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aws SUMMIT

AUT201

Building a Scalable Simulation Platform for AD/ADAS Testing & Validation

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Mission

Millions
miles in the Cloud

>10M
Simulations
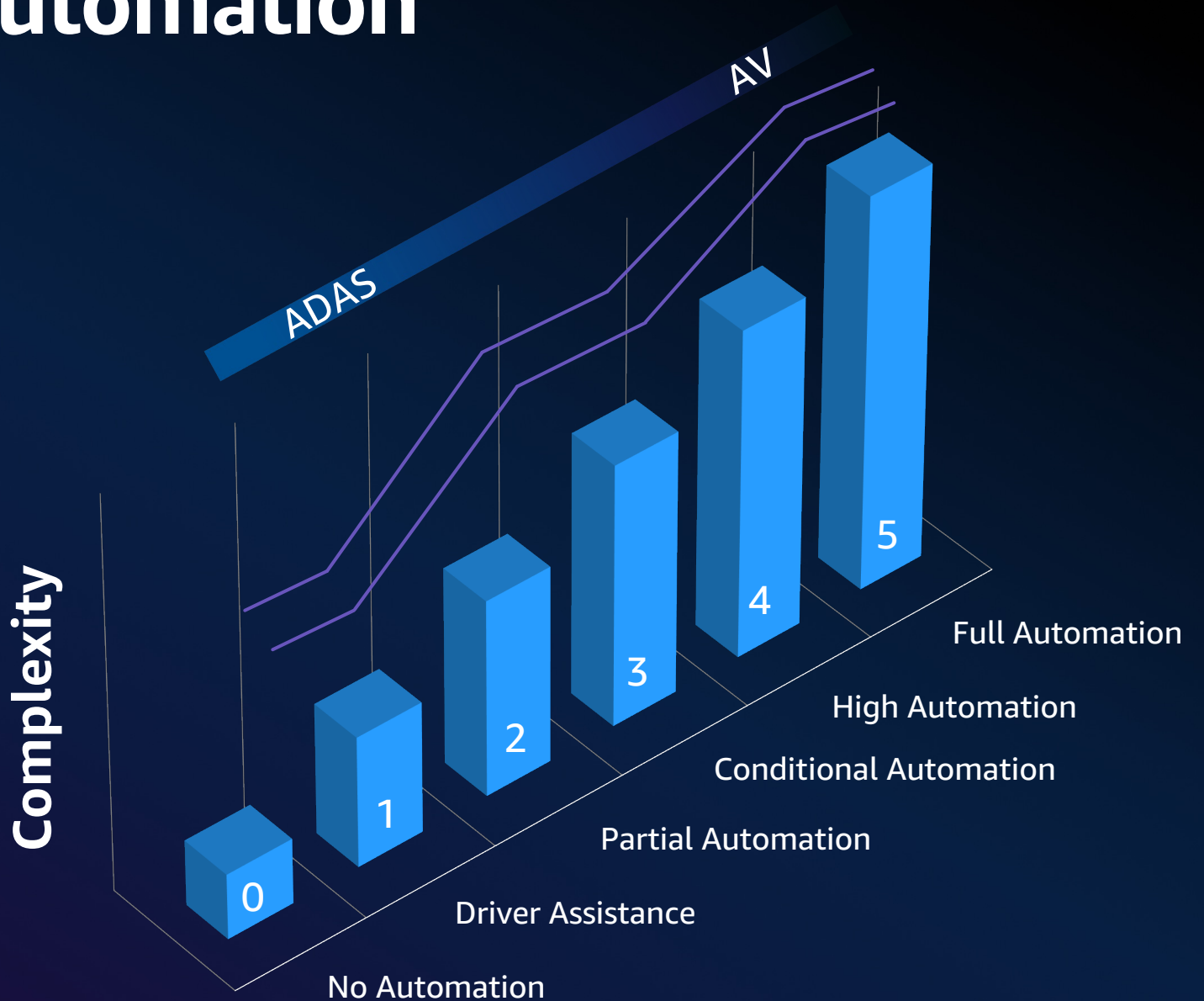
>1000
GPUs

>250 TB
vRAM

aws

Agenda

01   Autonomous Driving on AWS

02   Navigating AD/ADAS through complex challenges

03   Accelerating development & testing with simulation

04   Bridging challenges with a scalable platform architecture

05   Recap and key takeaways
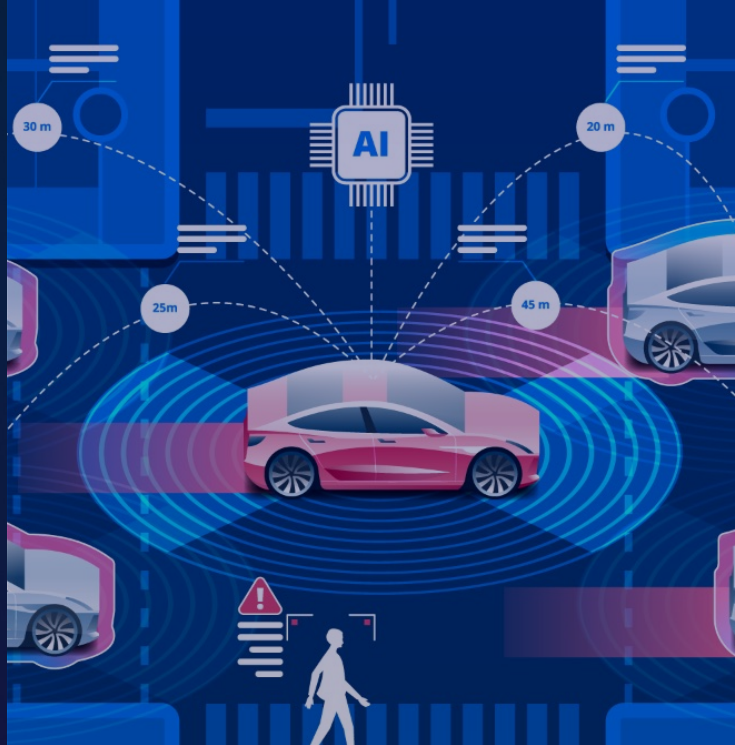
Levels of Driving Automation

Society for Automotive Engineers (SAE) outlines 6 levels of automation for automakers, suppliers and policymakers to classify a system's sophistication.

