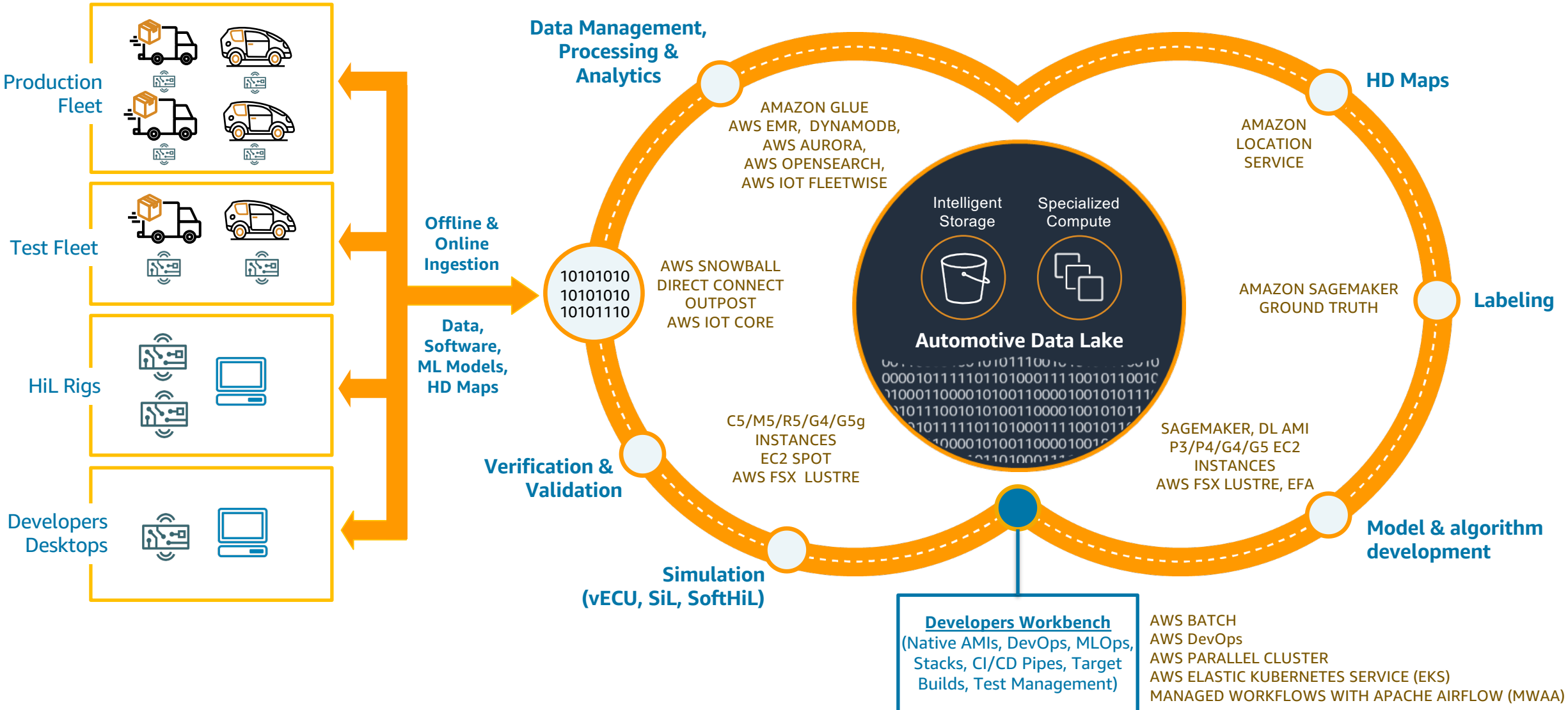
Virtual Electronic
Control Units (vECUs)



Automotive-Native
Amazon Machine
Images (AMIs)

(Automotive SW running in the cloud natively)

Automotive Development "Infinity" Workflow



Engineering Workbench / Customers

“Software is at the forefront of innovation in cars. With our CAEdge platform, we are establishing a new approach to developing vehicle architectures and software in the automotive industry. We have found a strong collaborator in AWS to help us accomplish this task and will continue to expand our leading role in the field of automotive software”



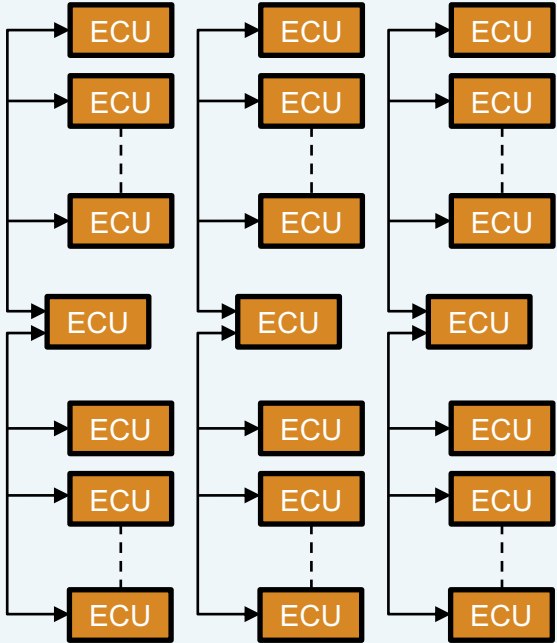
“Both companies are creating a cloud-based product development environment called the “Virtual Engineering Workbench,” which provides automated workflows to manage software development and testing, high-performance simulations, machine learning model training, and data collection and analysis. ”



