SOAFEE

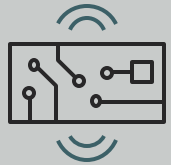
Cloud-First Automotive Development: a **Big Loop** with **Parity**

Kazuo Kajimoto, Stefano Marzani

Sep 21st, 2023

Vehicle Software complexity is growing

Today's vehicles



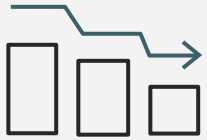
Number of ECUs

>100

Lines of code

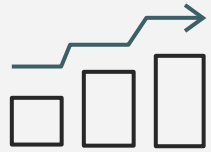
100–150M

Fully software-defined vehicles



Number of ECUs

Consolidating



Lines of code

Increasing

Software-defined vehicles journey

Breaking down SDV

Hardware abstraction

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

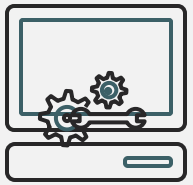
SW & Devices lifecycle management

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

Vehicle data management

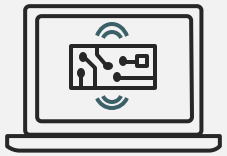
Enabling automotive customers to unlock enterprise-wide value from connected car data

How cloud can help



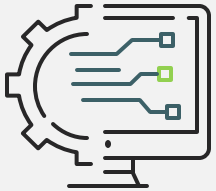
Virtual workbenches

Enabling developer efficiency through platform engineering concepts focused on providing self-service, global use and security, reduction in Hardware dependency, consistent reproducible SW artifacts and toolchains



Virtual Electronic Control Units (vECUs) and Targets

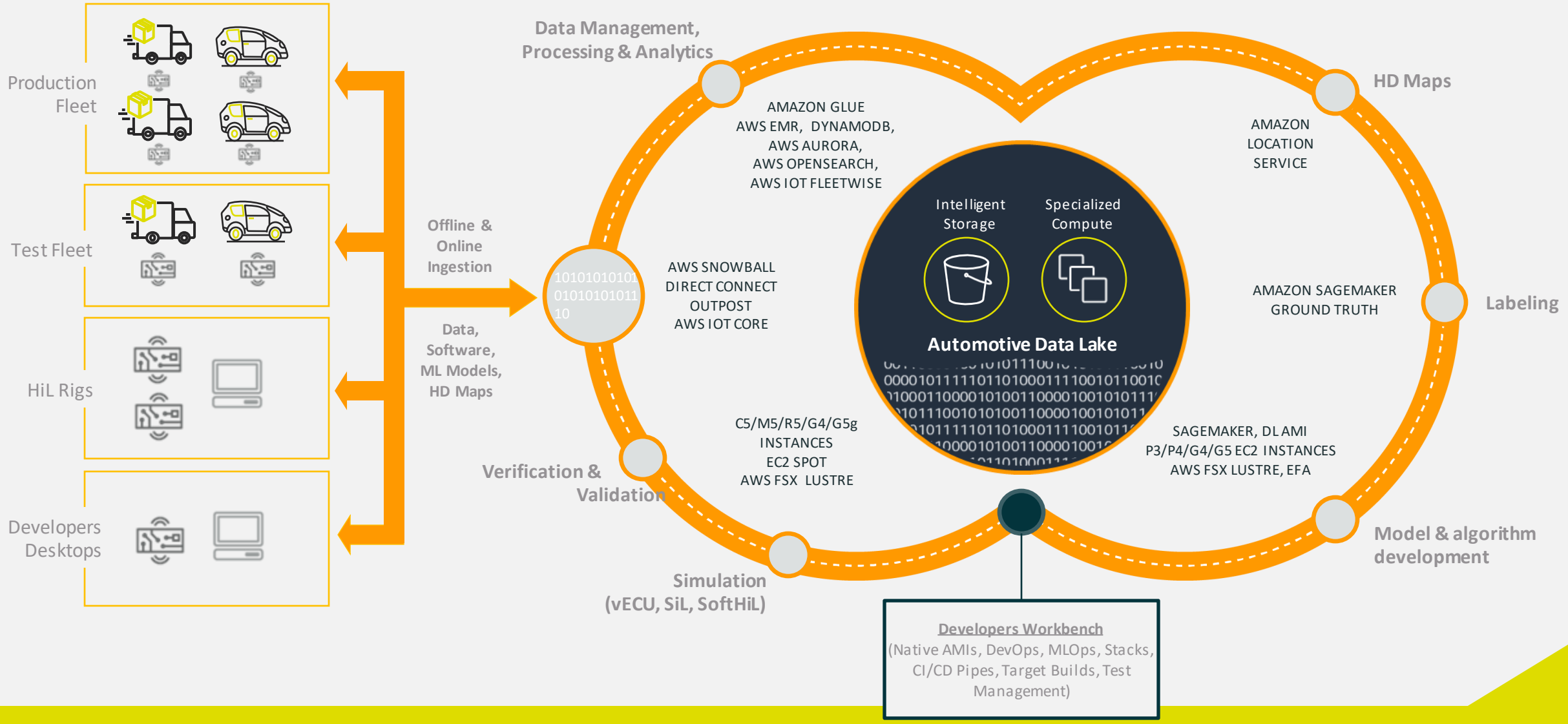
Enabling a seamless experience between a developer's local environment, the cloud, and the vehicle



Cloud-Native Automotive Software

Rearchitecting automotive software stacks and tools to facilitate software modularity, portability, and integration

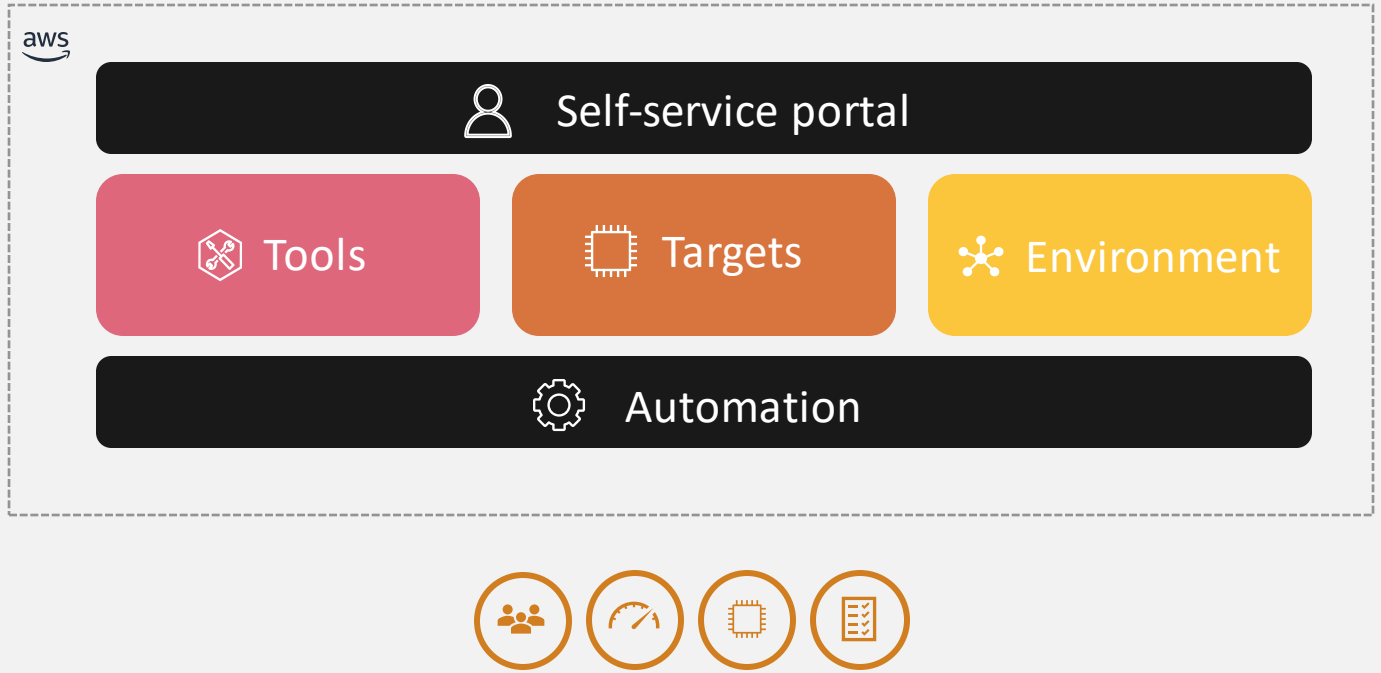
Automotive Development Workflow: a Big Loop



Virtual Engineering Workbench (VEW)

The Virtual Engineering Workbench consists of three main pillars: tools, targets and environment. We manage that on the platform and the interface to the user is a self-service portal empowering to do things in a fully automated manner.

- Predefined use case specific environments with all of the **tools**, IDE's, licensing – everything that enables a user to get started on a use case.
- Various levels of abstractions of the **target** platform that the user builds for.
- The **environment** is the input, in different levels of abstraction or fidelity, that we give to the workload on the targets to verify their function,



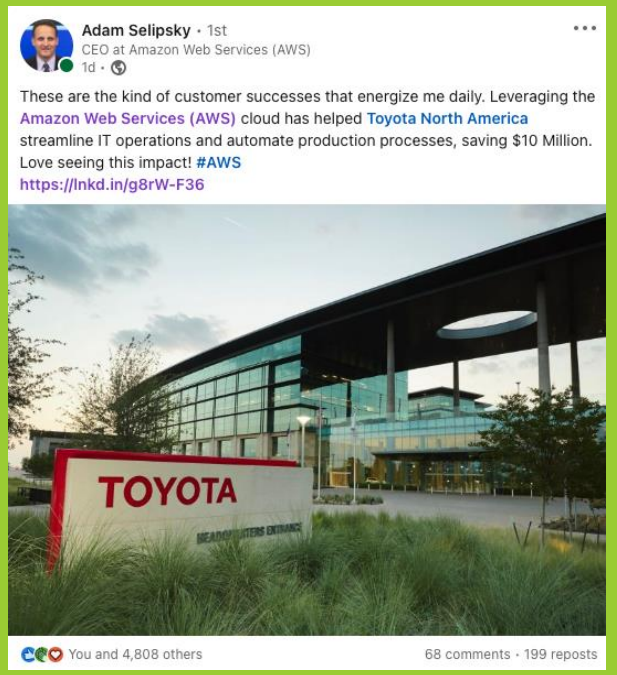
Engineering Workbench / Customers

“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”

Continental
The Future in Motion

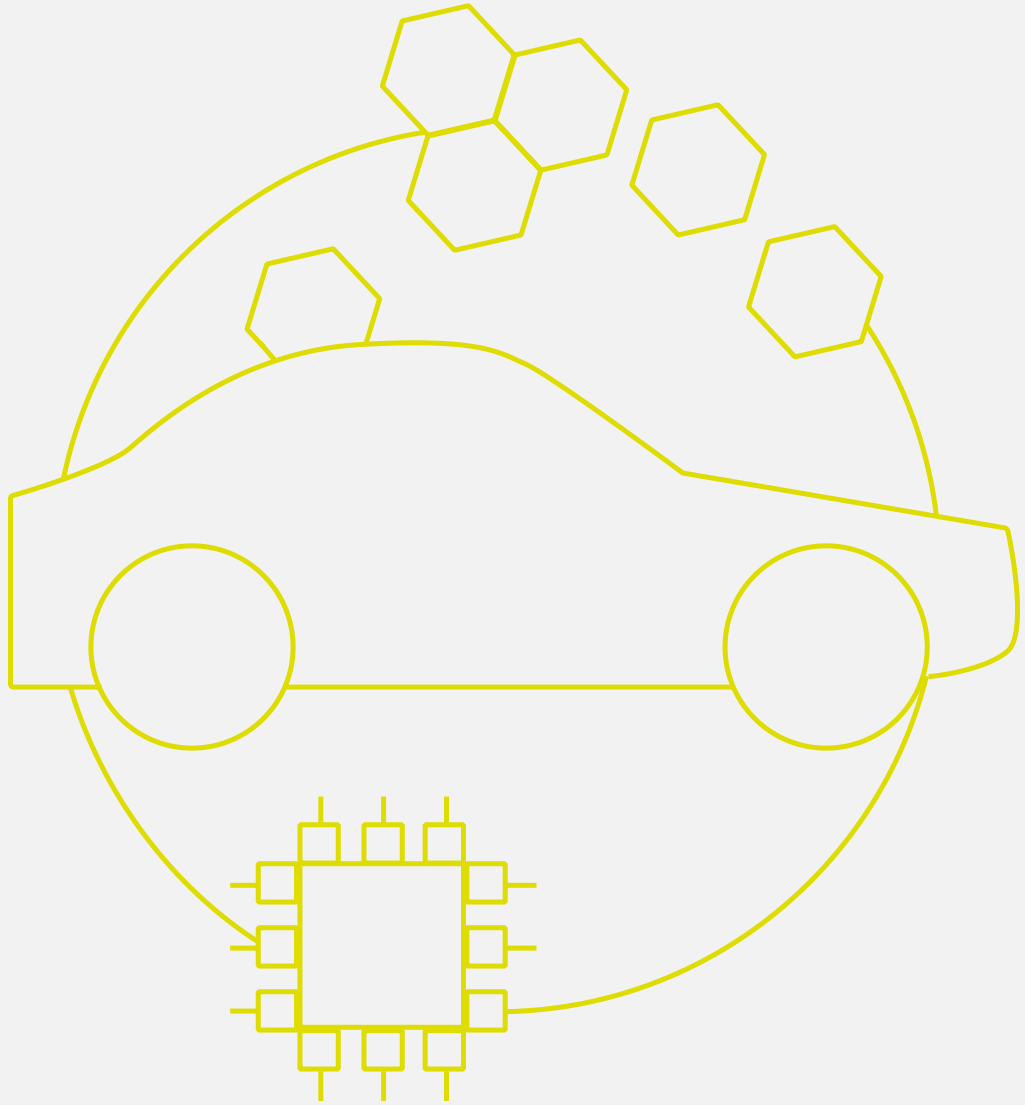
“Both companies are creating a cloud-based product development environment called the “Virtual Engineering Workbench,” which provides automated workflows to manage software development and testing, high-performance simulations, machine learning model training, and data collection and analysis. ”