AV

ADAS

Complexity

0 — No Automation

1 — Driver Assistance

2 — Partial Automation

3 — Conditional Automation

4 — High Automation

5 — Full Automation

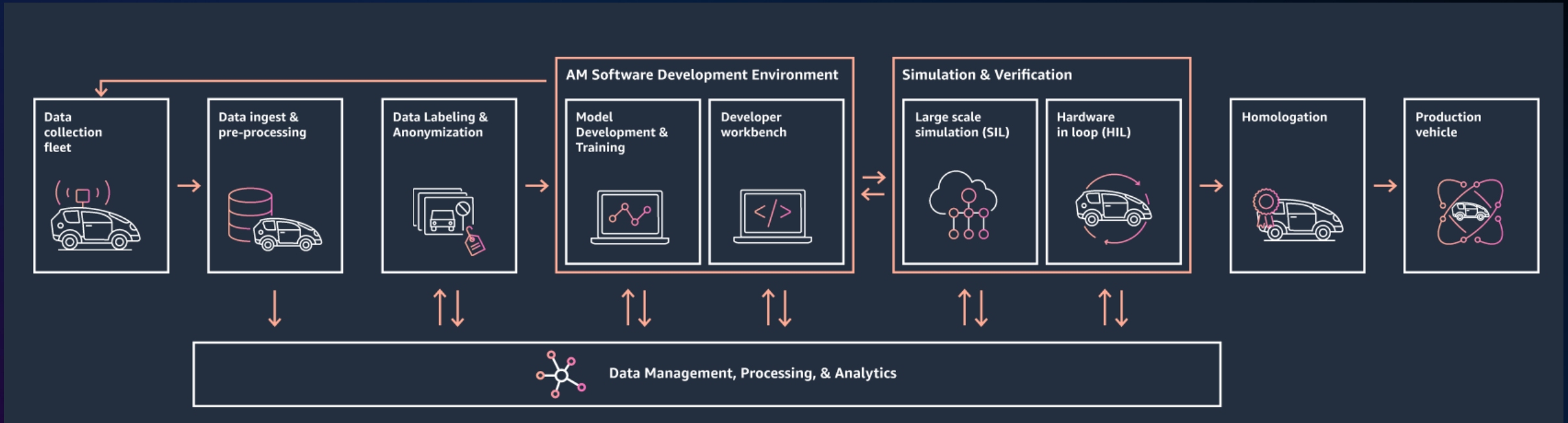# Evolving Challenges

Data Management

Tool Chain Complexity

Time to Market

Autonomous Mobility – Data Driven Development

ASAM STANDARD BASED DEVELOPMENT AND VALIDATION

AM Software Development Environment

- Data collection fleet
- Data ingest & pre-processing
- Data Labeling & Anonymization
- Model Development & Training
- Developer workbench

Simulation & Verification

- Large scale simulation (SIL)
- Hardware in loop (HIL)