Cloud-Native Software Development

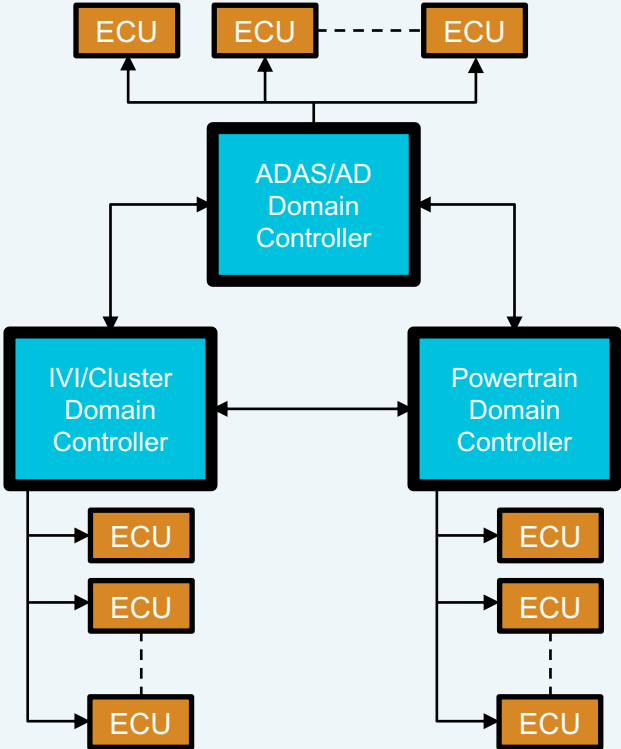
E/E Architectural Evolution

Traditional Architecture



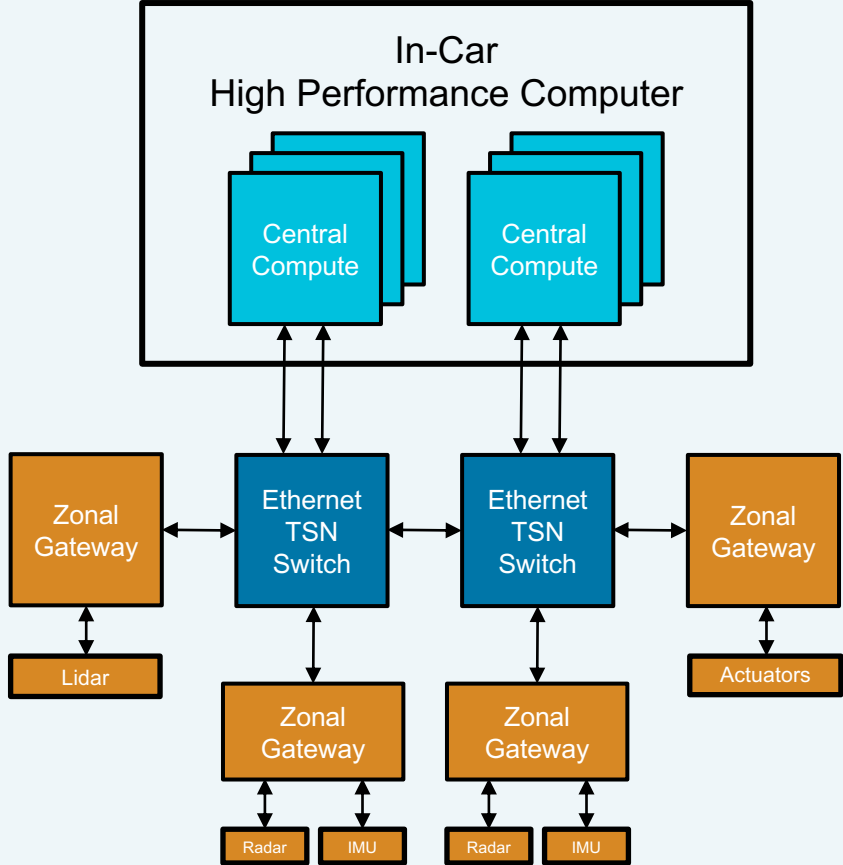
Legacy

Domain Architecture



Today

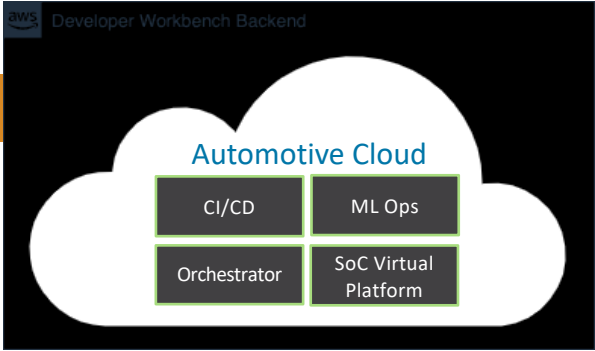
Zonal Architecture



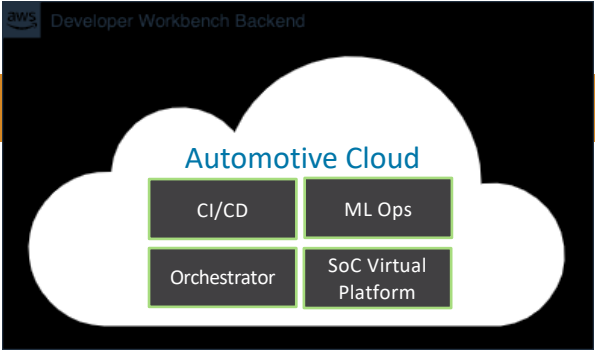
Next Generation

Cloud-Native In Automotive Is A Journey

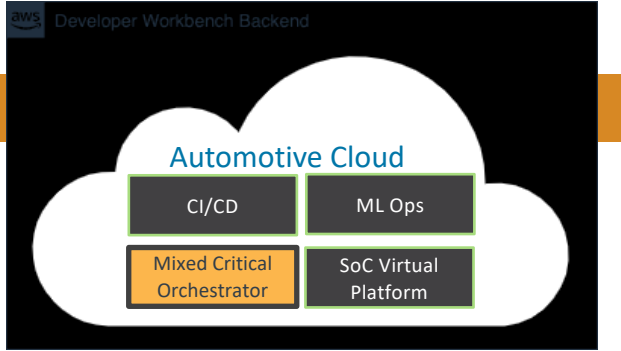
Monolithic Automotive Stack



Microservices Based Automotive Stack

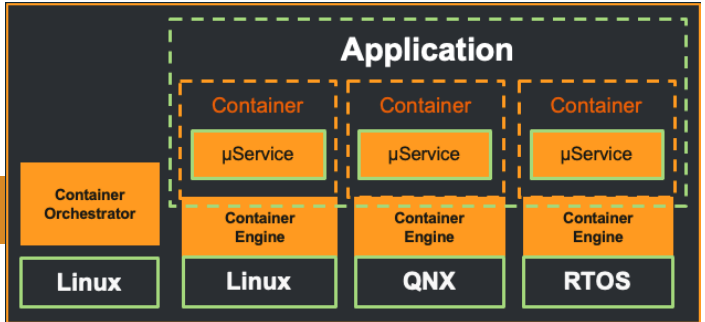
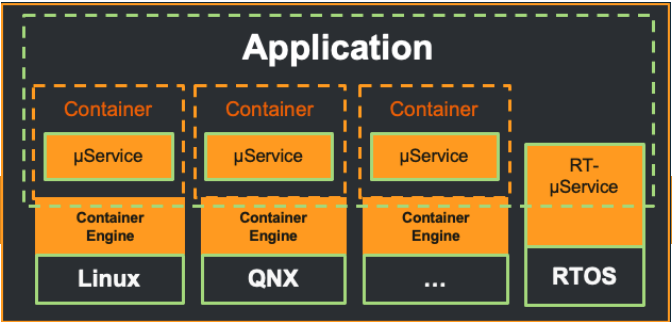
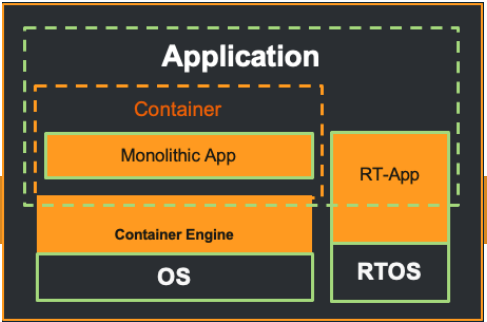


Microservices Based Automotive Stack With Mixed Criticality Orchestrator

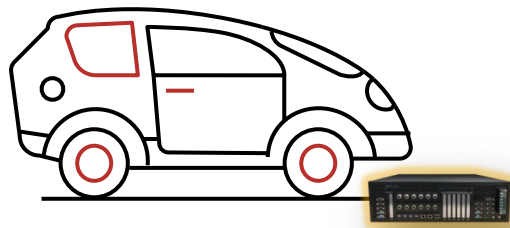
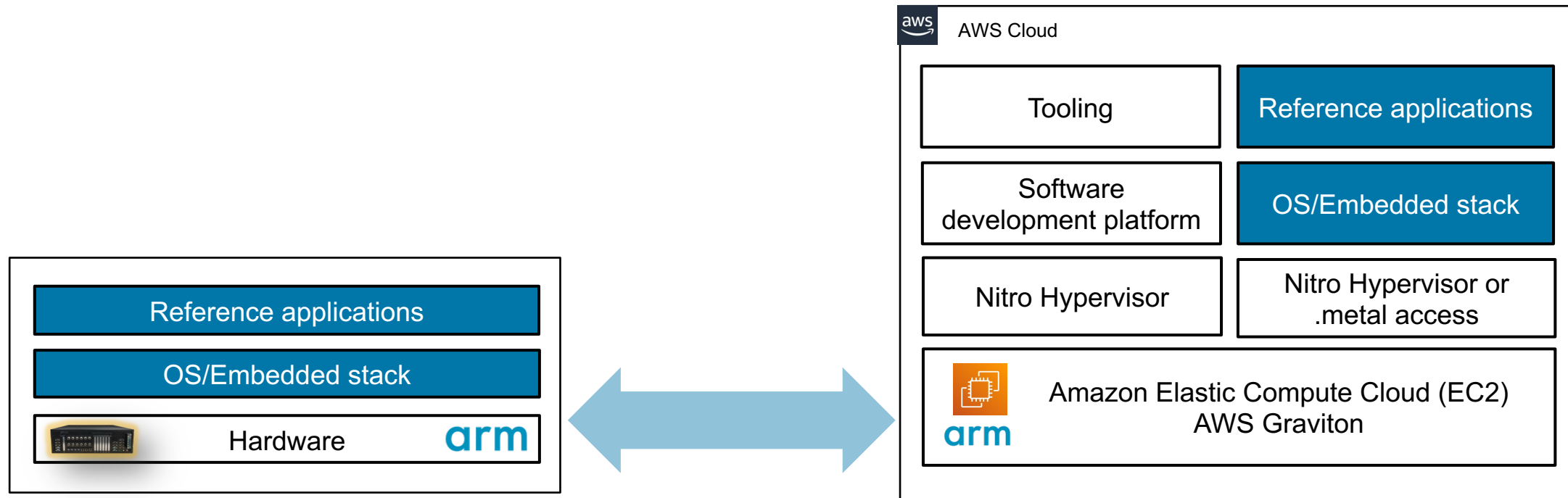