STELLANTIS



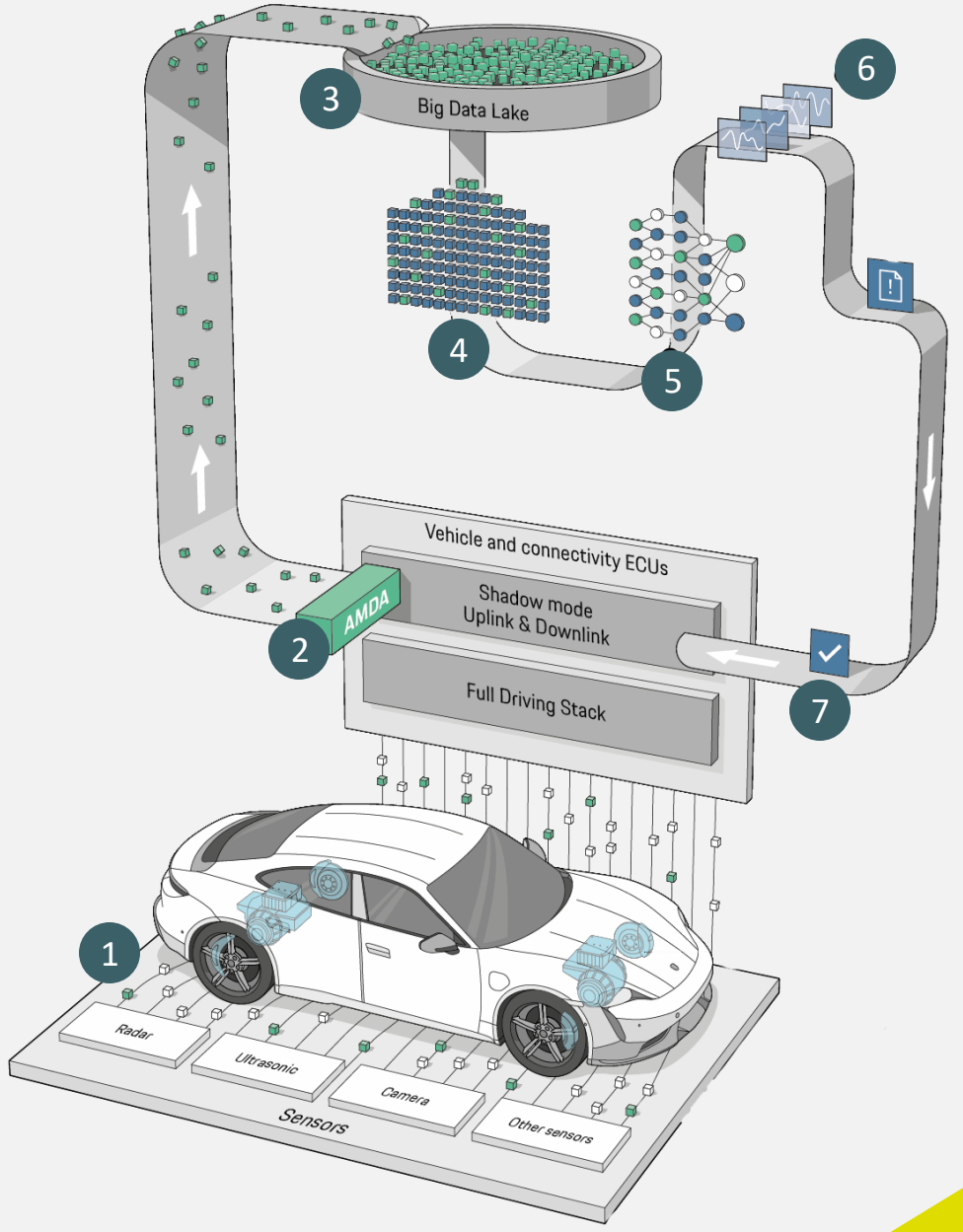
SOAFEE

Automotive is a “**Big Loop**”…



Enter **Big Loop**

1. Vehicle Sensors provide data
2. An algorithm selects relevant data to be transferred to the Cloud
3. Data is collected in the Cloud
4. Variants of the situation are generated in Cloud
5. Neural Network is retrained
6. New software version is created
7. The new SW release is uploaded over the air to the vehicle and activated



The Big Loop: artificial intelligence and machine learning; Porsche Engineering; July 2021, LINK

Connected Vehicle platform architectural layers

Cybersecurity protection & lifecycle management

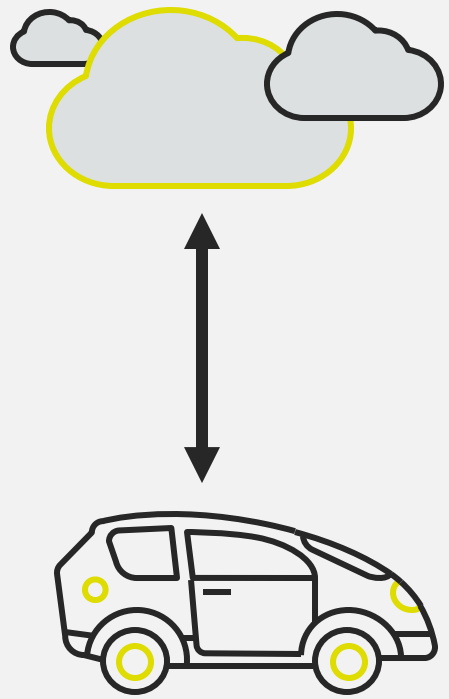
Applications layer
Business use cases, differentiation (Kinesis Video Streams)

Operations layer
Monitoring, customer support, deployment

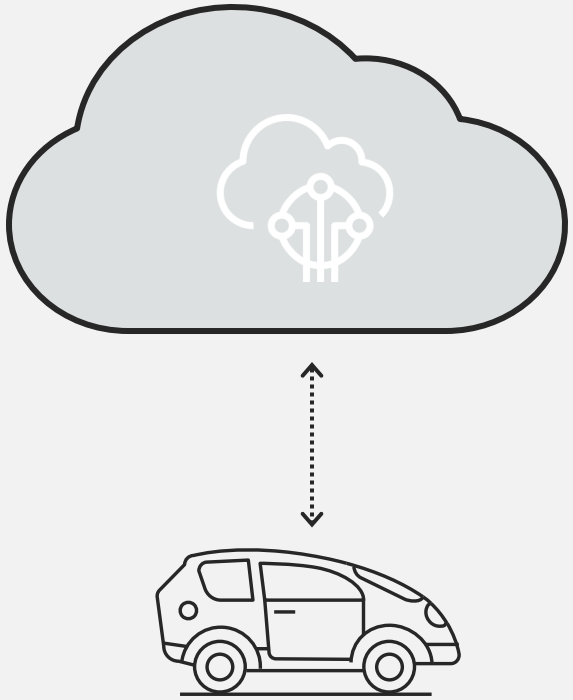
Data abstraction layer
Model, select, collect

Connectivity layer
Secure connection from vehicle to cloud (MQTT)

Device layer
Hardware abstraction, OS, device onboarding and management



AWS IoT Core is the optimal MQTT message broker for Connected Vehicle platforms



AWS IoT Core is a **fully managed** service that securely connects **millions of vehicles** and routes **trillions of messages** to AWS

Millions	Trillions	99.9%+
Devices connected to the cloud	Messages routed to and from the cloud every month	AWS IoT Core uptime Service Level Agreement

AWS IoT FleetWise

Standardized vehicle data

Analyze fleet-wide vehicle data by creating a common data format using virtual vehicle modeling

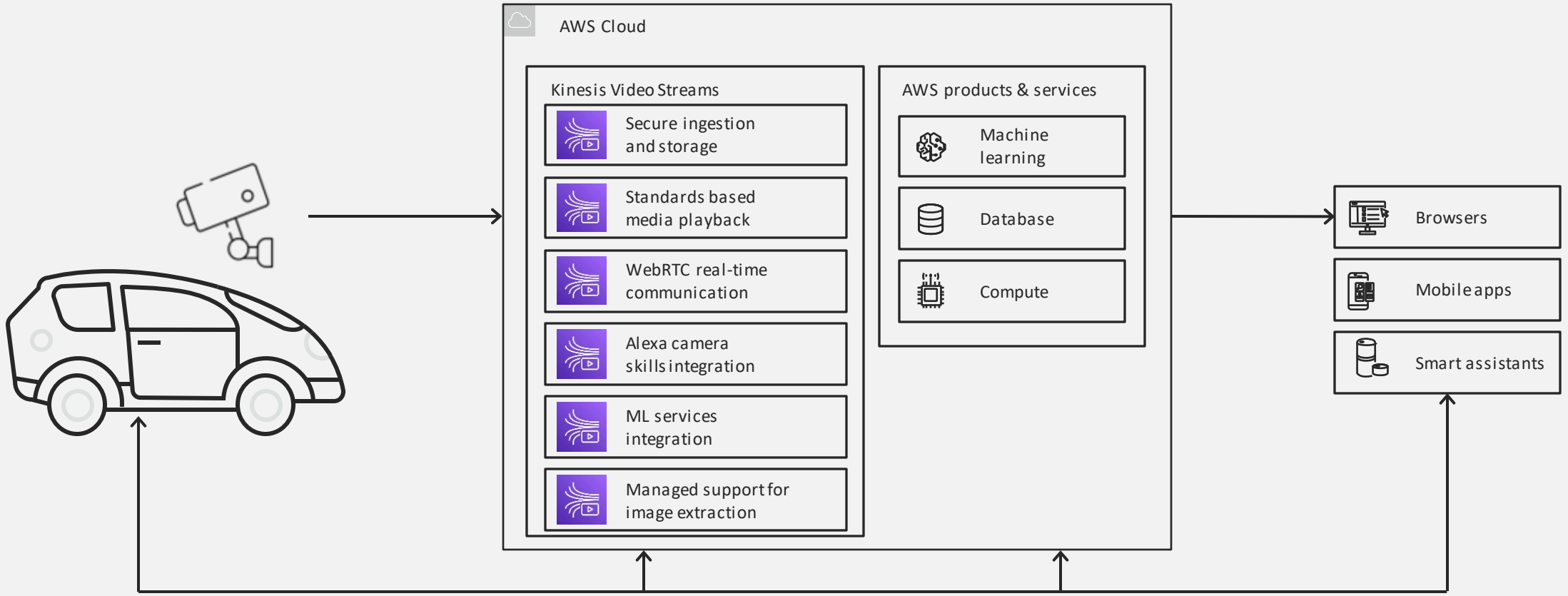
Intelligent data collection

Improve data relevance with time- and event-based data collection campaigns that give access to more useful data in the cloud

Near real-time data

Take quick, corrective action by notifying teams when problems occur

Kinesis Video Streams



Connect Vehicle camera and audio devices with open-source Kinesis Video Streams SDKs to securely stream media or upload clips

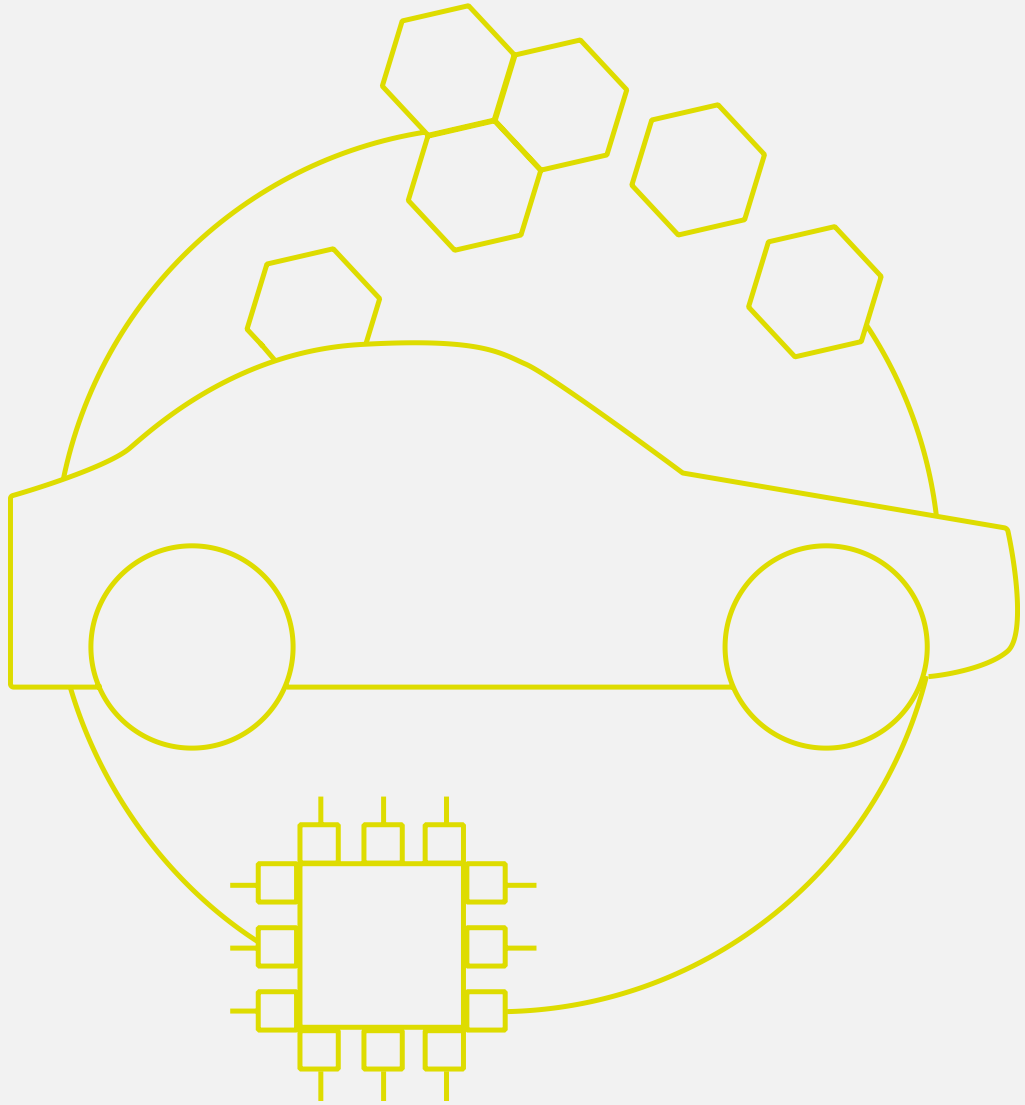
Ingest media in Kinesis Video Streams for secure storage, on-demand playback, and integration with ML services; connect over WebRTC for real-time communication and smart assistant integration