- Homologation
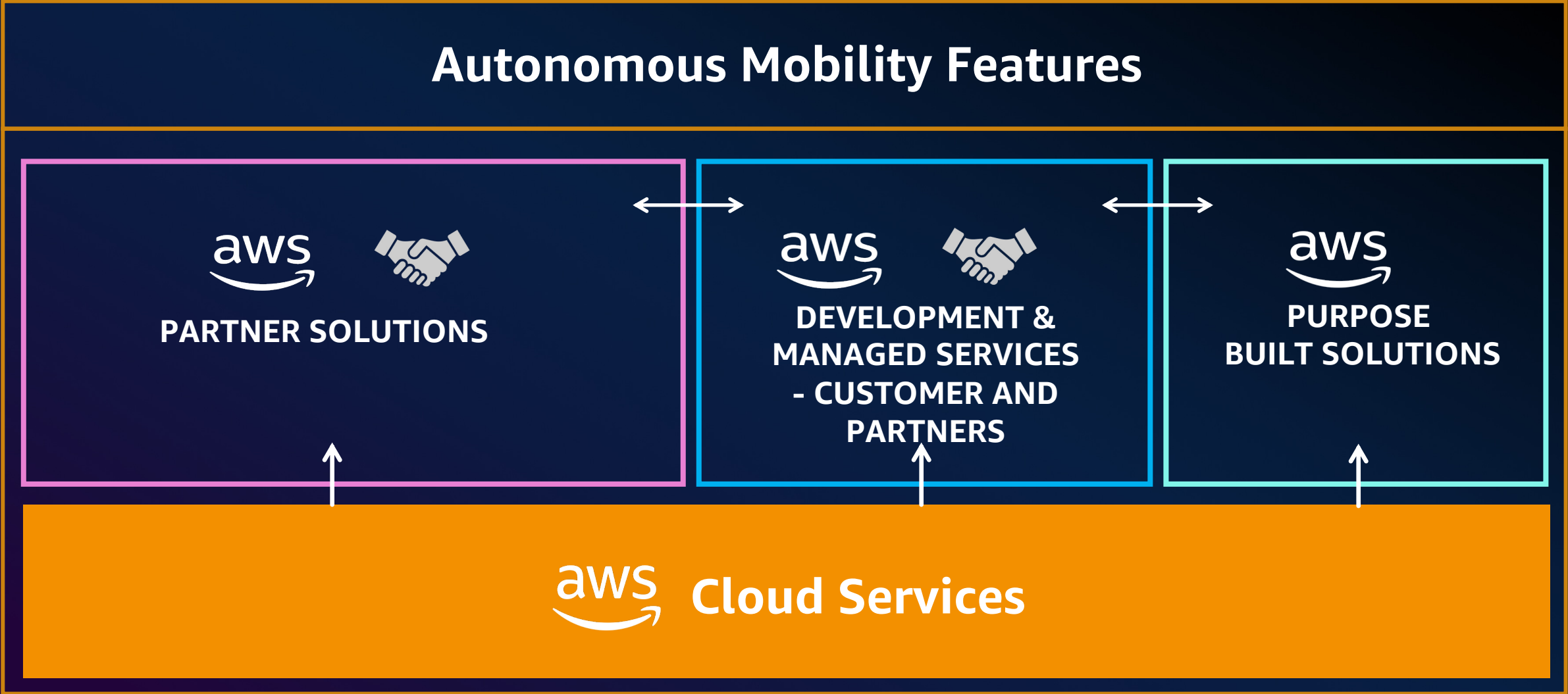- Production vehicle

Data Management, Processing, & Analytics

Example of large scale simulations on AWS
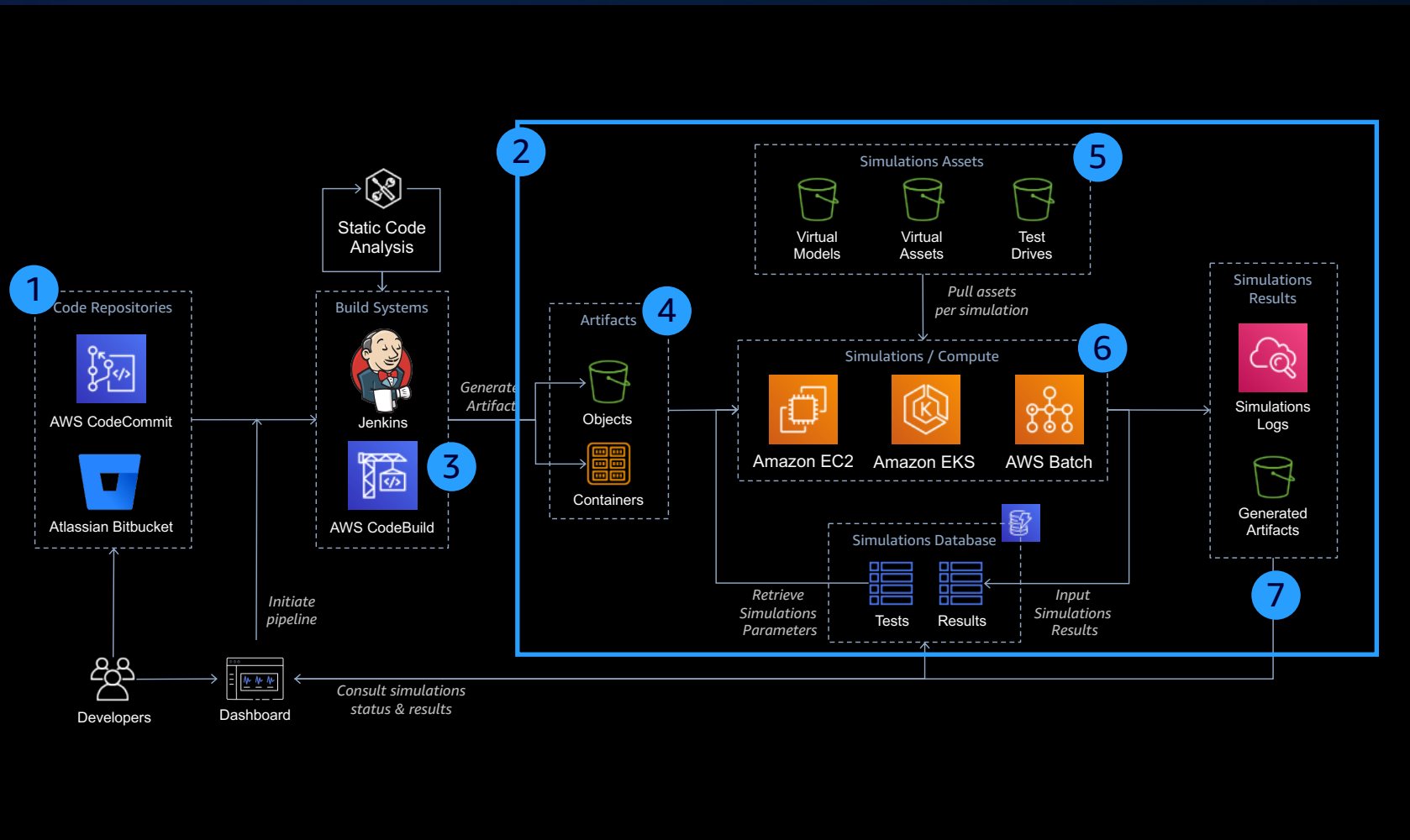
1. Development workflow
2. Static analysis and pipeline
3. Build workflow
4. Container, binary, package, static files
5. Storage and APIs
6. Test environments
7. Results and artifacts

Cloud Native Autonomous Mobility Development

Speakers

Benjamin Kraft

Lead Architect
ADAS Digital Test Platform
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Navigating AD/ADAS through Complex Challenges at Mercedes-Benz

Mercedes-Benz

Mercedes-Benz DRIVE PILOT

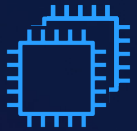## FIRST CARMAKER TO SECURE INTERNATIONALLY VALID SYSTEM APPROVAL FOR CONDITIONALLY AUTOMATED DRIVING (SAE LEVEL 3)

The Complexity of ADAS Systems

DRIVE PILOT IN THE NEW MERCEDES-BENZ S-CLASS

Redundant system architecture

More than **30** sensors

High computing power

Cameras
Optical Image Capture for 3D Environment

Driver Camera
Detection of Driver Attention

Antenna Array
Highly Accurate Positioning

Ultrasonic Sensor
Sonic Impulses to Detect the Near Vehicle Surroundings

LiDAR
Laser Beams for 3D Environment

Road Moisture Sensor
Detection of Road Surface Wetness

Radar
Electromagnetic Waves for Distance and Speed Measurement

Unveiling the Complexity beneath the Surface

Accelerating Development & Testing with Simulation

Mercedes-Benz

Finding Issues before Testing in the Car

A DIGITAL FIRST APPROACH
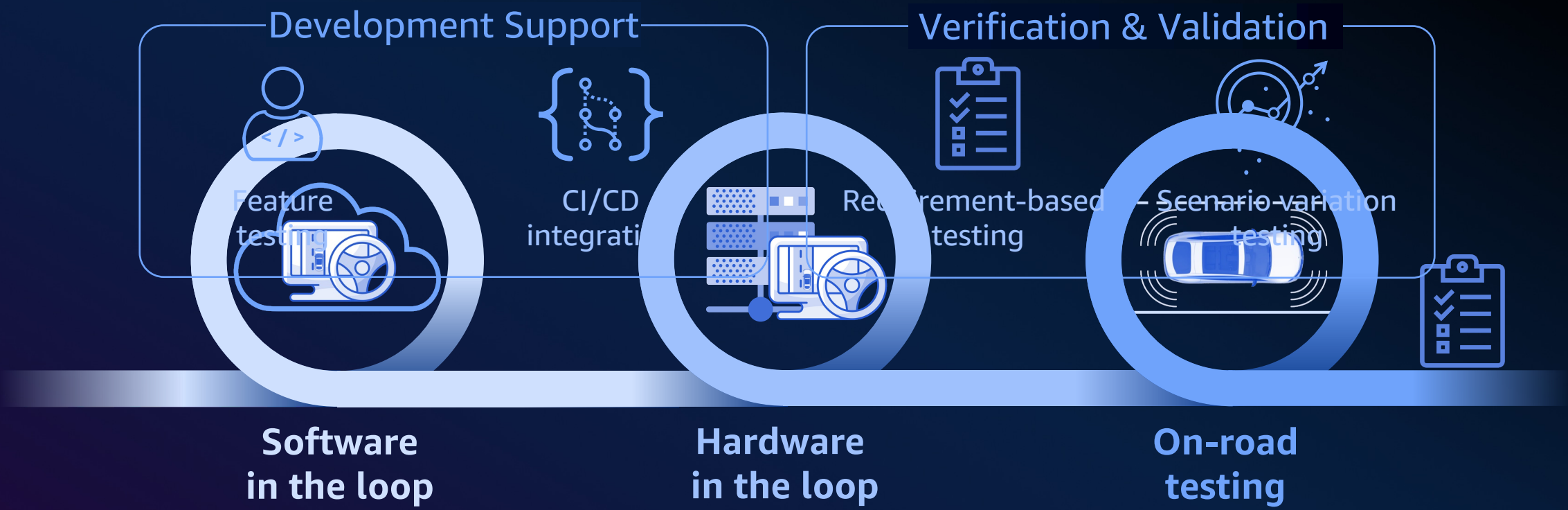
Software in the loop