Cloud-Native Development

- DevOps / MLOps
- Continuous Delivery
- Microservices based approach
- Containers for SW parity
- Environmental parity at multiple levels



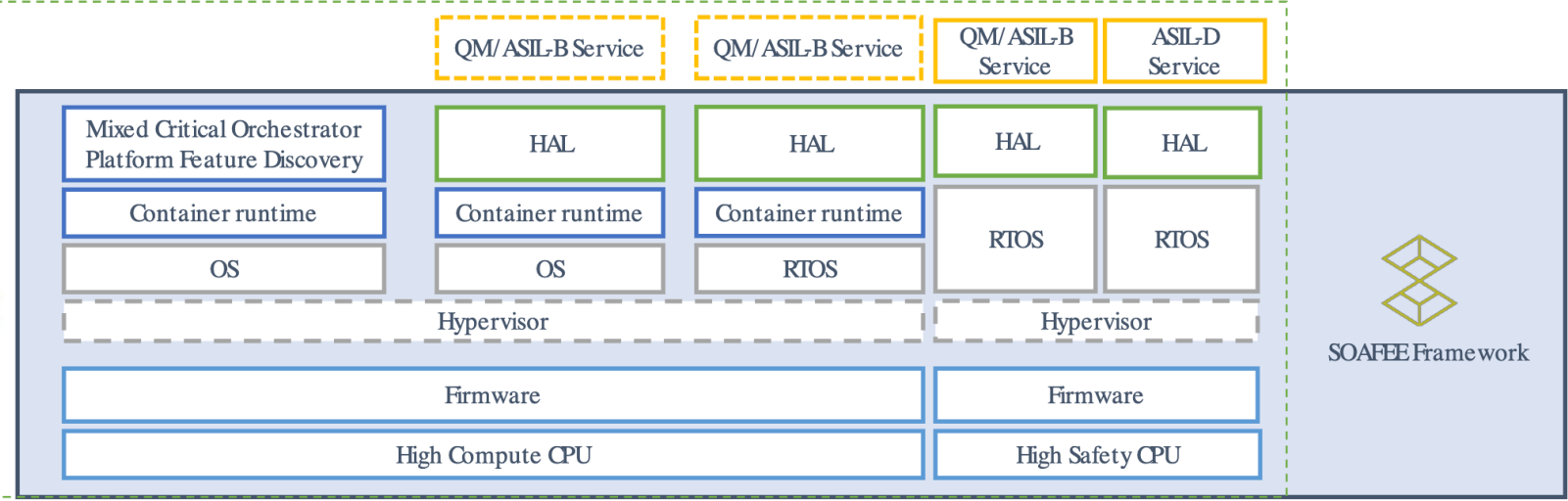
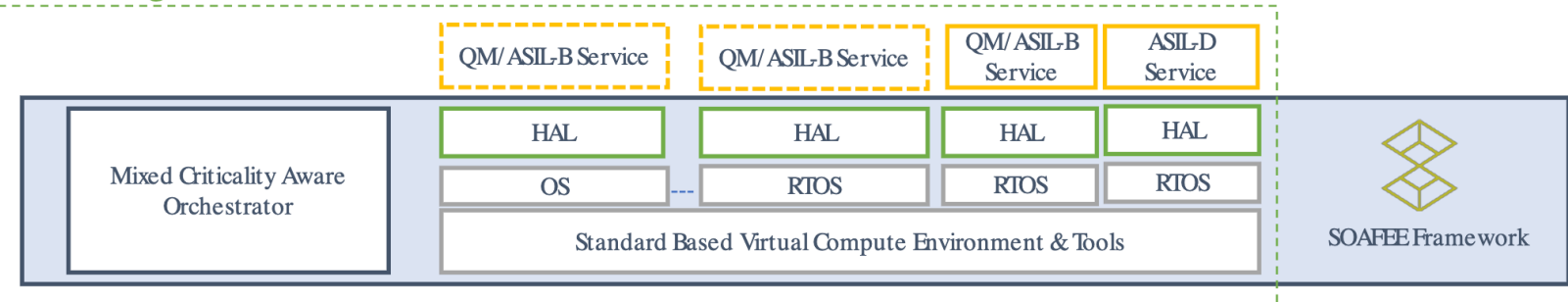
Environmental parity with AWS Cloud and Arm



- Run SW in the cloud
- Perform V&V activities in the cloud at scale
- Deploy bit-perfectly equal binaries, using ISA parity



SOAFEE High-Level Reference Architecture



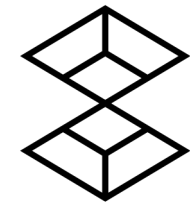
 = container
 = monolithic
 = optional

Democratizing SDV: SOAFEE

✦ An **industry initiative** to extend cloud-native software experience to automotive workloads, incorporating a **Special Interest Group (SIG)**

✦ A **software architecture** which enables cloud technologies to be combined with automotive functional safety and real-time requirements for the first time

✦ An **open-source reference software implementation**, enabling prototyping and early development