Connect to AWS AI/ML services for computer vision and other AWS services to build a unique product experience

Develop customer-facing apps and experiences

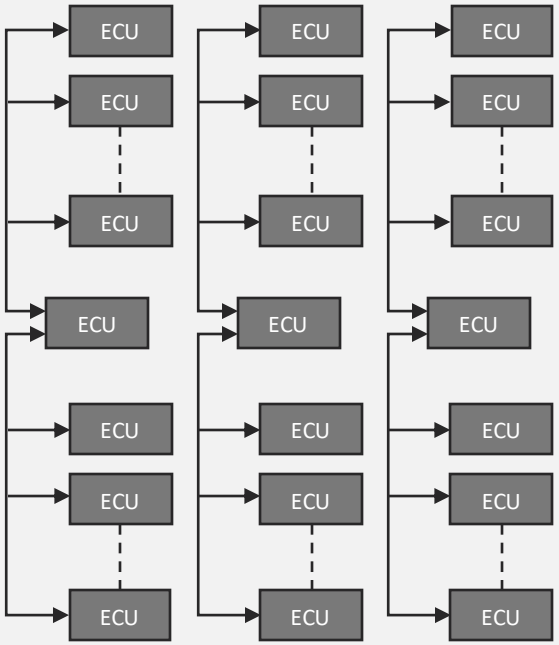
SOAFEE

Automotive is a “**Big Loop**” that requires “**Parity**”



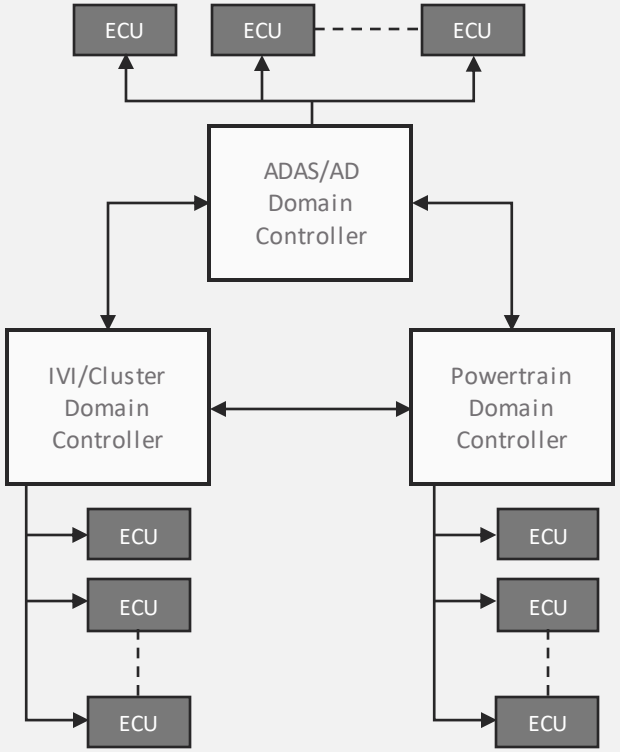
E/E Architectural Evolution

Traditional Architecture



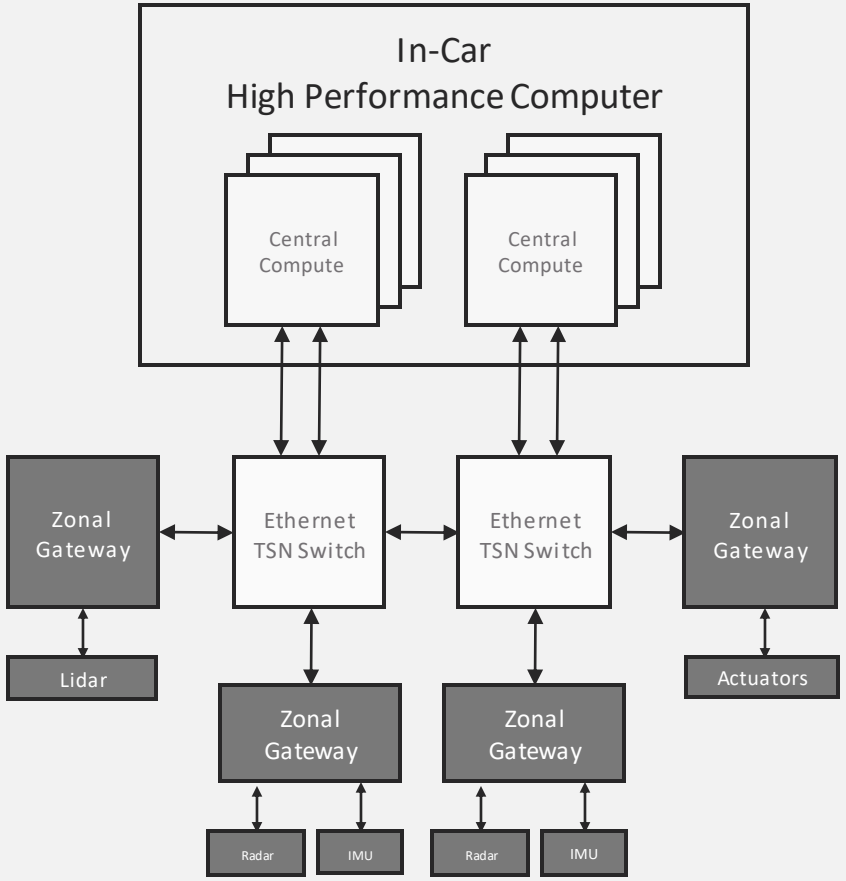
Legacy

Domain Architecture



Today

Zonal Architecture

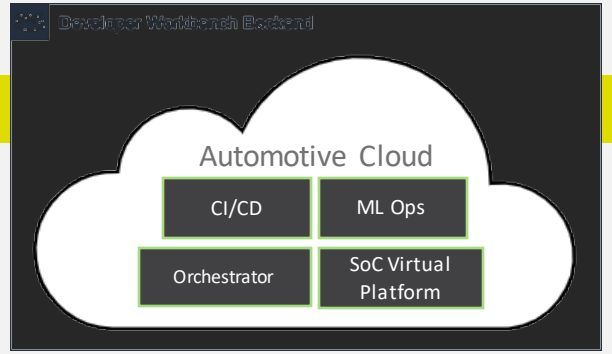


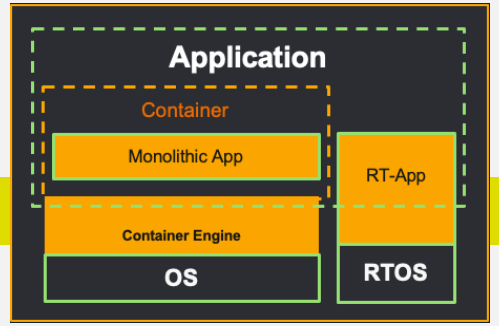
Next Generation

Cloud-Native In Automotive Is A Journey

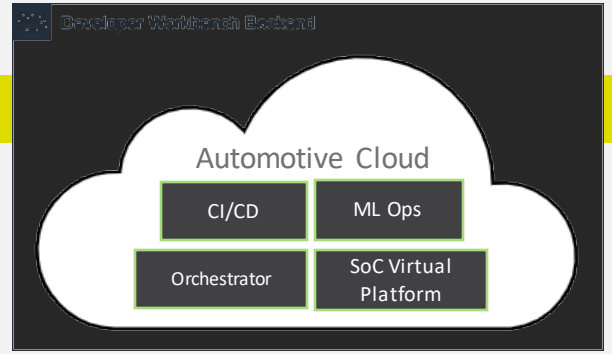
Cloud-Native Development
- DevOps / MLOps
- Continuous Delivery
- Microservices based approach
- Containers for SW parity
- Environmental parity at multiple levels