Hardware in the loop

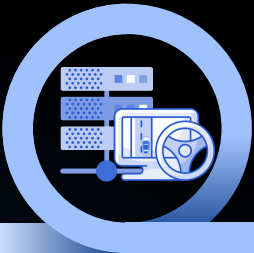**On-road testing**

Finding Issues before Testing in the Car
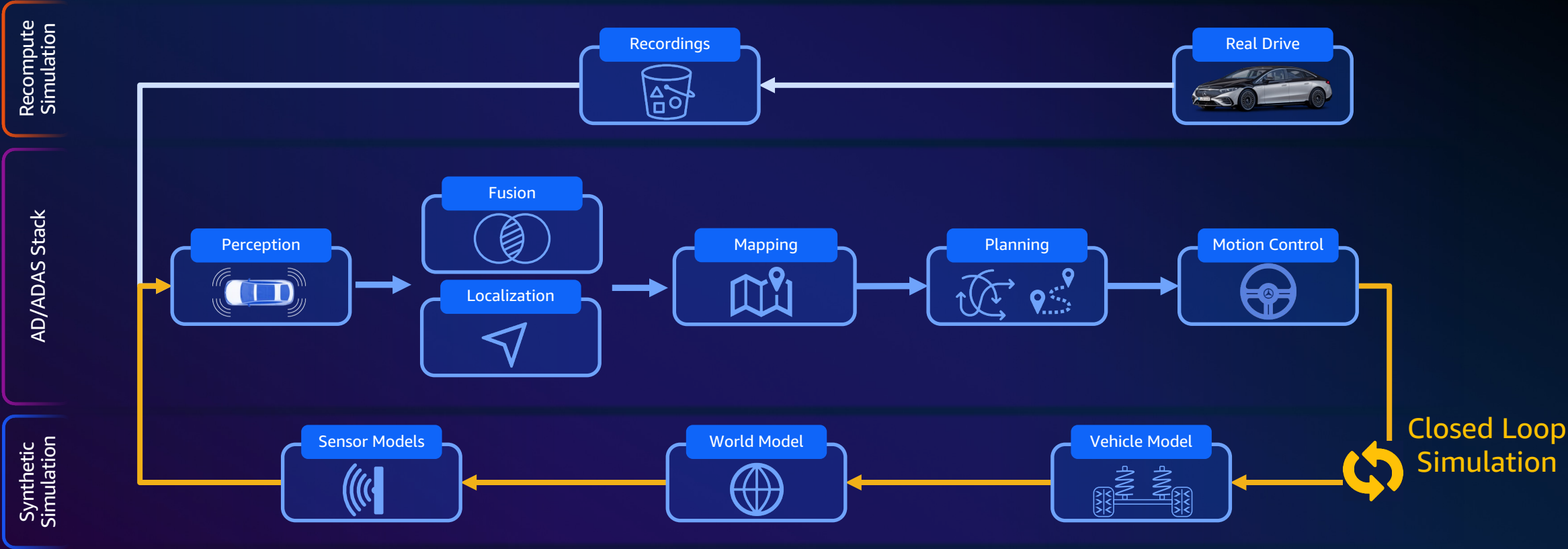
A DIGITAL FIRST APPROACH

Development Support

Verification & Validation

Feature testing

CI/CD integration

Requirement-based testing

Scenario variation testing

Software in the loop

Hardware in the loop

On-road testing

Exploring simulation variants

Software in the Loop

Hardware in the Loop

Recompute Simulation

Recordings

Real Drive

AD/ADAS Stack

Perception

Fusion

Localization

Mapping

Planning

Motion Control

Synthetic Simulation

Sensor Models

World Model

Vehicle Model

Closed Loop Simulation

Accelerating AD/ADAS development trough seamless access to our Mercedes-Benz digital test platforms for developers & testers by providing a scalable infrastructure with full data and compute continuity.

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Bridging Challenges with a Scalable Platform Architecture

Core architecture motivations

Minimal Turnaround Times
Reduce time from trigger to test results with optimized efficiency and responsiveness
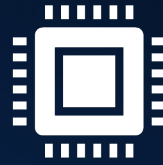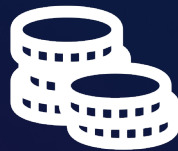
Massive Compute
Ensure high-fidelity simulations with up to 8 GPUs per simulation instance

Scalability
Enable millions of simulations per month with full adaptation to variable workloads
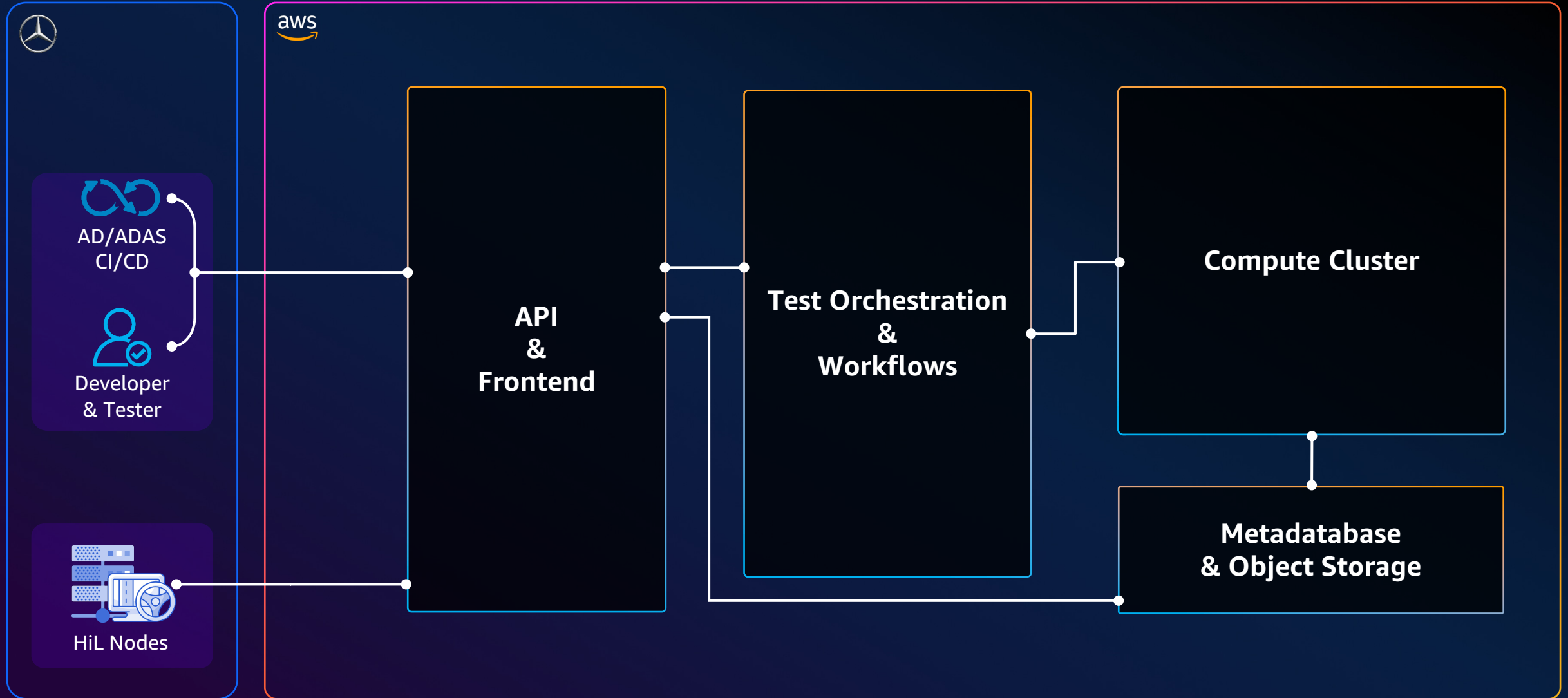
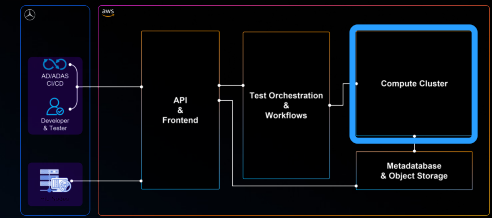**Cost Optimization**
Maximize the value of cloud resources