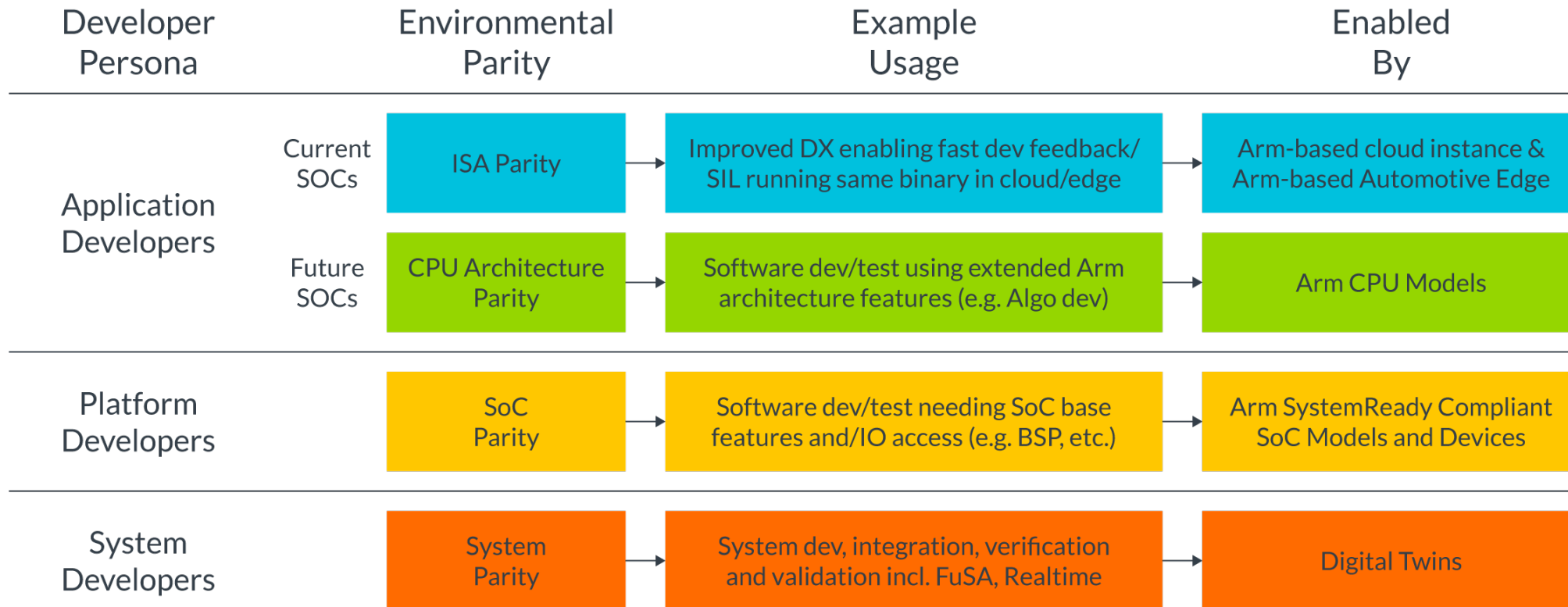


S O A F E E

<https://gitlab.arm.com/soafee>

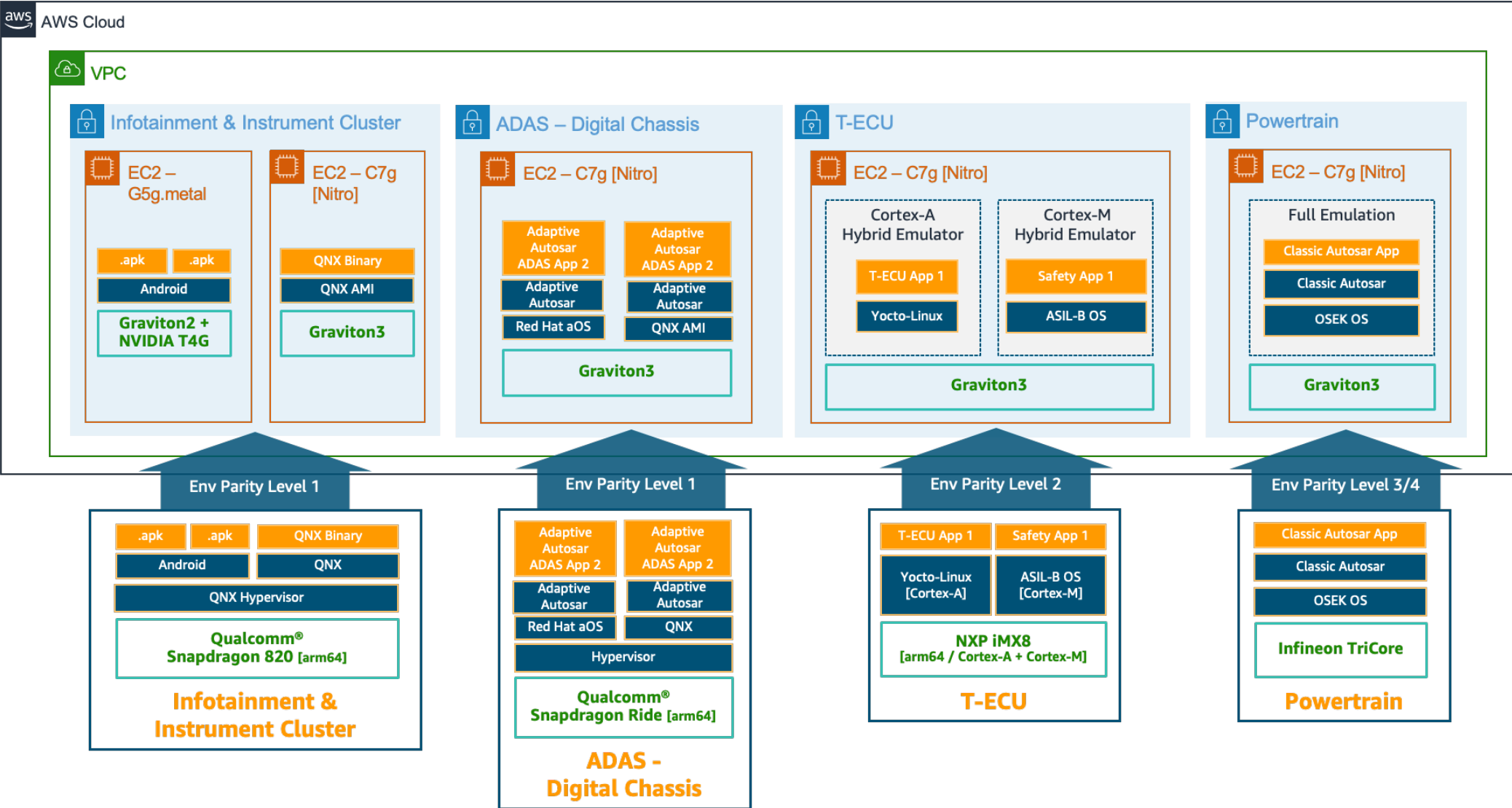
AWS is a founding member,
The MathWorks is a voting
member

vECU: Environmental Parity Levels

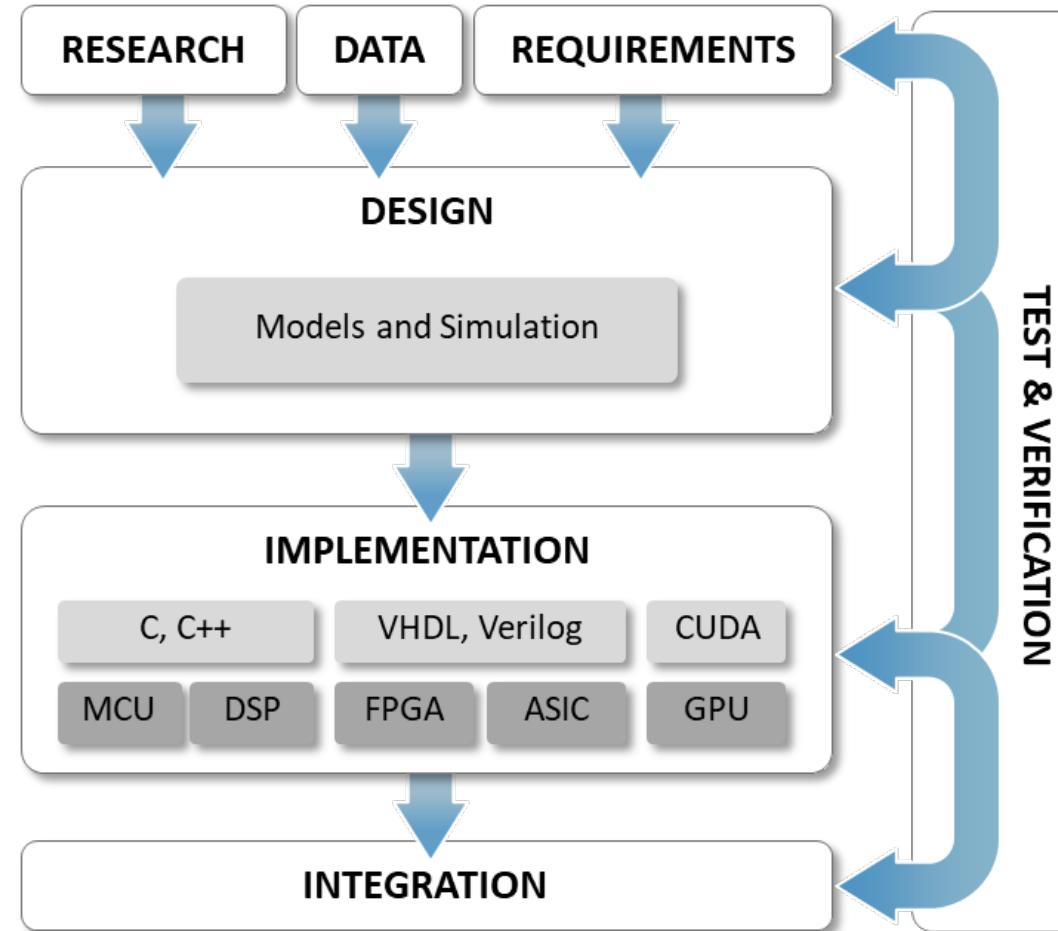


<https://armkeil.blob.core.windows.net/developer/Files/pdf/wite-paper/arm-aws-edge-environmental-parity-wp.pdf>