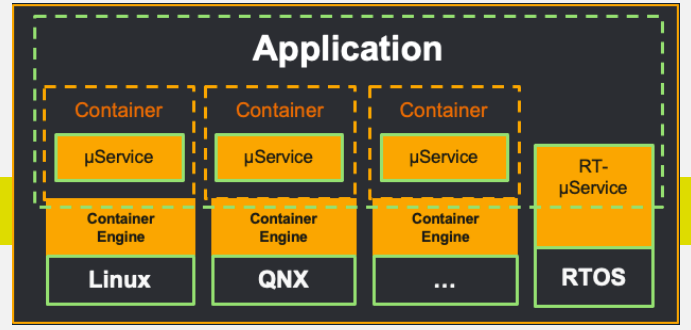
Monolithic Automotive Stack



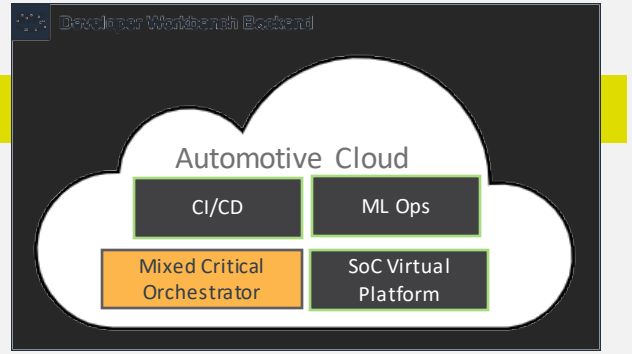


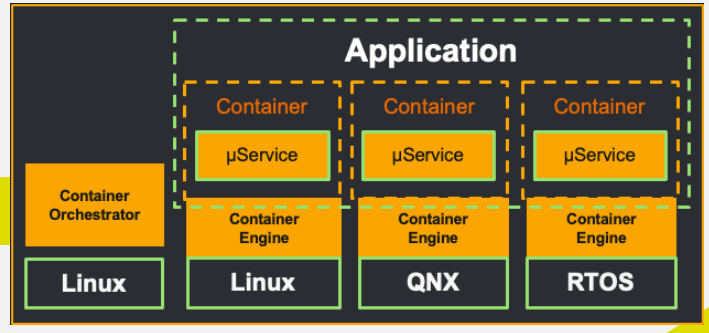
Microservices Based Automotive Stack





Microservices Based Automotive Stack With **Mixed Criticality Orchestrator**





AWS Graviton

Graviton

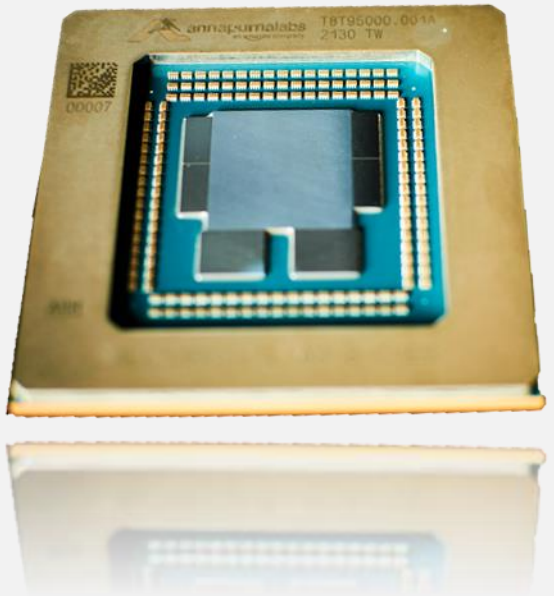
2018

Graviton2

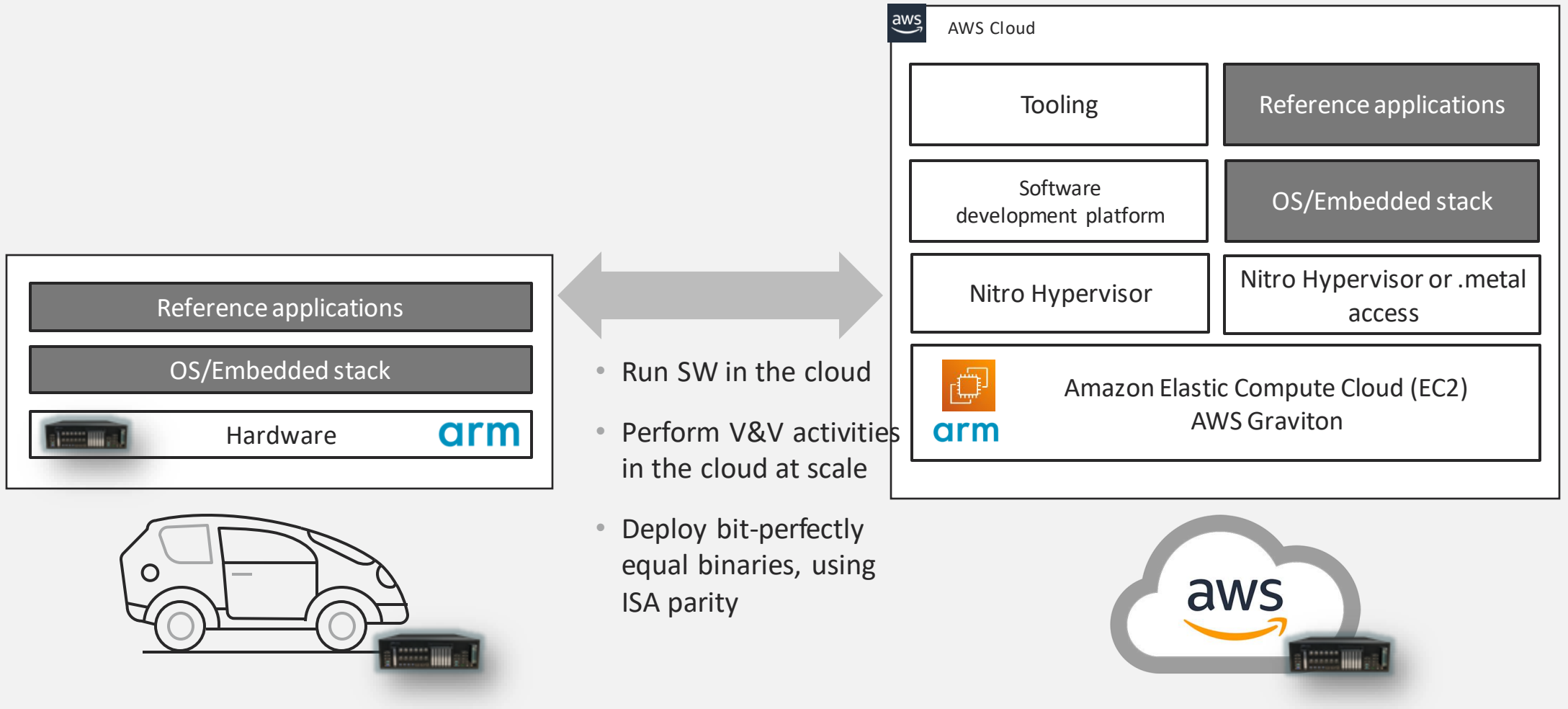
2019

Graviton3

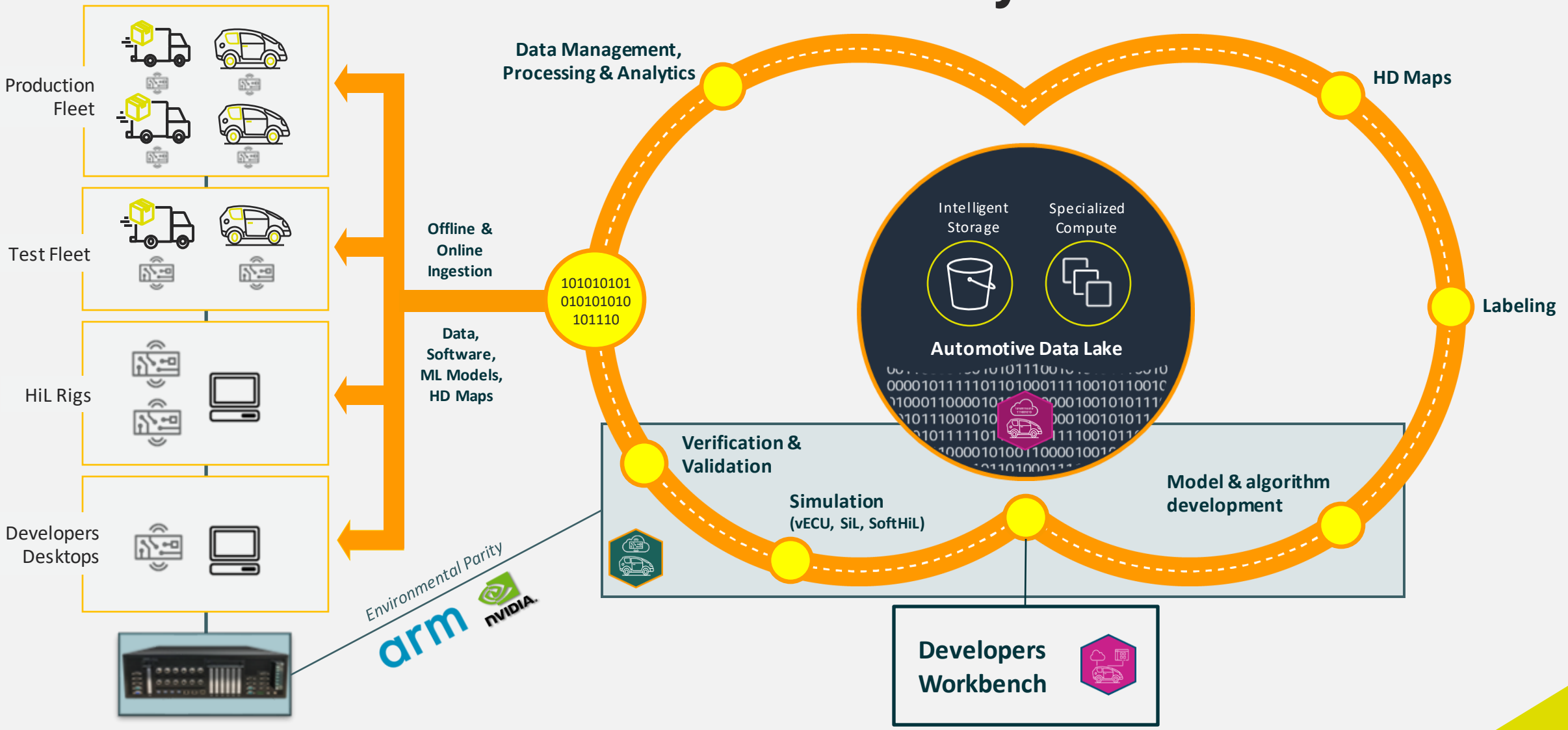
2021



Environmental parity with AWS Cloud and Arm

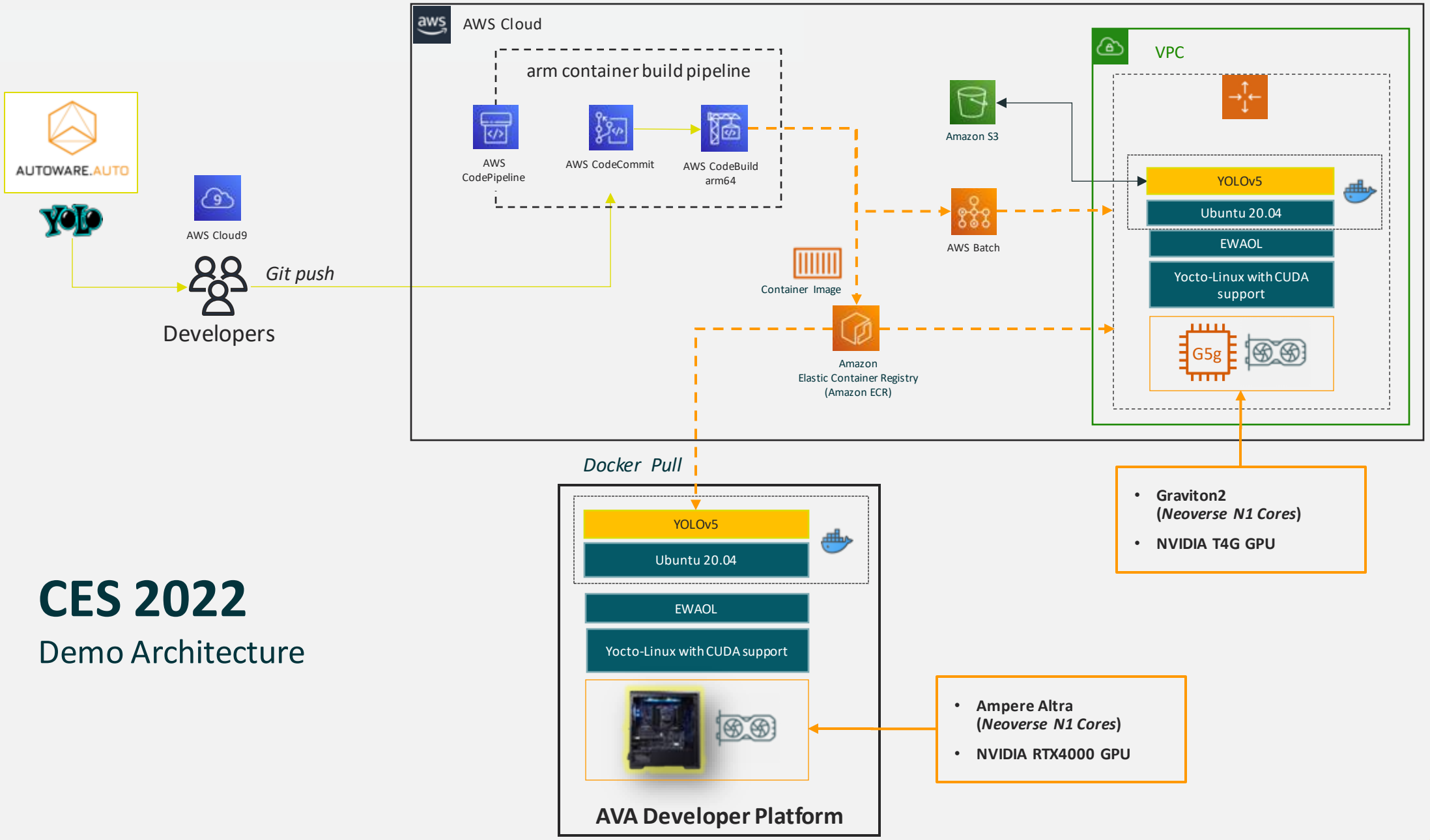


Native Environment Execution Parity

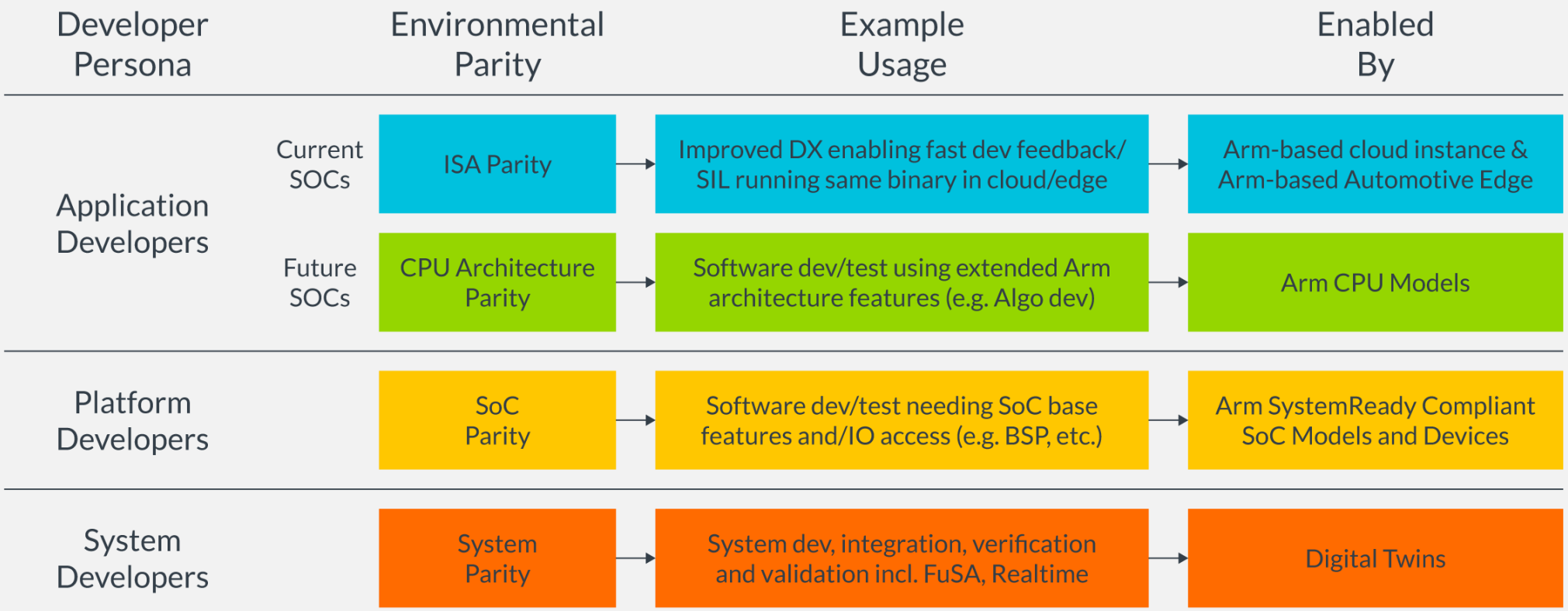


CES 2022

Demo Architecture