Security
Protect sensitive data and ensure compliance

Architectural Overview

AD/ADAS CI/CD

Developer & Tester

HiL Nodes

API & Frontend

Test Orchestration & Workflows

Compute Cluster

Metadatabase & Object Storage

Selecting the Best-Fit Compute Service

Workload Requirements

Multi-Container Tasks

Job Prioritization

GPU Hardware settings

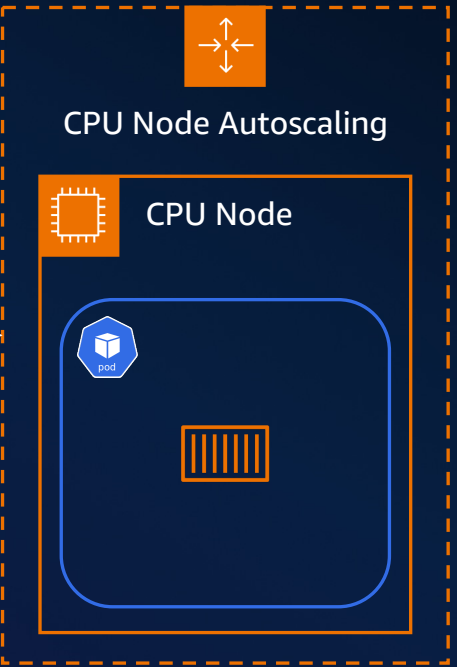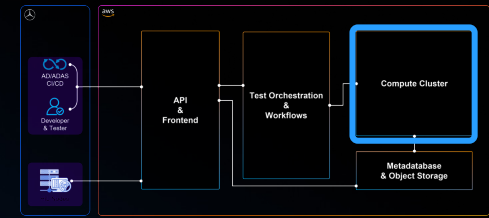Exclusive Node Allocation

① Simulation
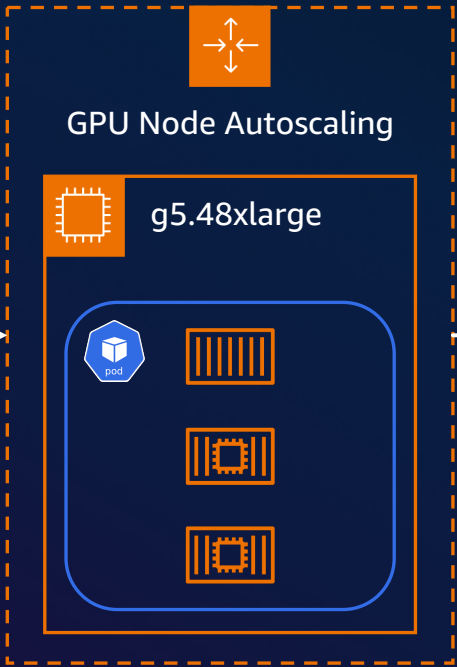
② Data Evaluation

Simulation Batch

GPU Node Autoscaling

g5.48xlarge

pod

CPU Node Autoscaling

CPU Node

pod

Mercedes-Benz

Selecting the Best-Fit Compute Service

Workload Requirements

Multi-Container Tasks	Job Prioritization	GPU Hardware Settings	Exclusive Node Allocation

Amazon Batch

- ✓ Optimized for batch jobs
- ✓ Managed service
- ✗ Multi-container tasks
- ✗ Limited GPU control, node affinities and networking

Amazon Elastic Container Service (Amazon ECS)

- ✓ Multi-container tasks
- ✓ Managed service
- ✗ No job prioritization
- ✗ Limited GPU control, node affinities and networking

Amazon Elastic Kubernetes Service (Amazon EKS)

- ✓ Full flexibility
- ✓ Managed control plane
- ! Higher maintenance

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Efficient Workload Modularization
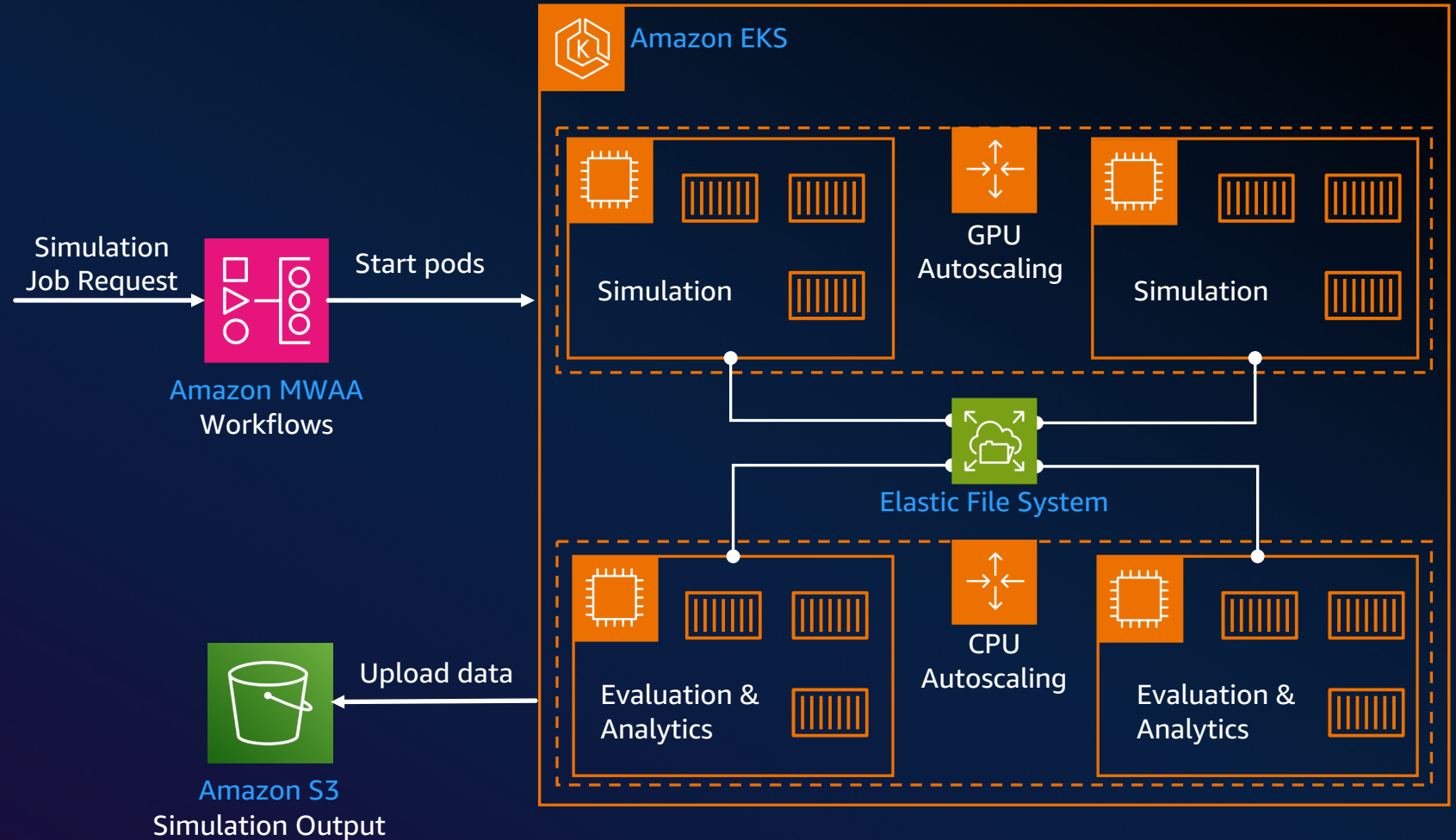