Parity Levels Use Cases

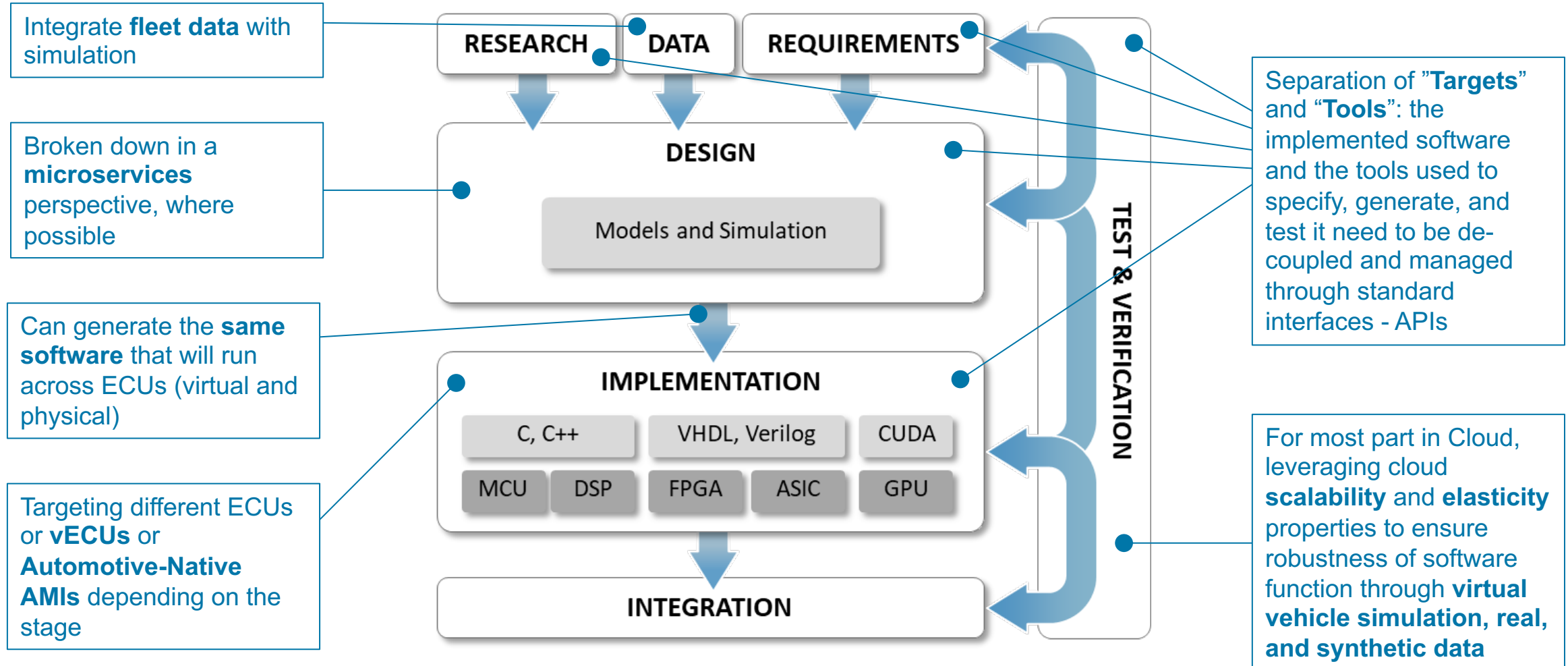


Model-Based Design Workflow



<https://www.mathworks.com/content/dam/mathworks/white-paper/gated/auto-model-based-design-with-simulation-white-paper.pdf>

Model-Based & Cloud-Native Design Workflow

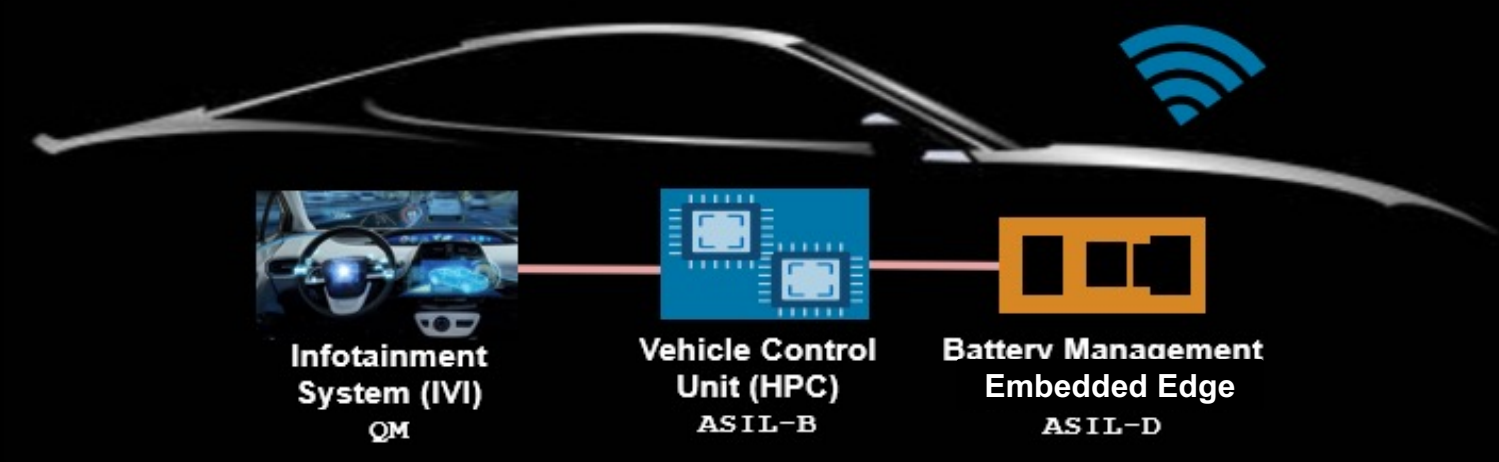


<https://www.mathworks.com/content/dam/mathworks/white-paper/gated/auto-model-based-design-with-simulation-white-paper.pdf>

SDV Development in Action - Demo Vision



“Sport+” Mode
 ▲ TrqDemand ▲ MaxBattCurrent
 ▲ RegenOperation



Infotainment System (IVI)
QM

Vehicle Control Unit (HPC)
ASIL-B

Battery Management Embedded Edge
ASIL-D



SDV Development in Action - Demo Vision

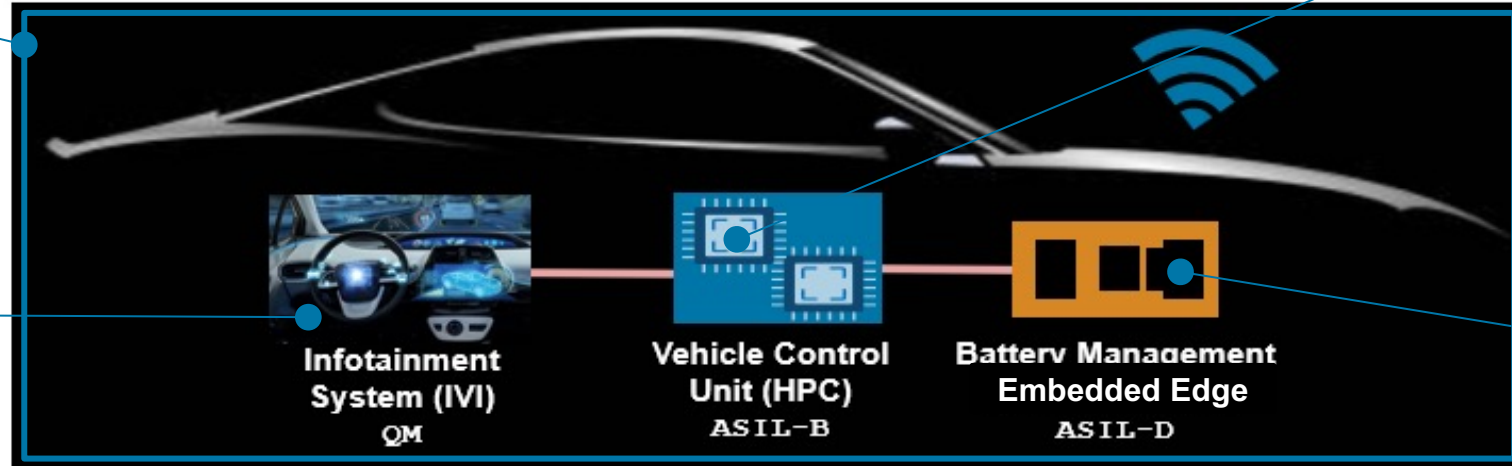


“Sport+” Mode

- ▲ TrqDemand ▲ MaxBattCurrent
- ▲ RegenOperation

Elektrobit Adaptive Autosar
Virtual ECU running on a POSIX containerized environment on AWS Graviton EC2