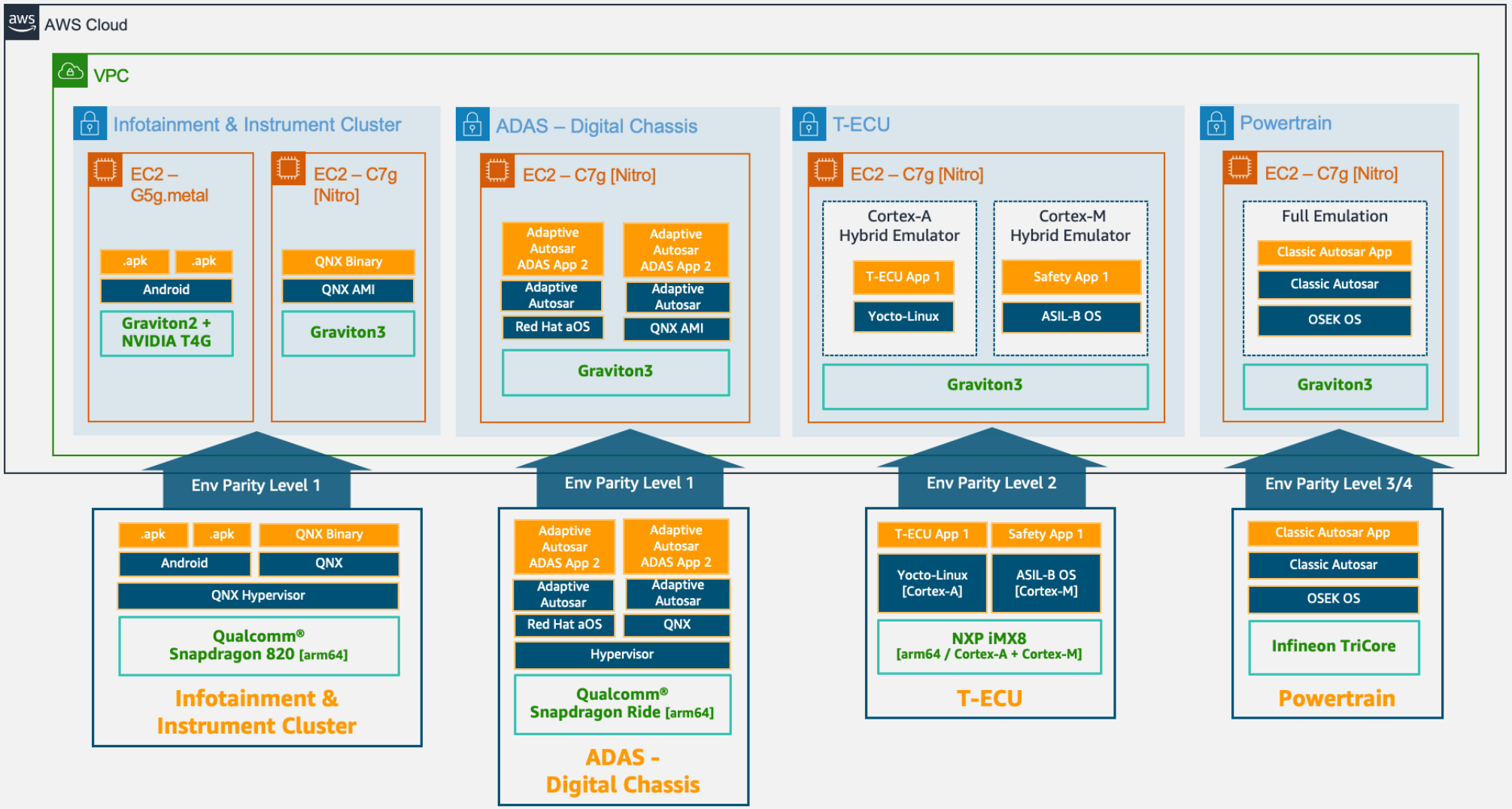


Environmental Parity

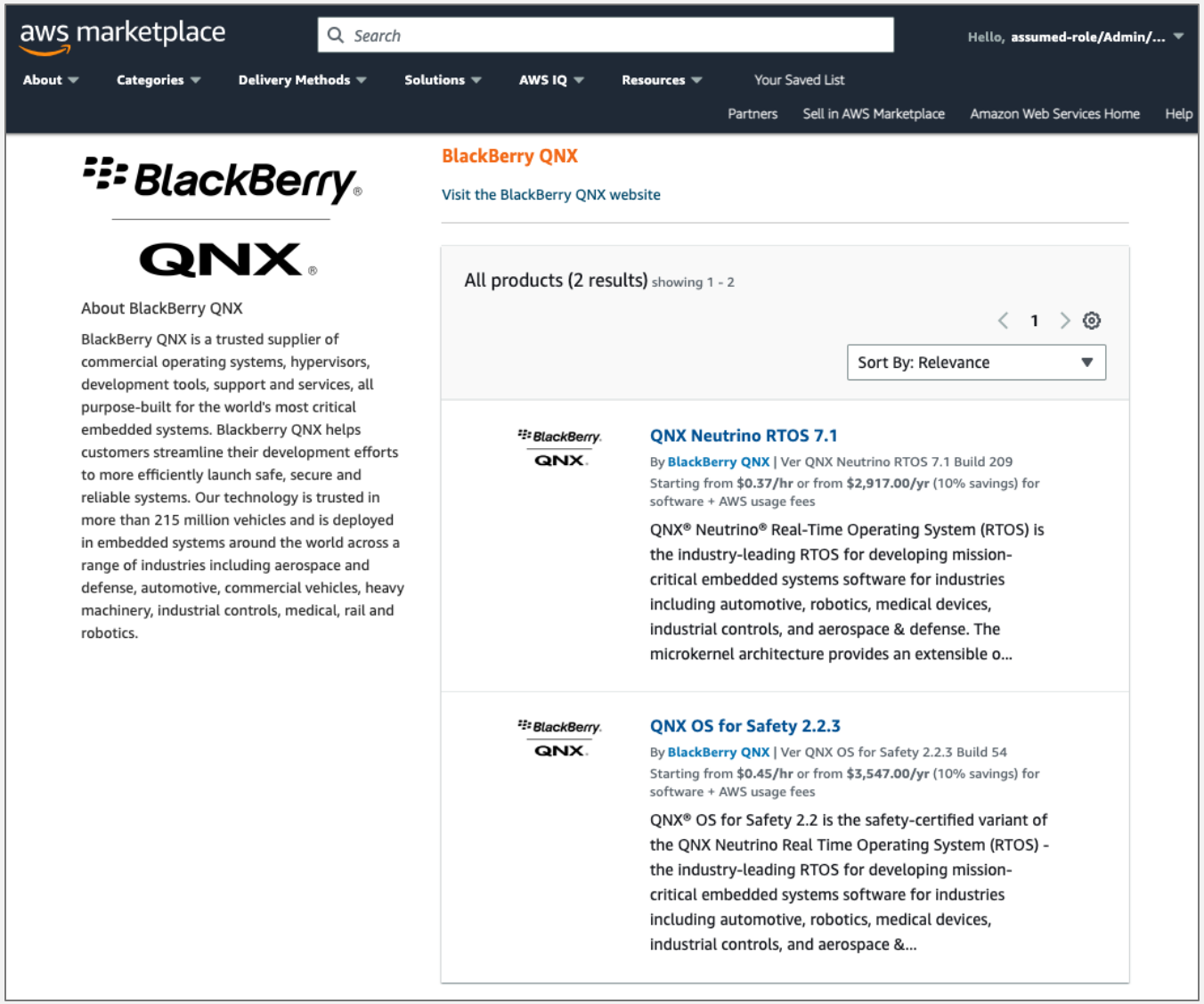


https://armkeil.blob.core.windows.net/developer/Files/pdf/white-paper/arm-aws-edge-environmental-parity-wp.pdf

Environmental Parity Examples

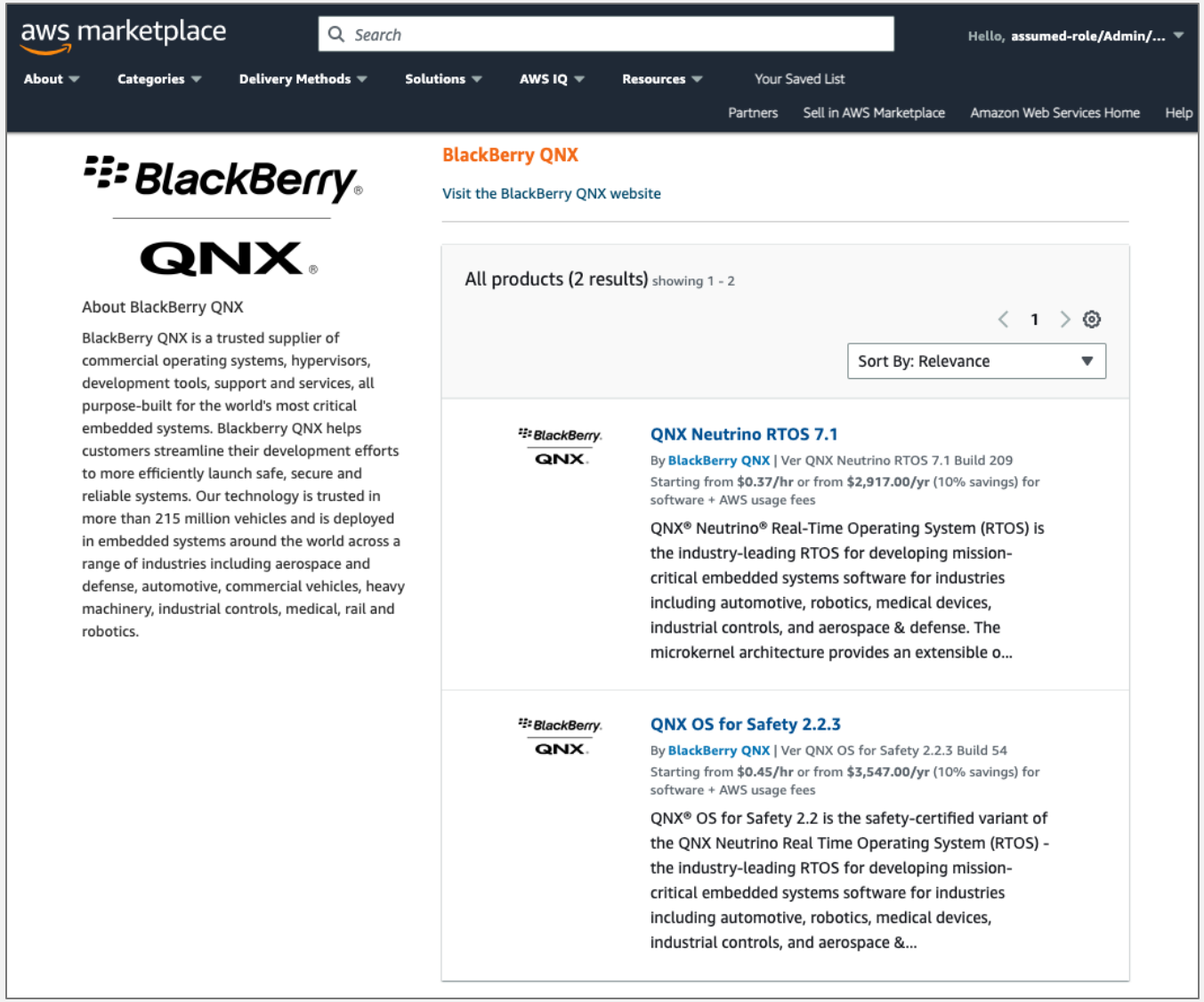


Example of an Automotive-Native AMI: QNX

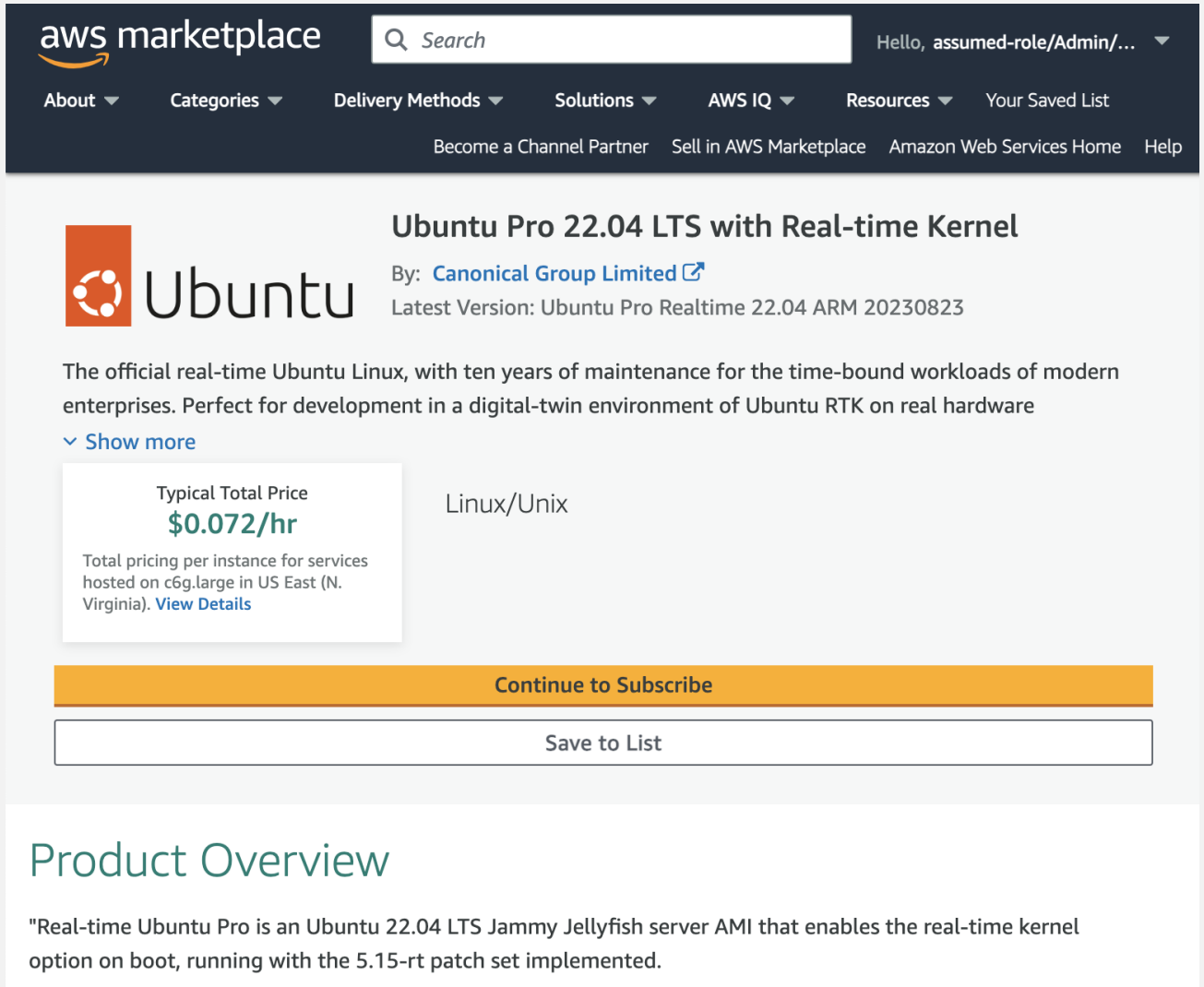


Workshop Link

Example of an Automotive-Native AMI: QNX



Example of an Automotive-Native AMI: Ubuntu RT*



Product Overview

"Real-time Ubuntu Pro is an Ubuntu 22.04 LTS Jammy Jellyfish server AMI that enables the real-time kernel option on boot, running with the 5.15-rt patch set implemented.