Modularize Workflow
Separate tasks by resource profile

Resource Optimization
Offload non-GPU tasks to general-purpose nodes

Data Management
Utilize EFS for short-term and S3 for long-term storage

Simulation Job Request

Amazon MWAA
Workflows

Start pods

Amazon EKS

Simulation

GPU Autoscaling

Simulation

Elastic File System

Evaluation & Analytics

CPU Autoscaling

Evaluation & Analytics

Upload data

Amazon S3
Simulation Output

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Managing GPU Hardware Configuration in EKS

Initialization and GPU Configuration
Changes to GPU settings require a reboot of the node to take effect

Node Replacement
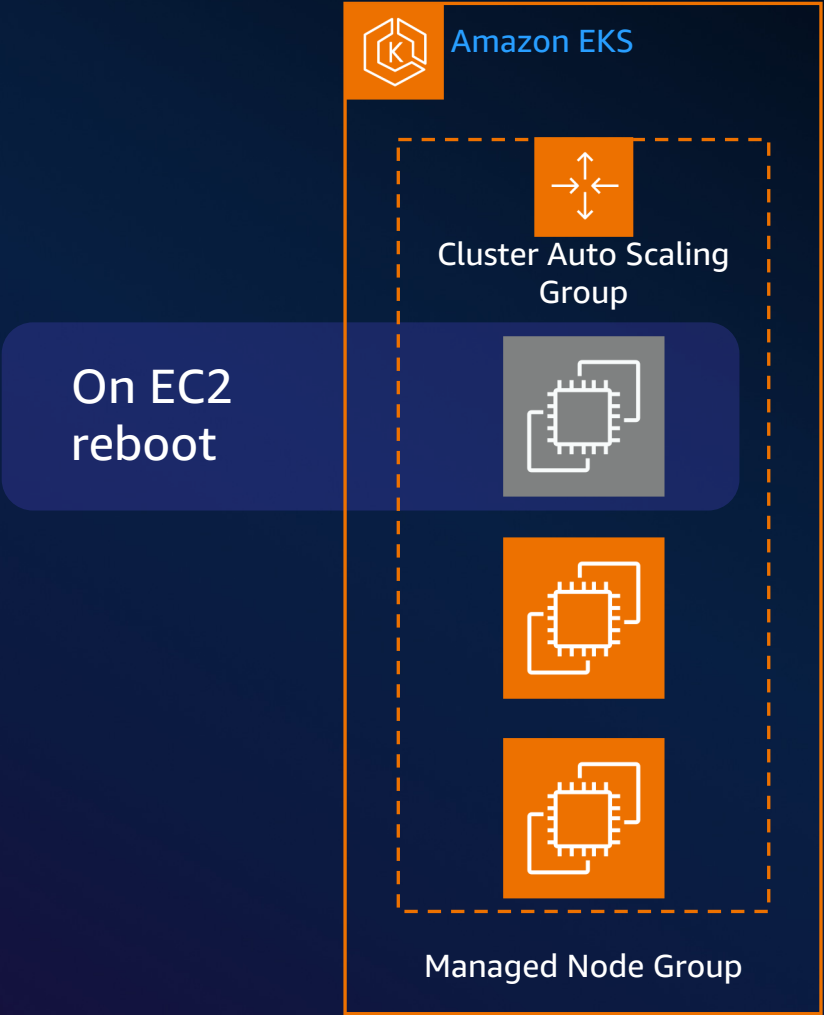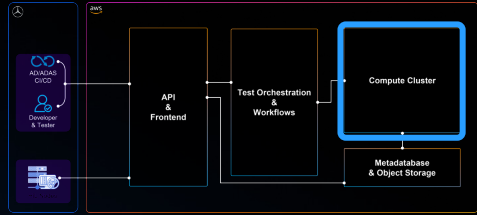Removed nodes are replaced by Cluster Autoscaler

Options:
EC2 Auto Scaling lifecycle hooks

Karpenter

Amazon EKS

Cluster Auto Scaling Group

On EC2 reboot

Managed Node Group

Managing GPU Hardware Configuration in EKS

Initialization and GPU Configuration
Changes to GPU settings require a reboot of the node to take effect

Node Replacement
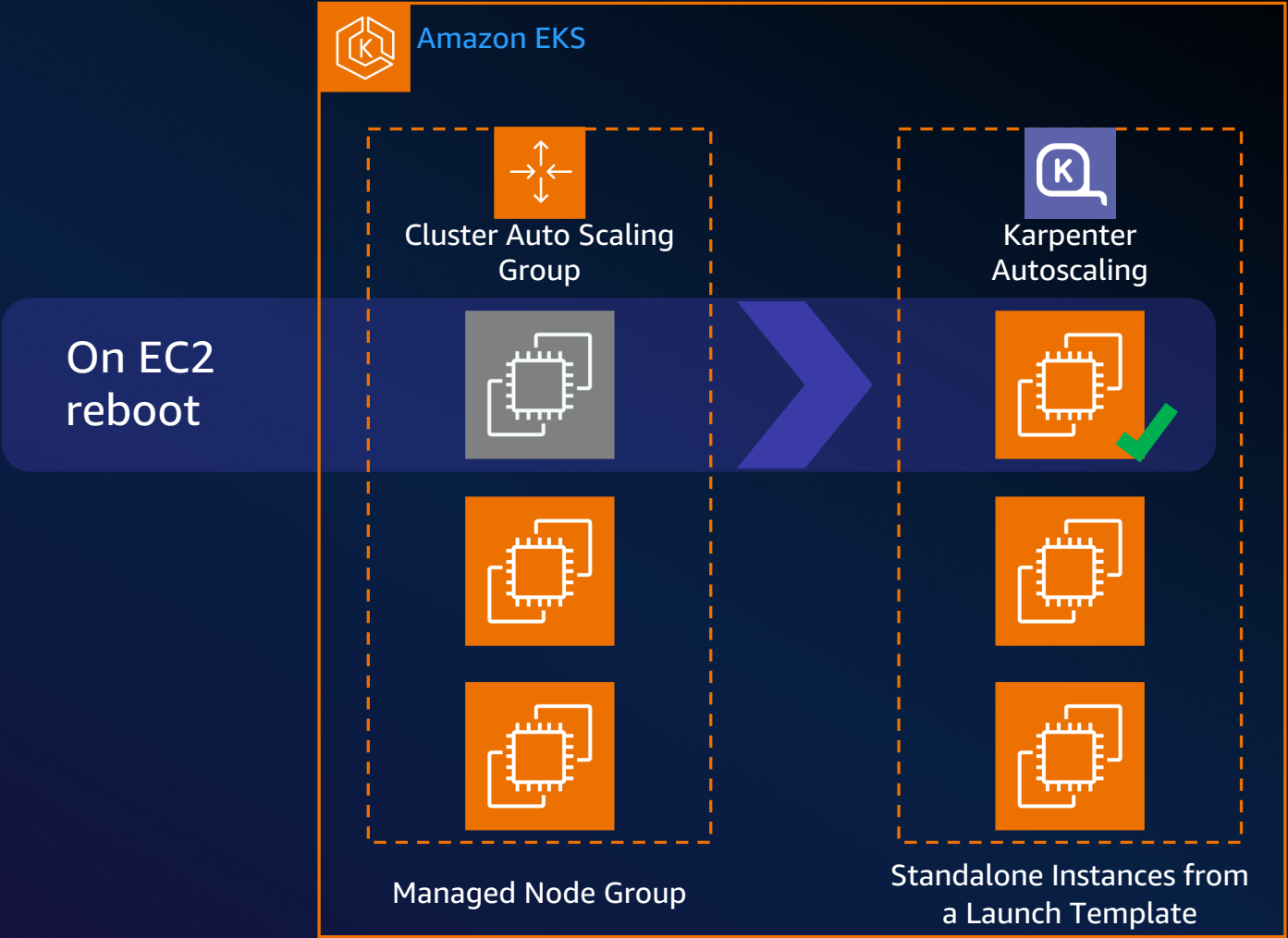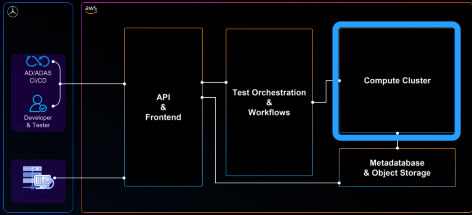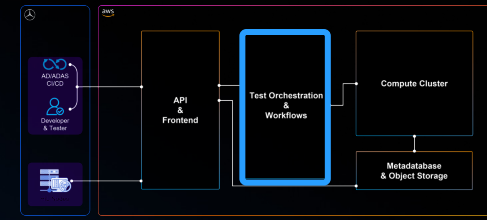Removed nodes are replaced by Cluster Autoscaler