Model-Based Design and integration in **Simulink**



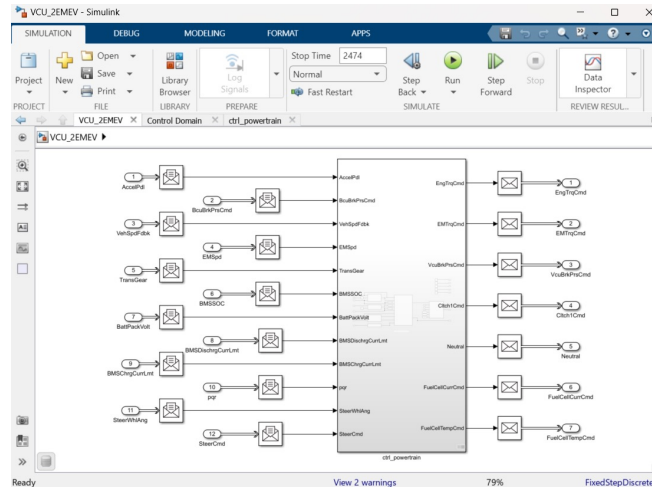
Automotive-Native **Amazon Machine-Image (AMI)**

Elektrobit Classic Autosar ECU
Level 3 emulation and simulation with **Synopsys Silver**



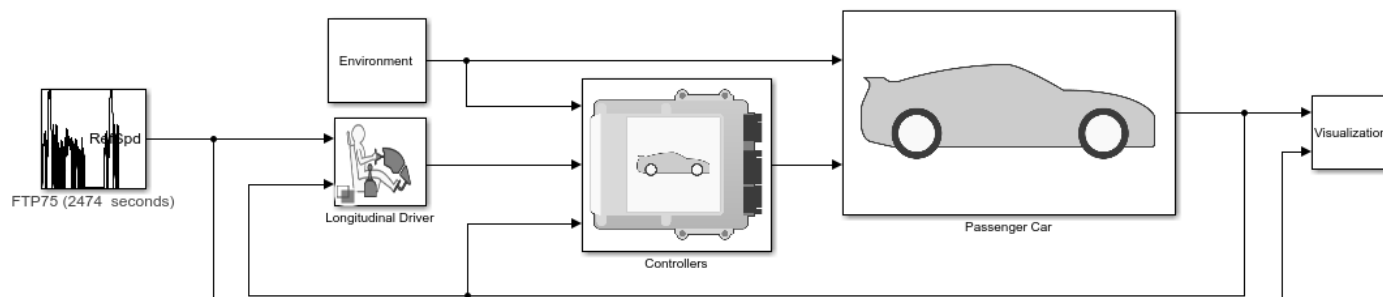
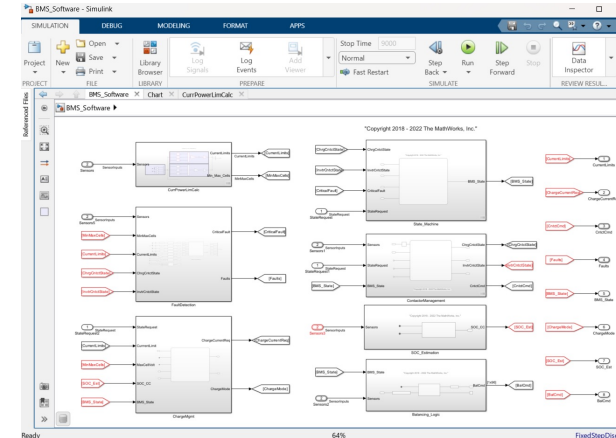
SDV Development in Action – Simulink Workflow

Vehicle Control Unit (VCU) Model



Update Control strategies

Battery Management System (BMS) Model



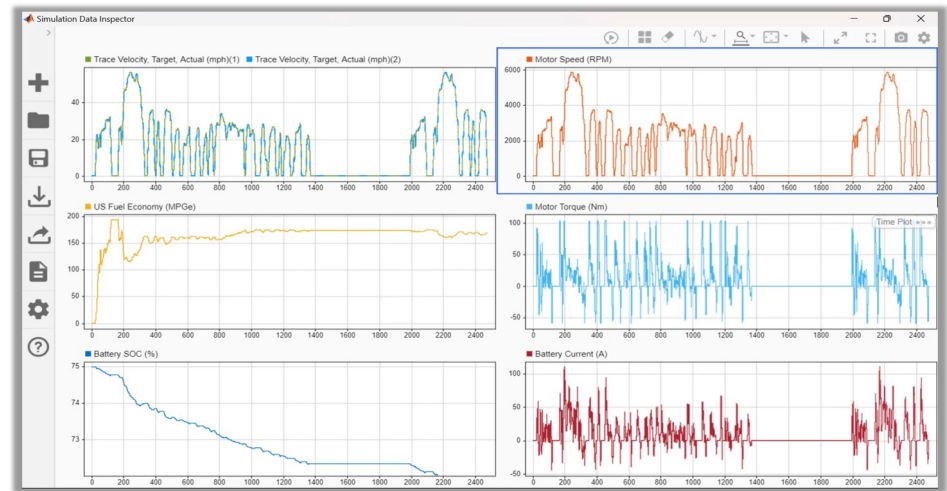
Analyze Power and Energy

Variant Selected: Powertrain Blockset
Toggle To Simscape Electric Plant

Help

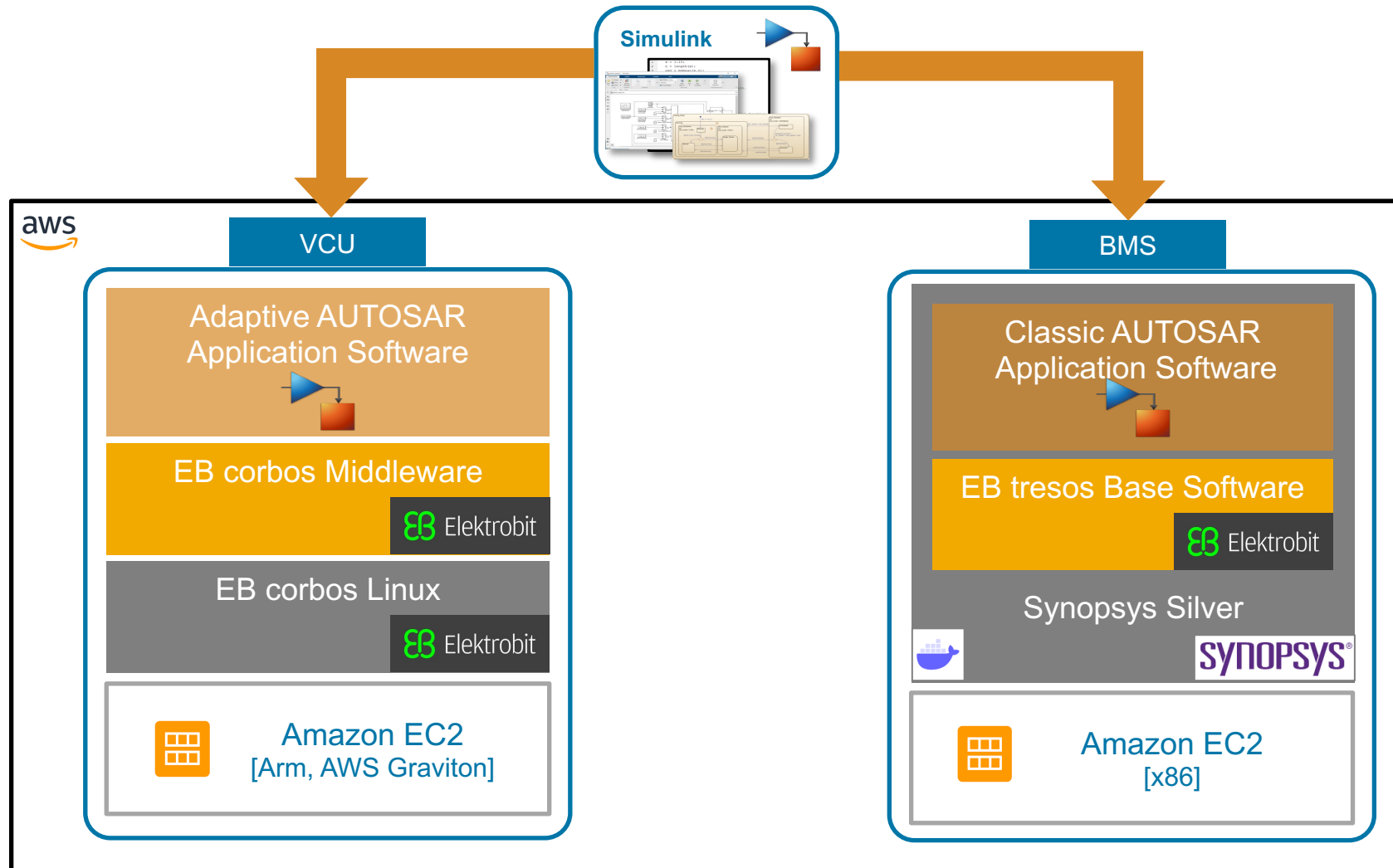
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Integrate VCU and BMS into Virtual Vehicle Model