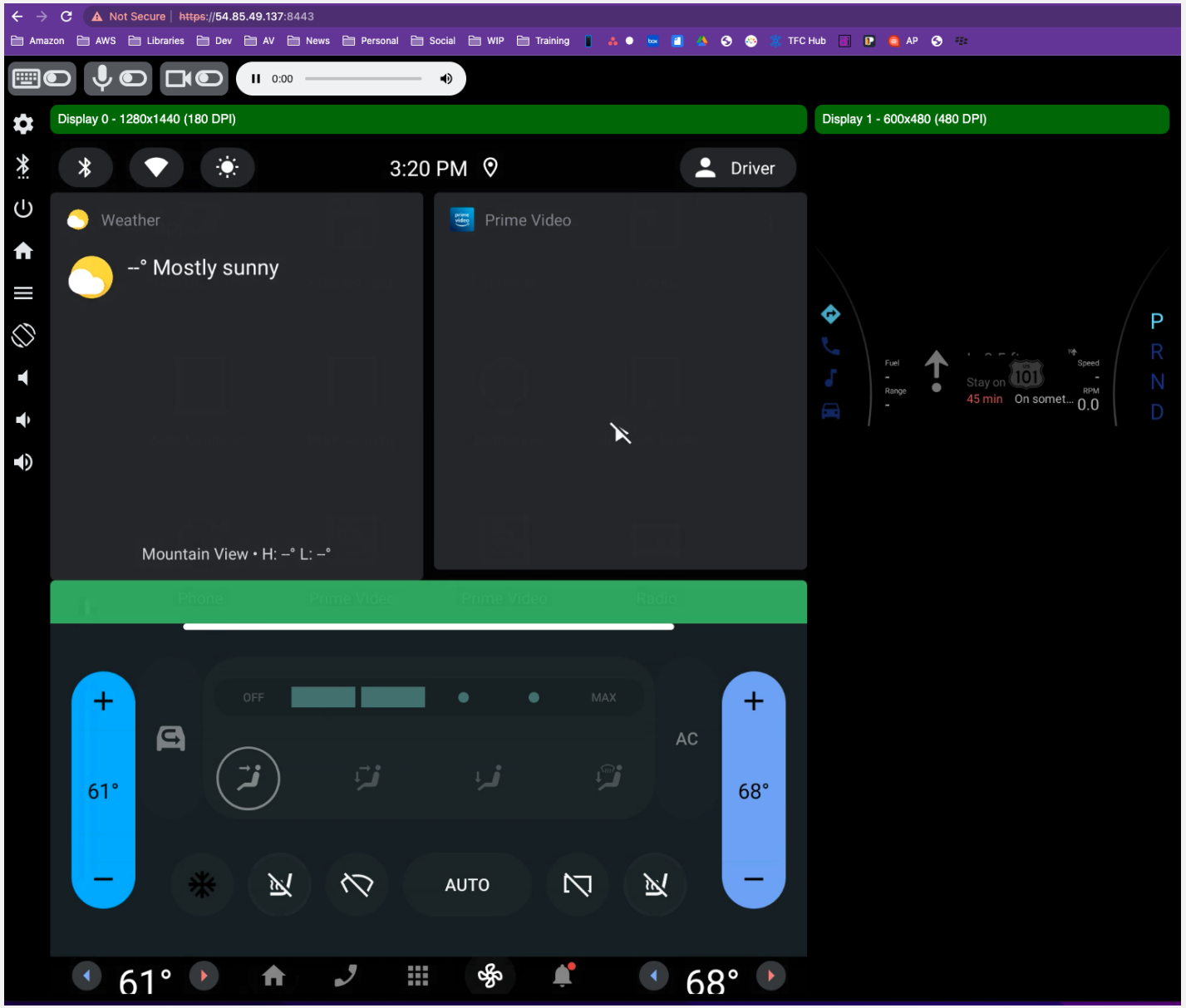
NEW

```
ubuntu@ip-172-31-51-159:~$ uname -a
Linux ip-172-31-51-159 5.15.0-1043-realtime #48-Ubuntu SMP PREEMPT_RT
 Thu Jul 13 20:54:21 UTC 2023 aarch64 aarch64 aarch64 GNU/Linux
ubuntu@ip-172-31-51-159:~$
```

i-086b473d312a4014b (Ubuntu RT)

PublicIPs: 18.246.8.107 PrivateIPs: 172.31.51.159

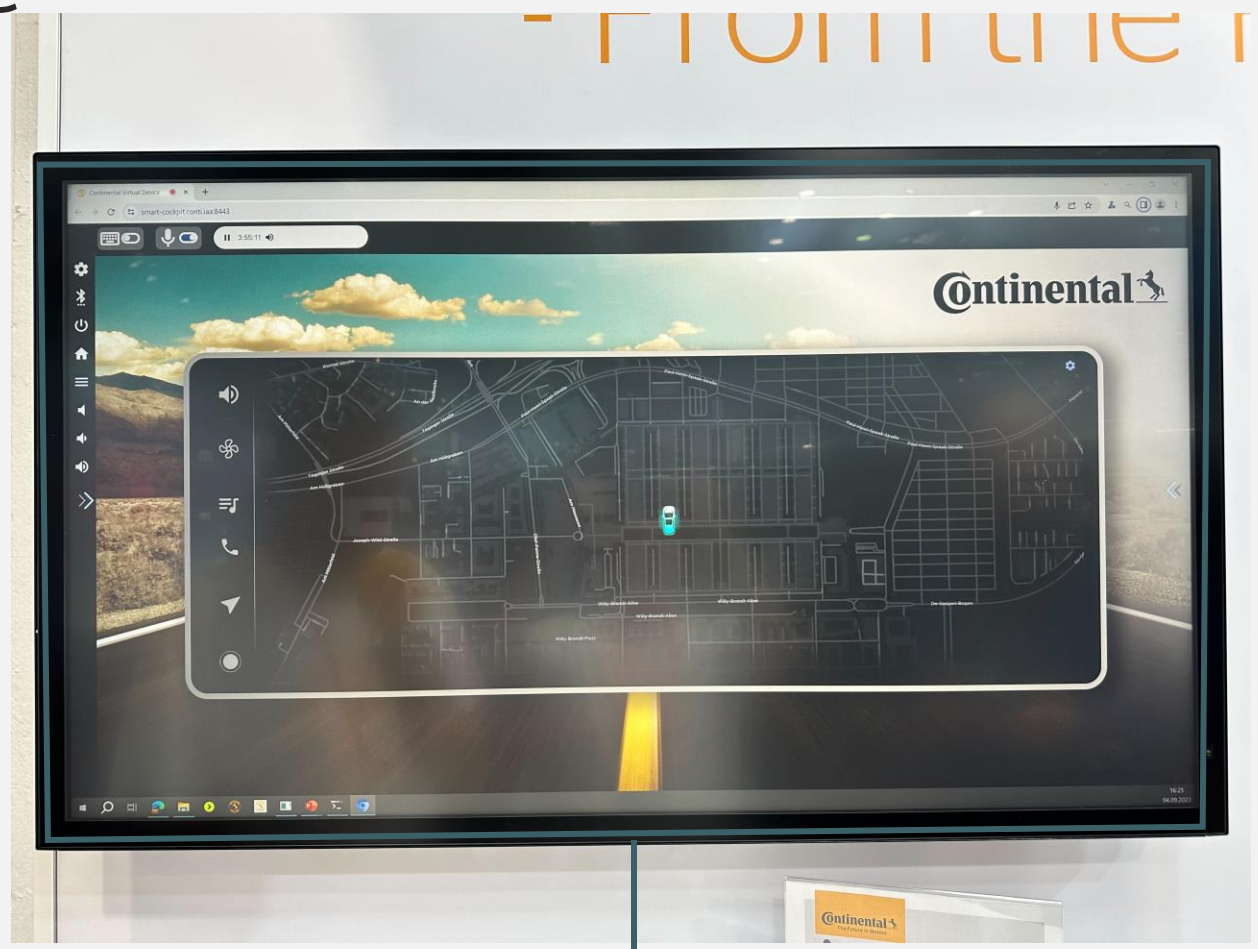
Android on Graviton



26

Customer implementation @ IAA Munich 2023

Android OS in vehicle



Same Android OS image running on Graviton, bi-directional UI streamed in browser through WebRTC

27


the Vehicle Together
the Road to the Cloud.
Continental
MEDIA PLAYER
PHONE
NAVIGATION
CLIMATE
ANDROID AUTO
360

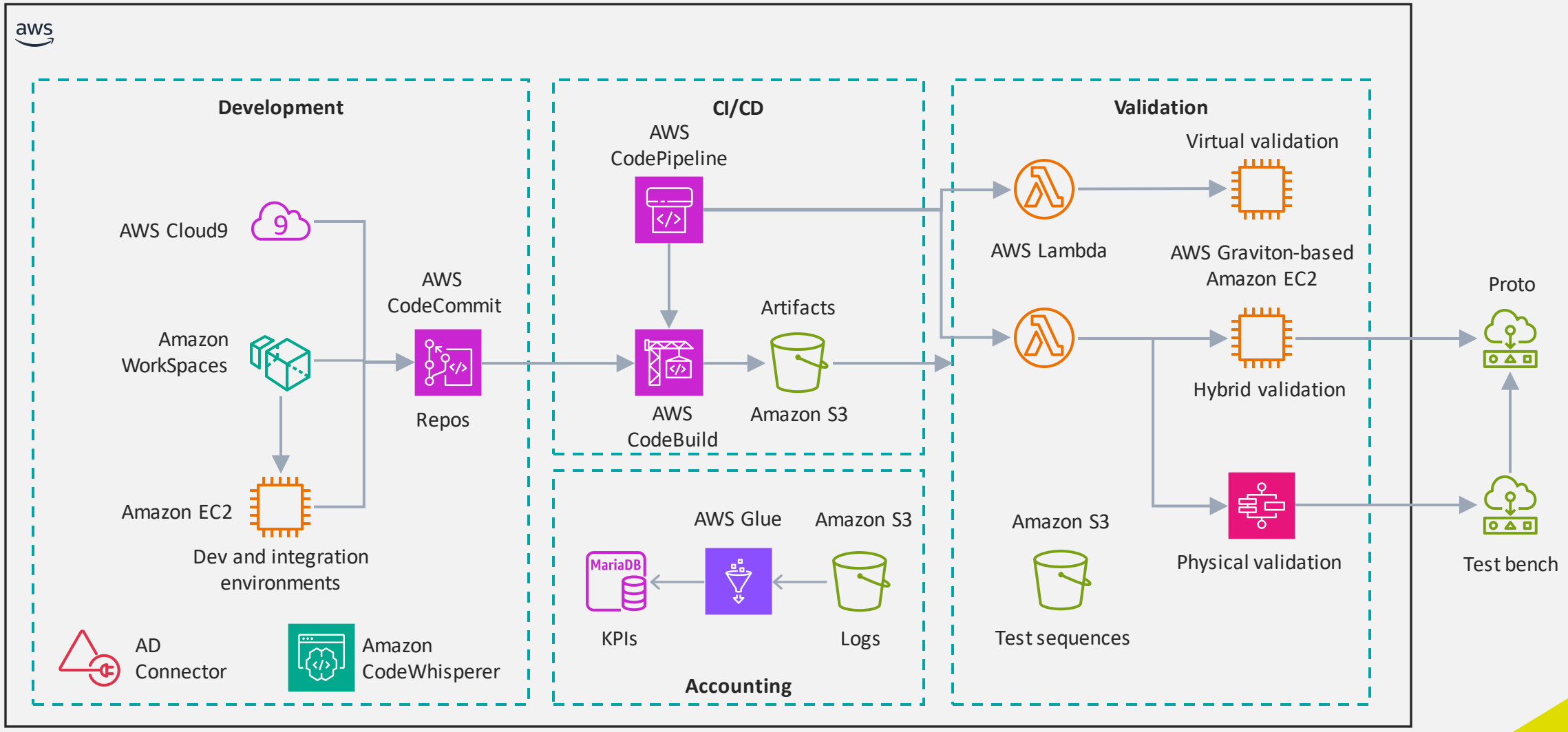
Cabin digital twin on AWS and QNX AMI

Marelli press release: bit.ly/3qVCTNB

"By combining the strengths of Marelli and AWS services, we can deliver the driving experience consumers want while ensuring security and reliability. Marelli's digital twin empowers software engineers to reduce development time by up to 70% and realize cost savings on prototypes up to 30%, delivering software evolutions more efficiently and cost-effectively."

Yannick Hoyau
VP and Head of Engineering & Innovation,
Marelli Electronic Systems

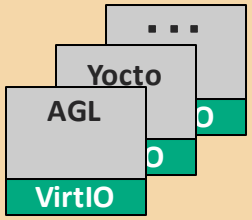
Marelli DigiMate project



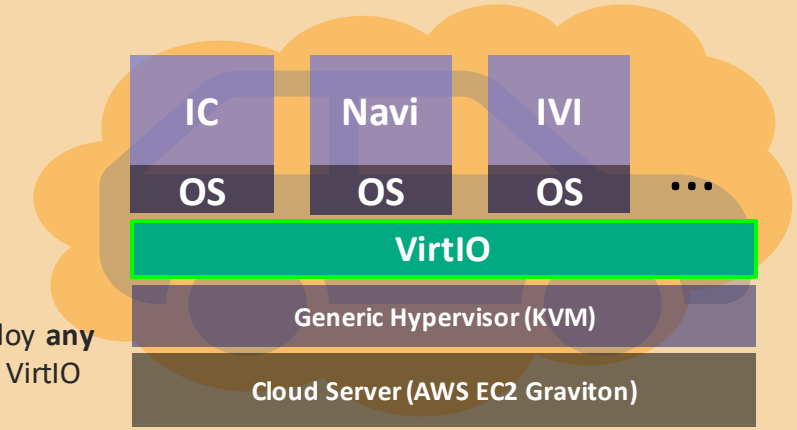
The Next Level: AGL CES2023 Demo from Panasonic and AWS

VirtIO Abstraction for OS portability

Virtual ECU



Able to virtually develop & deploy **any operating systems** supporting VirtIO

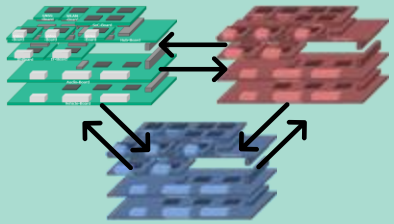


aws

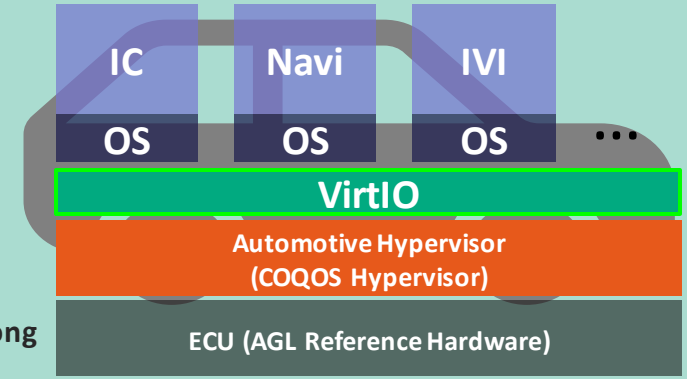
Remote software development without the need for hardware