Options:
EC2 Auto Scaling lifecycle hooks

Karpenter

Amazon EKS

Cluster Auto Scaling Group

Karpenter Autoscaling

On EC2 reboot

Managed Node Group

Standalone Instances from a Launch Template

Resilience and Scaled Orchestration

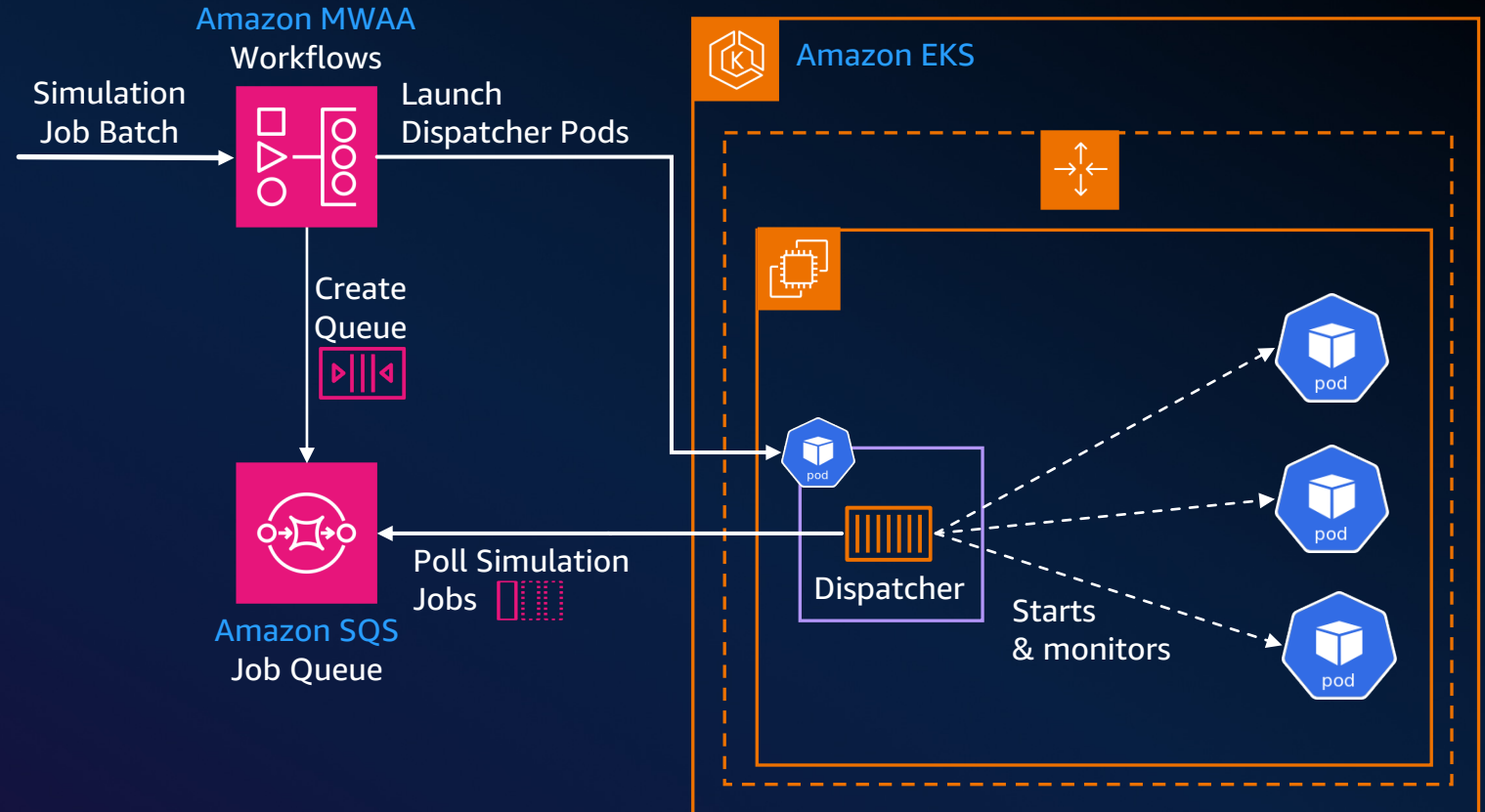## Scaling Beyond Airflow's Limits
Maintaining stability becomes challenging as concurrent simulations and worker counts increase
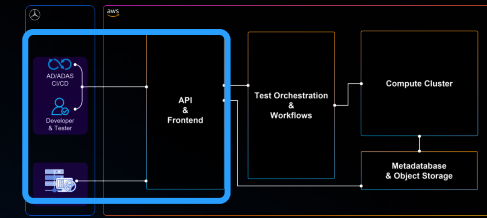
Tailored Batch Control
Dispatcher ensures efficient orchestration of high-scaled simulation batch execution

Enhancing Fault Tolerance
Utilization of SQS for resilience and support of concurrent Dispatchers per simulation batch