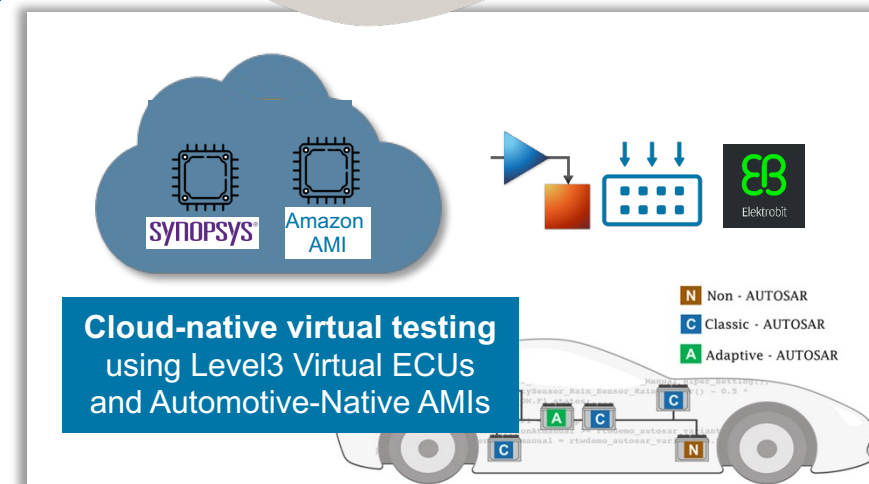
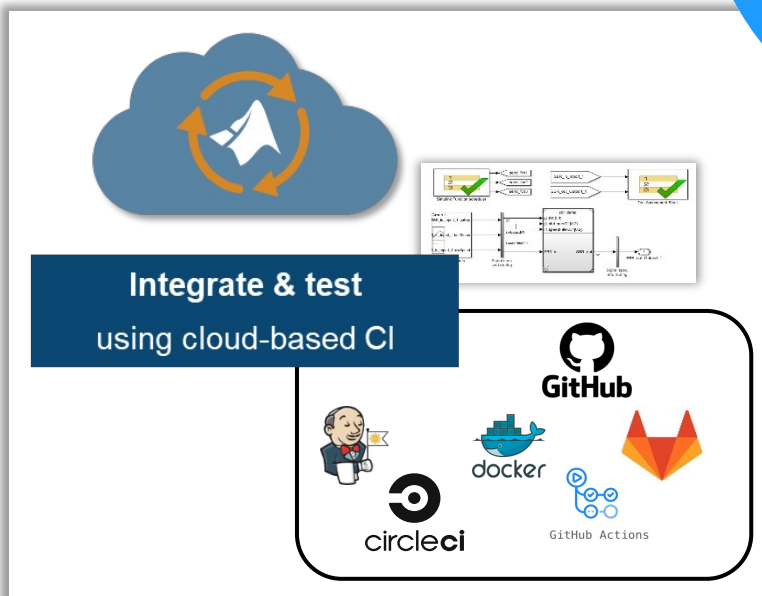
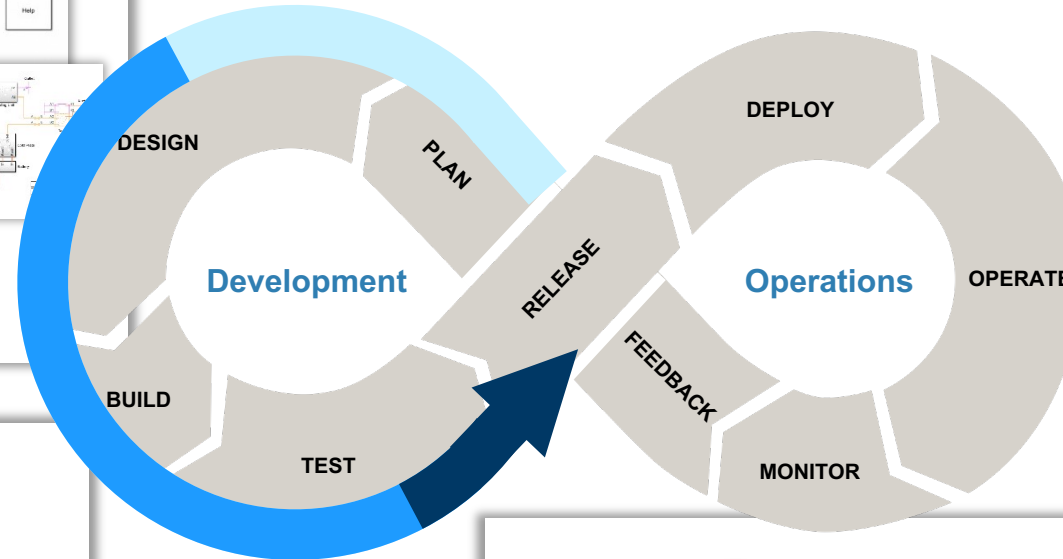
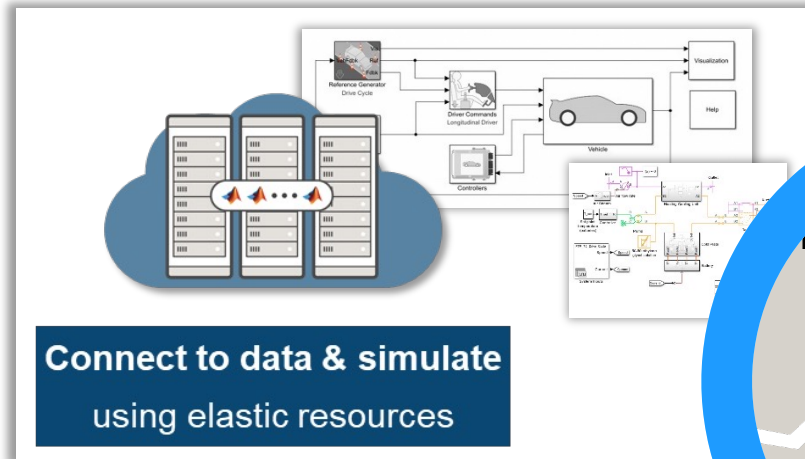