Deploy VM Binaries without any changes

Physical ECU



Capable to migrate **same binary among various** automotive hardware



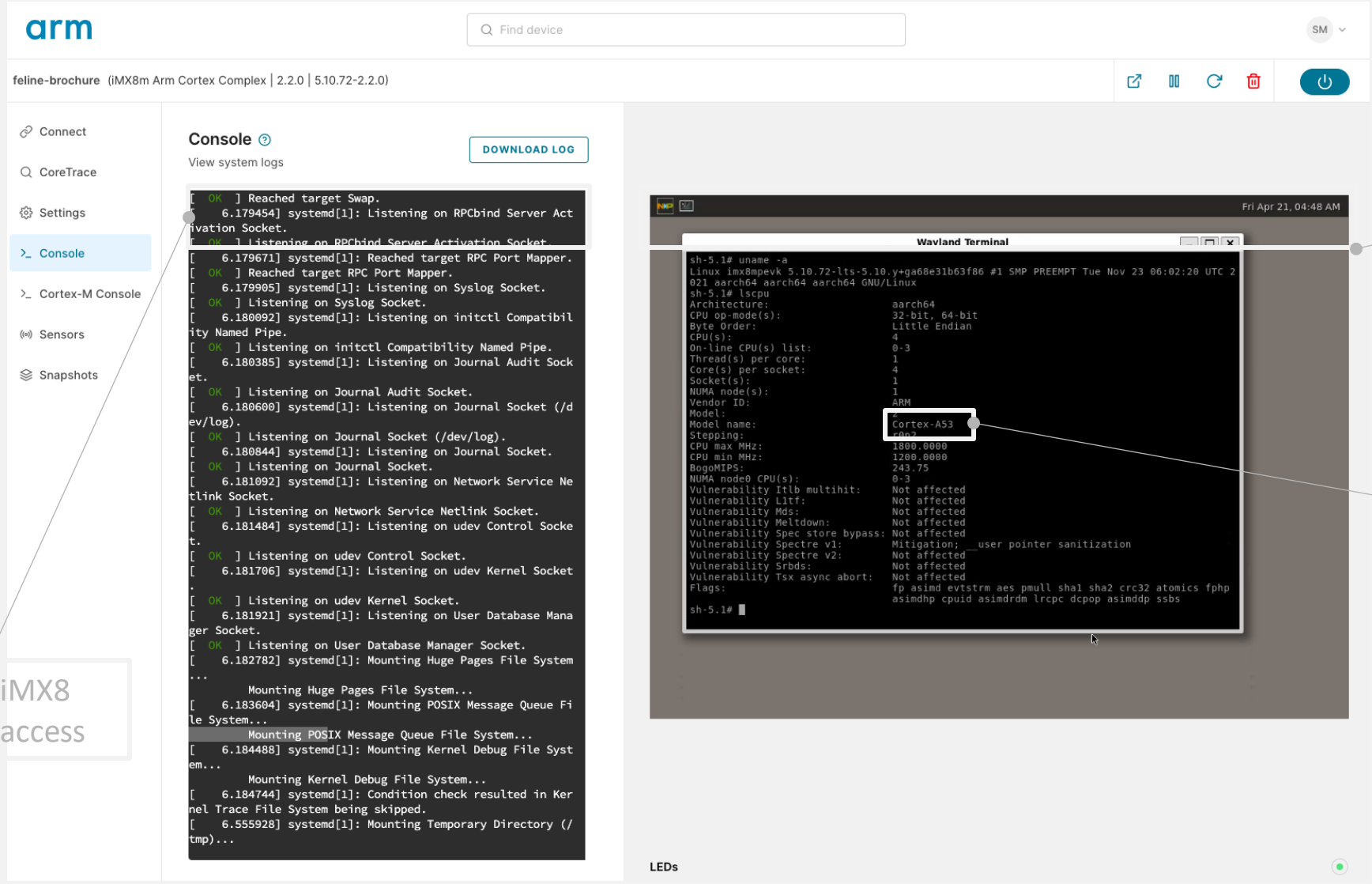
Panasonic
AUTOMOTIVE

Developer PC

Thin client

Only network connection and light graphics processing power required

Example of an “Hybrid-Emulation”: Arm Virtual HW

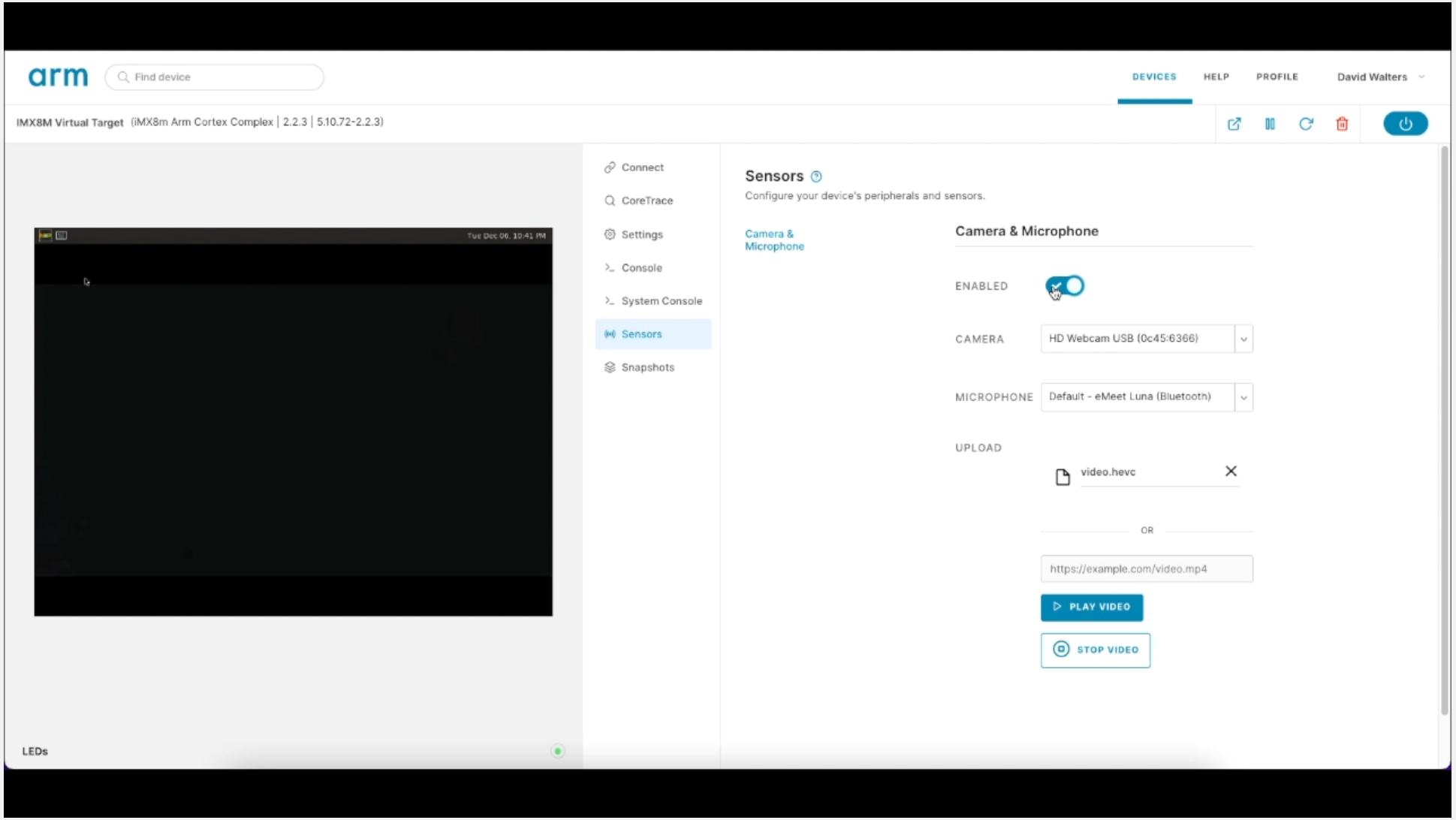


Virtual iMX8 console access

Virtual iMX8 display in in Browser

Cortex-A53 “hybrid” emulation on AWS Graviton’s Neoverse

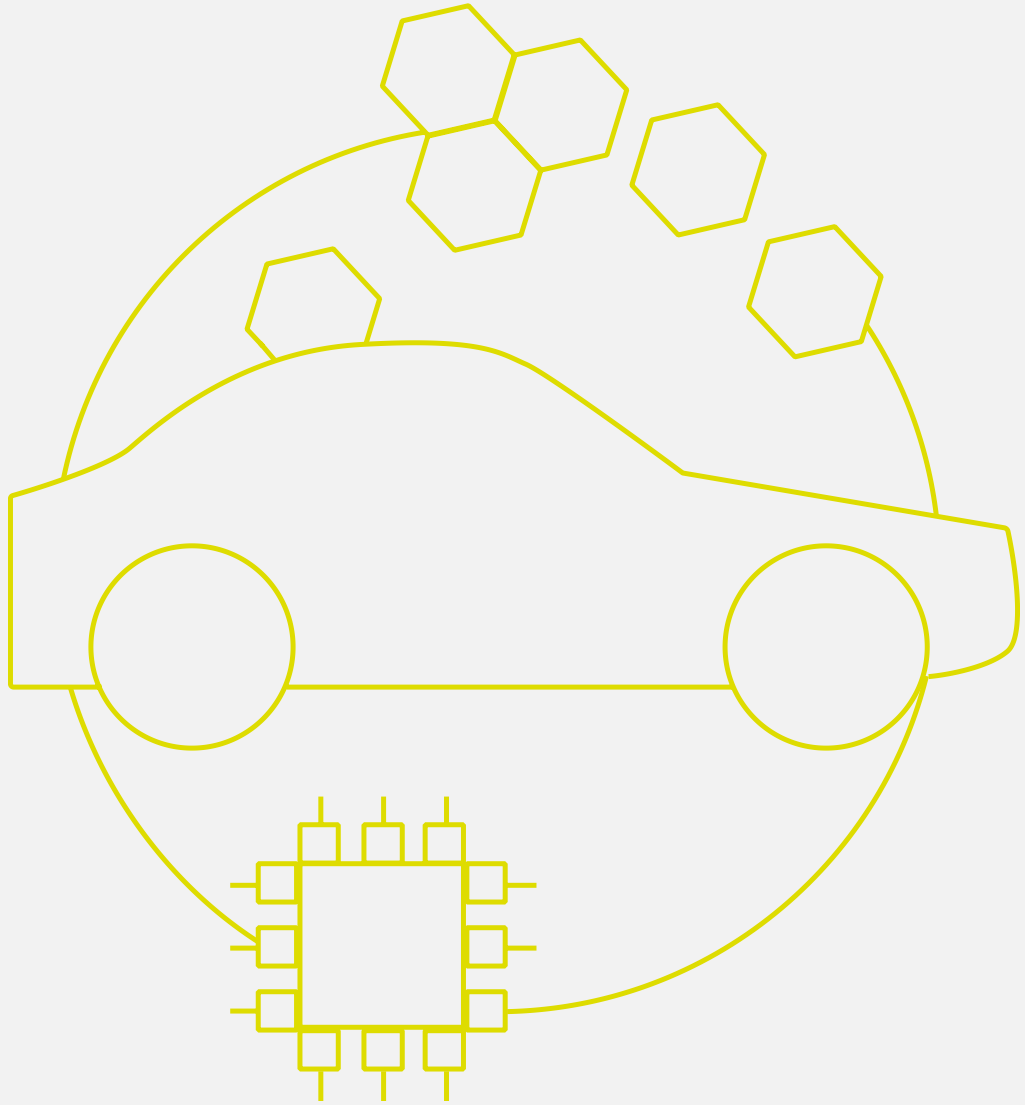
Hybrid Emulation on Arm Virtual HW / Corellium