Amazon MWAA
Workflows

Simulation Job Batch

Launch Dispatcher Pods

Create Queue

Amazon EKS

Amazon SQS
Job Queue

Poll Simulation Jobs

Dispatcher

Starts & monitors

pod

pod

pod

Mercedes-Benz

Streamlining the Access to Simulations
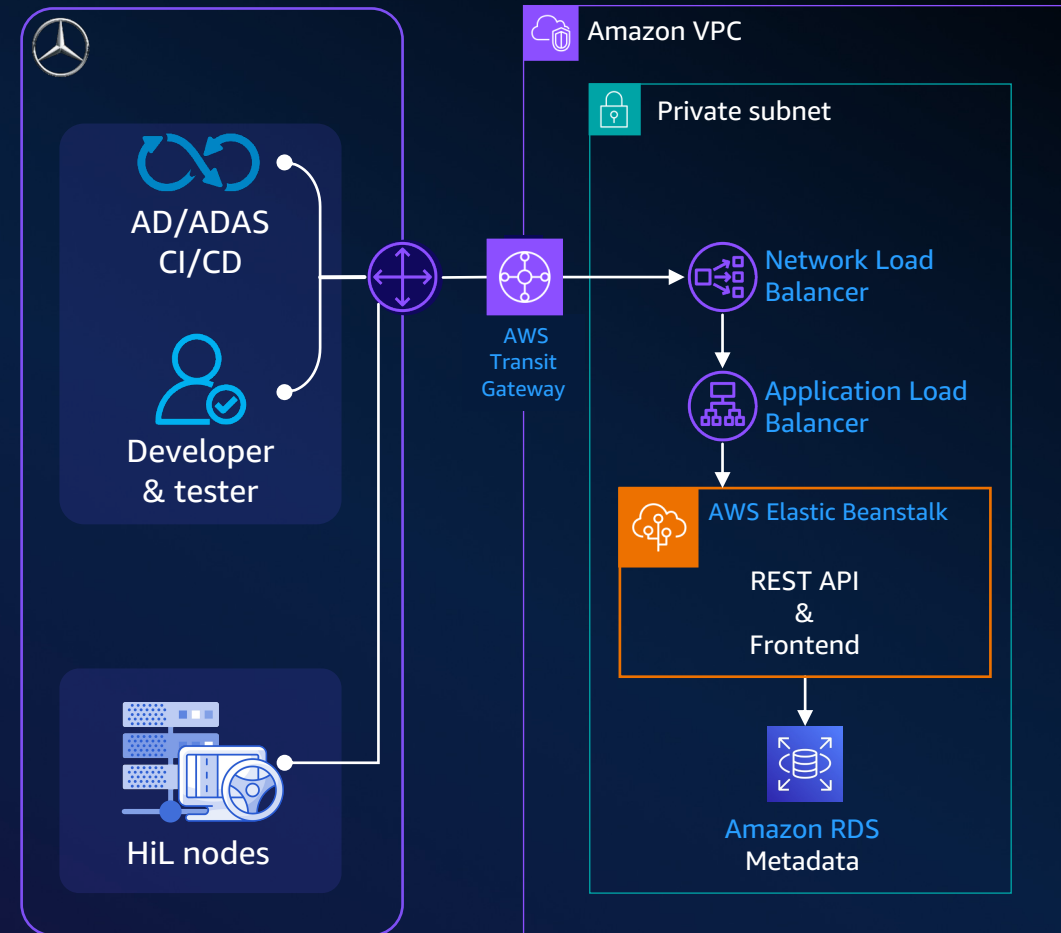

Streamlined Access
Serving a unified entry point to provide seamless access for both human and technical users to abstract business logic complexities

Effortless Hosting
Elastic Beanstalk simplifies API and Frontend hosting and deployment

Secured Connectivity
Customized load balancers enable private routing of traffic from on-premises sources
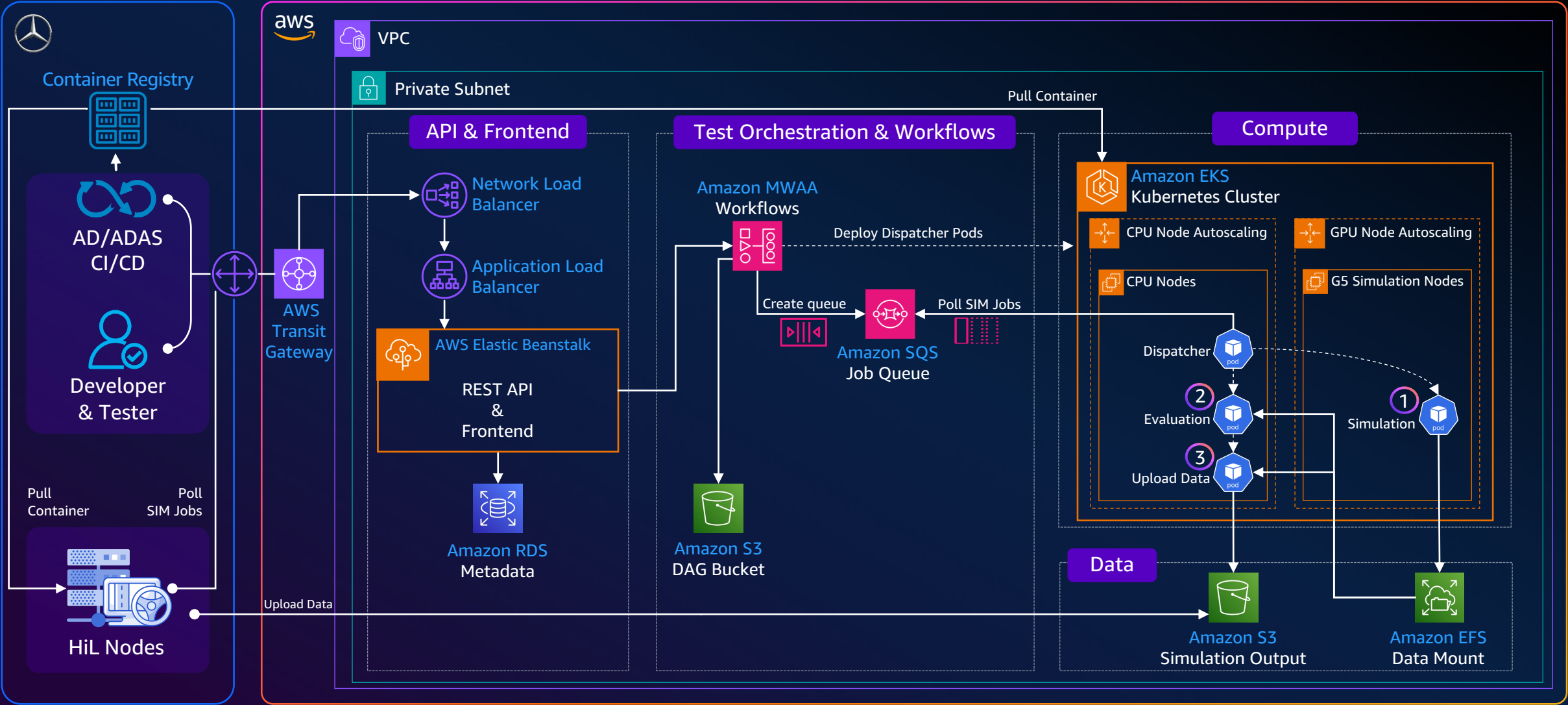
Recap and Key Takeaways

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Architectural Overview: Unveiling the Data Flow

Summary

Minimal Turnaround Times
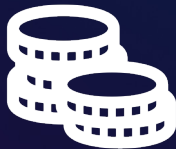Accelerating single test results delivery in <1 hour

Digital-First Approach
Identifying issues before real-world testing

Scalability
Empowering millions of simulations each month

Cost Efficiency
Maximizing cost-effectiveness through efficient resource utilization

Seamless Integration
Providing convenient access to simulation for all developers and testers

Fast build-up
Rapid platform setup and teardown in under a day with Amazon CDK

Thank you!

Please complete the session survey in the mobile app

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