Analysis of Cloud based Simulation Data

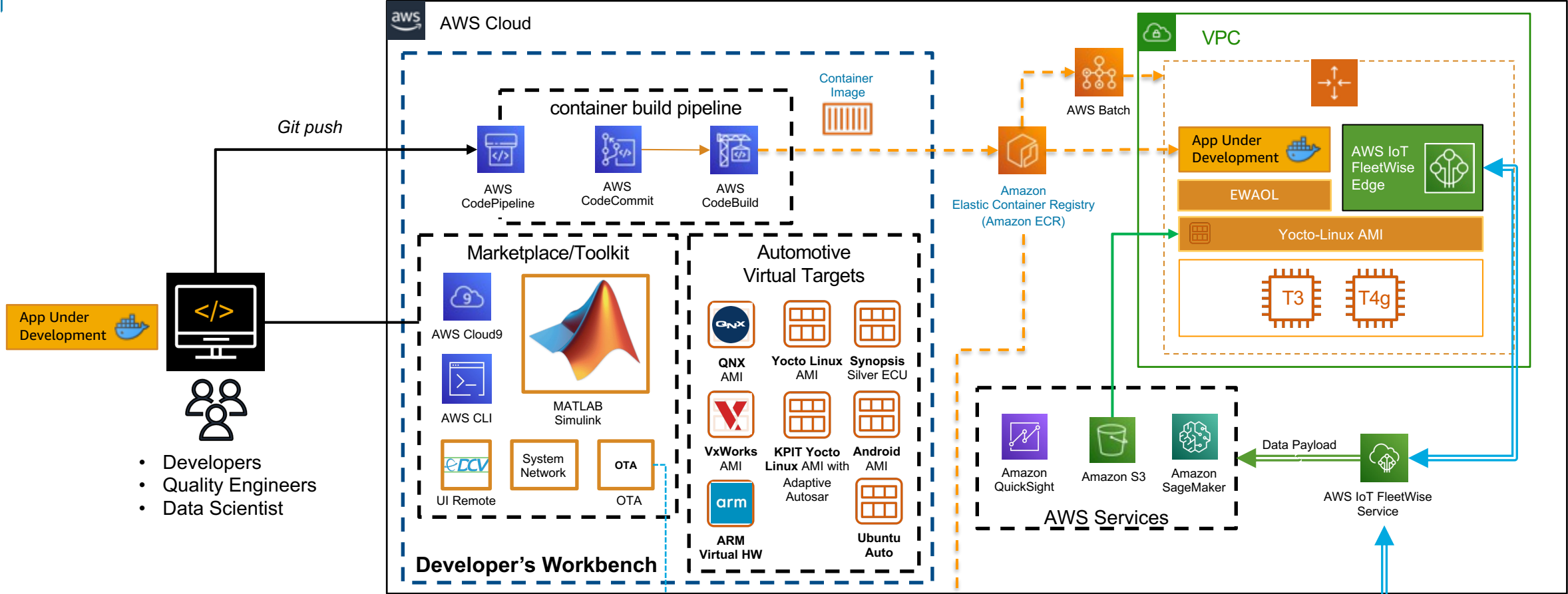
SDV Development in Action - Cloud Deployment / Step 1



SDV Development in Action: connect to DevOps



Conclusion



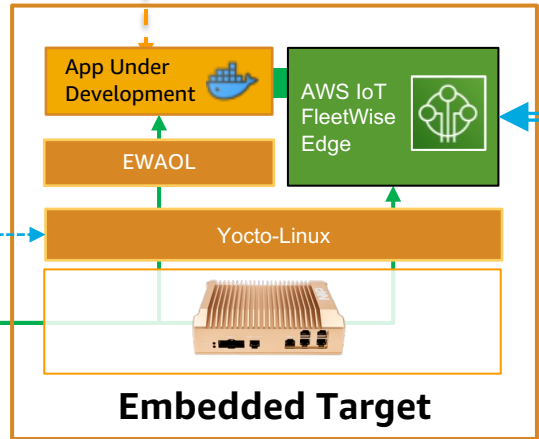
App Under Development



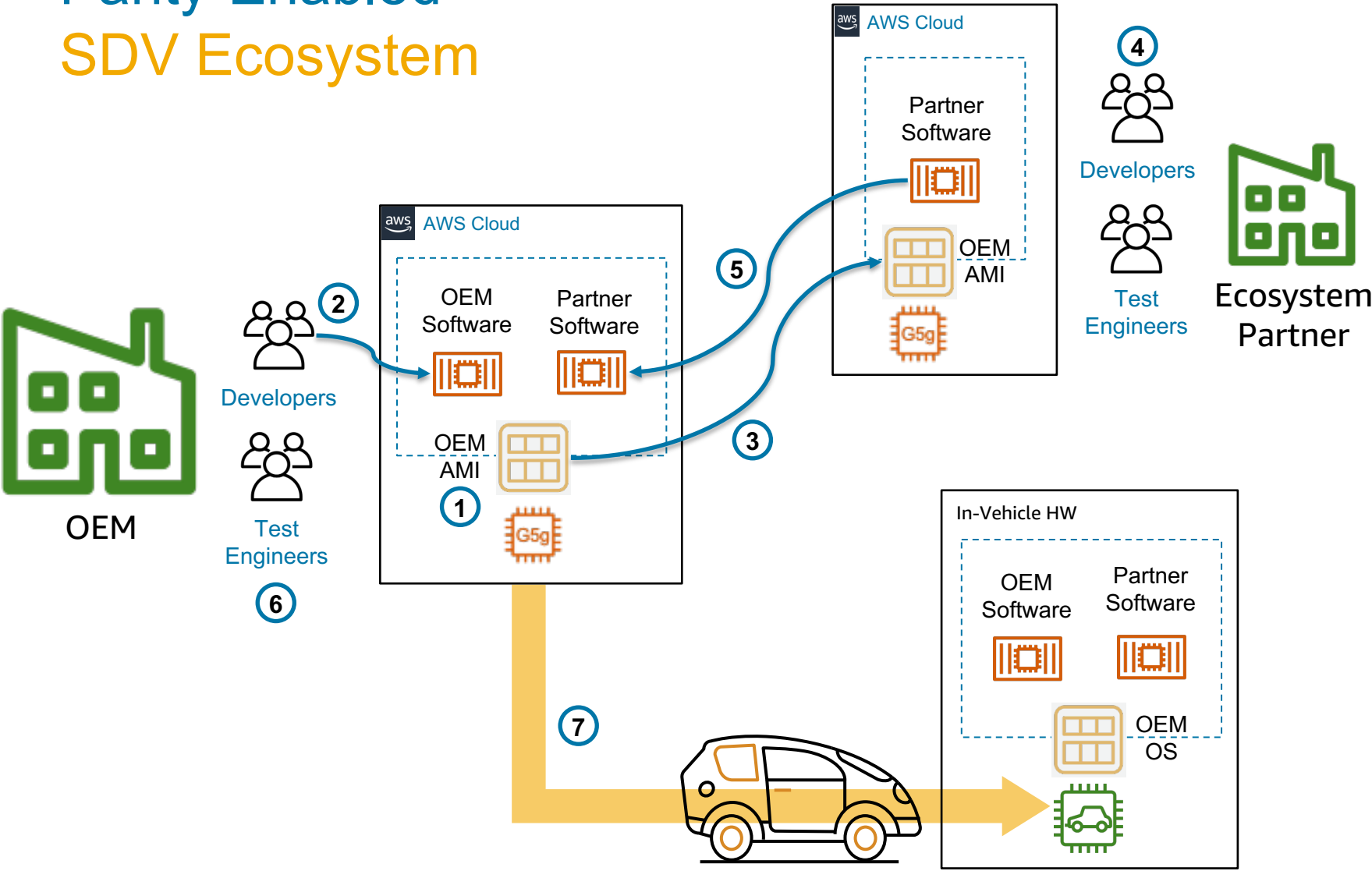
- Developers
- Quality Engineers
- Data Scientist

SDV:
 a **CONCEPT**
 architecture

CAN Network



Parity-Enabled SDV Ecosystem



- 1 OEM creates and maintains "native" OEM AMIs and vECUs
- 2 OEM developers can start to develop native applications on AWS Cloud
- 3 OEM distributes the OEM AMI to its ecosystem of partners
- 4 Using the native OEM AMI, partners can develop and test containerized applications and services
- 5 The partner submits the container back to OEM
- 6 OEM validates the containerized app/service
- 7 The containers are deployed in production vehicles

Final remarks

- SDV is happening, and requires a deep transformation of the tools and workflows in automotive
- Model-Based is a first layer of abstraction perfect to design SDV systems!
Thanks to the collaboration with MathWorks, we can provide our customer with even more powerful and “SDV”-aligned Model-Based tools, properly architected, and leveraging cloud-native practices.
- Please come to see the demo in the demo area!

Automotive Customers

TOYOTA

STELLANTIS

**BMW
GROUP**

HONDA
The Power of Dreams

VOLVO

WirelessCar

TATA

RIVIAN

JAGUAR

**LAND
ROVER**

SCANIA

VOLKSWAGEN
AKTIENGESELLSCHAFT

BlackBerry®

DENSO

HARMAN
A SAMSUNG COMPANY

Continental

in
mobileye™

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Thank you