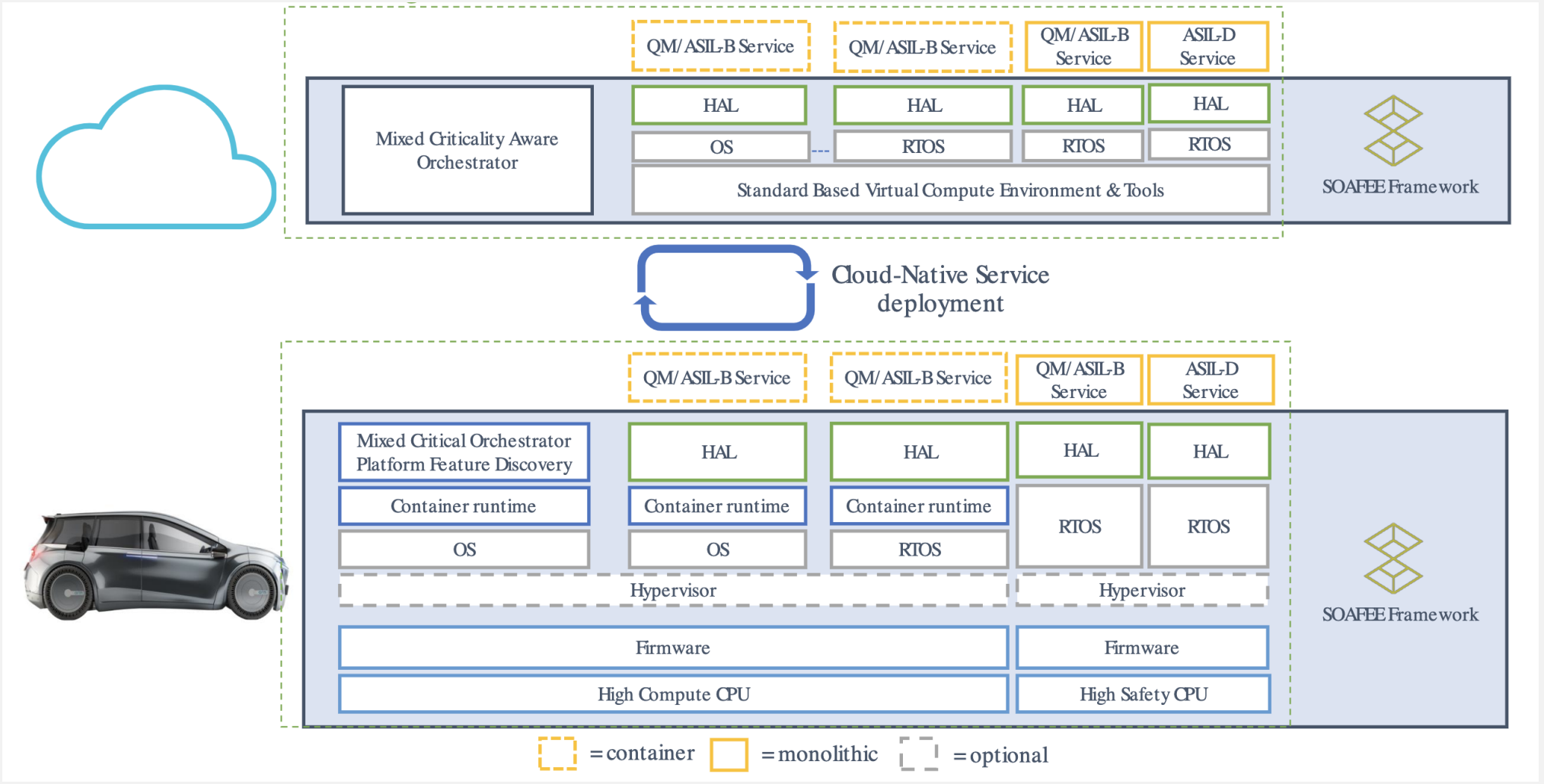
LINK

SOAFEE

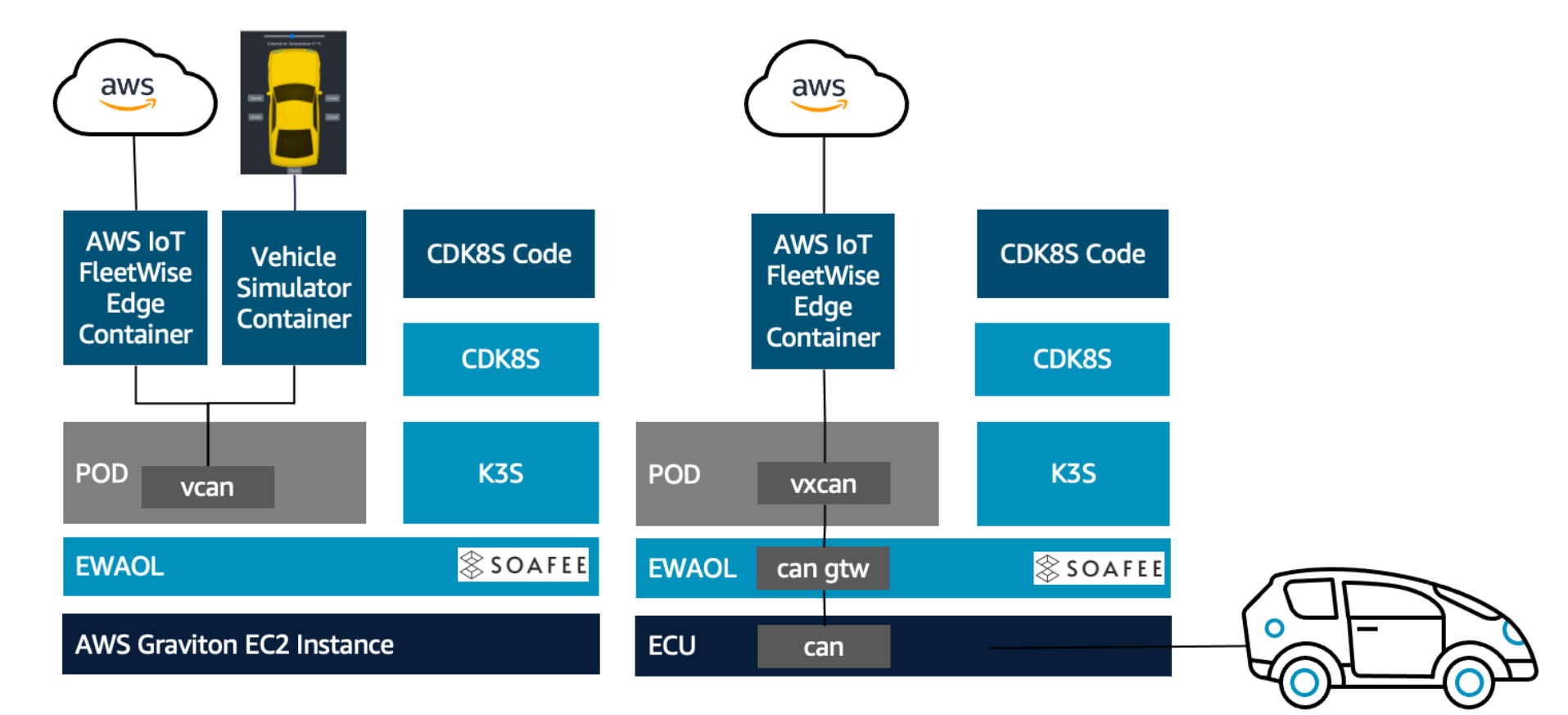
SOAFEE & Upper layers: **orchestration**



SOAFEE High-Level Reference Architecture



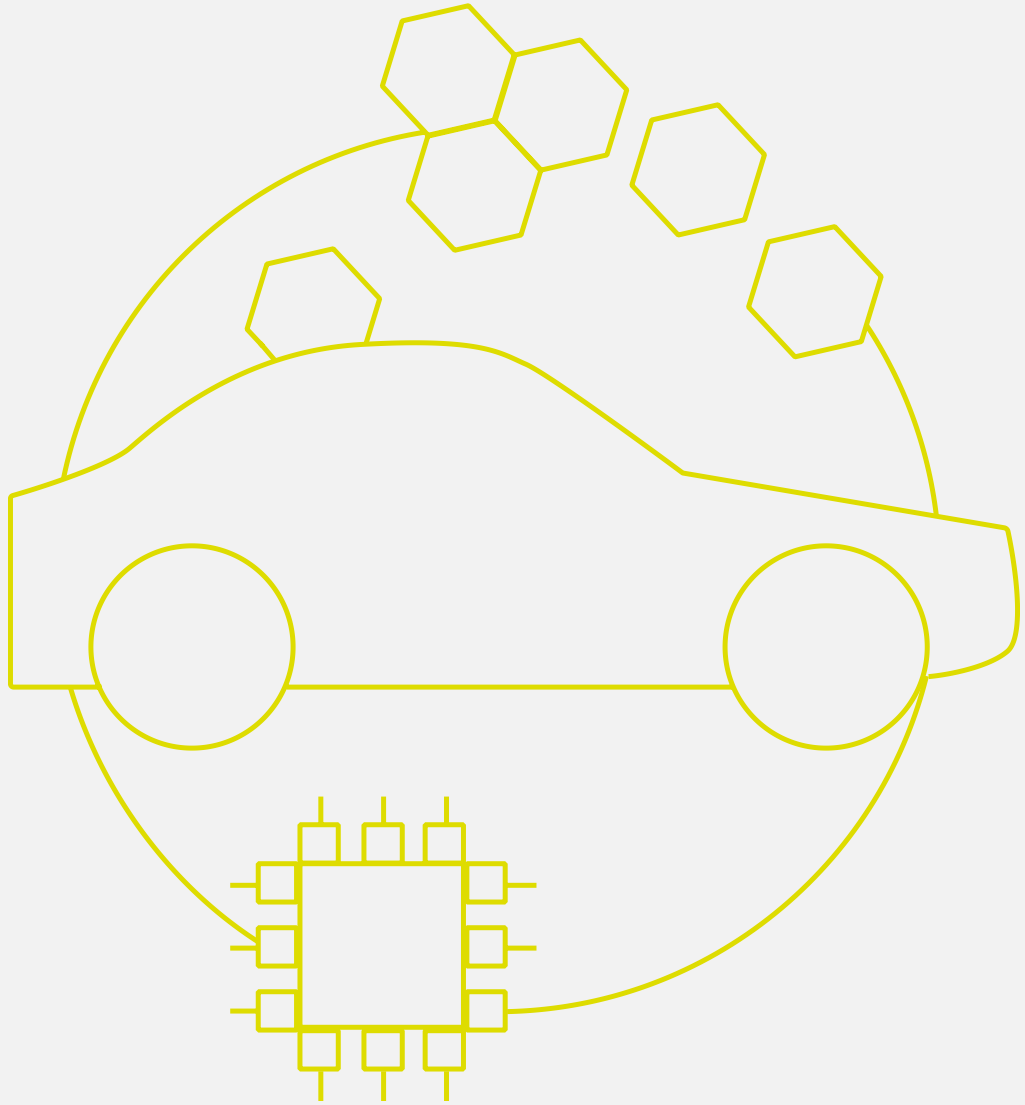
SOAFEE Container Orchestration with CDK8S



https://github.com/aws-samples/demo-soafee-aws-iotfleetwise

SOAFEE

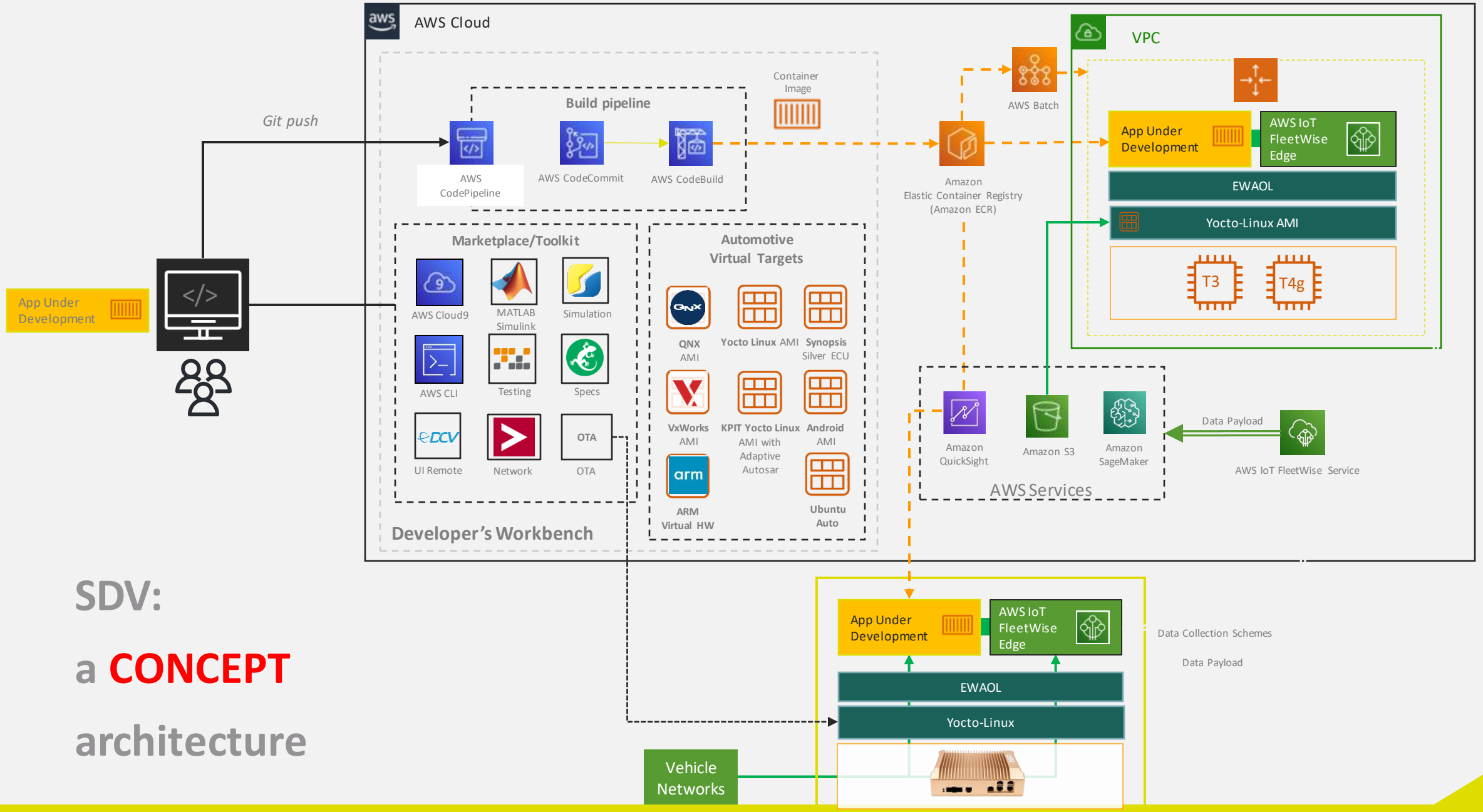
Towards an SDV Architecture: **Cloud-First Development**



SDV:

a **CONCEPT**

architecture



AWS **Partners** & **Ecosystem** Engagement in SDV

Virtual Engineering Workbench

Continental
TOYOTA
STELLANTIS
KPIT

Cloud-Native Tool Collaborations

MathWorks
Qt Group
RIGHTWARE
dSPACE
CORELLIUM
SYNOPSYS
VECTOR
Genymotion
Elektrobit
ETAS

Virtualized Targets

yocto PROJECT
AUTOMOTIVE GRADE LINUX
BlackBerry | QNX
Ubuntu
VxWorks
MARELLI
Red Hat

arm
SOAFEE

AWS Graviton

Final remarks

- → **SDV is happening**, and requires a deep transformation of the technologies, tools and workflows in automotive.
- → Part of that transformation is to find the **right level of abstraction** (HALs and Container orchestration), develop and diffuse new technologies if necessary.
- → It’s a **deep ecosystem play**, and each of us has opportunities to engage, for example with SOAFEE, Eclipse SDV, AGL, Yocto, etc.

Thank You
Danke
Gracias
Grazie
谢谢
ありがとう
Asante
Merci
감사합니다
धन्यवाद
Kiitos
شكرًا
ধন্যবাদ
תודה