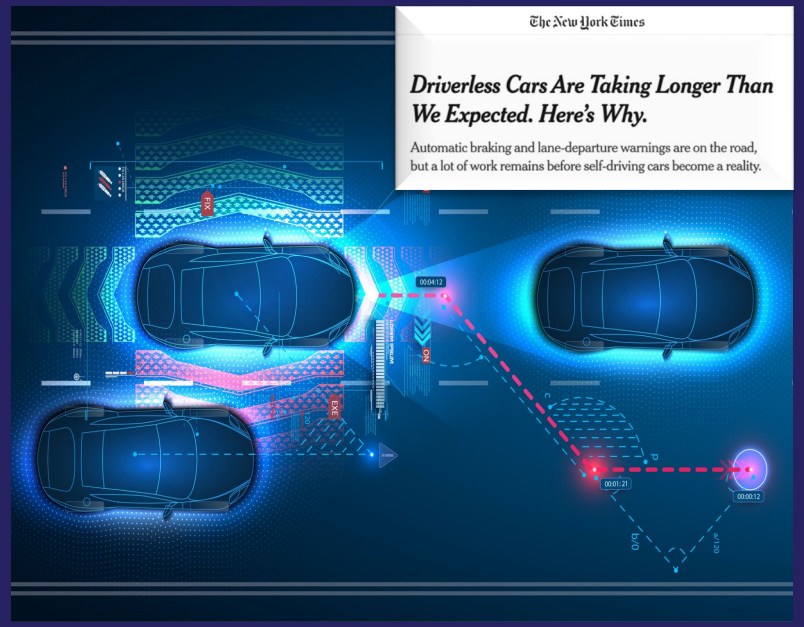
Autonomous Driving Data Framework (ADDF)

Providing efficiencies for autonomous driving development

Karthik Krishnan

Autonomous Vehicle Industry Shifts

Create More Operational Domains but with Incremental Development and Reduced Risk



Industry Vision in ~2015

- Level 4 AV's will launch by 2021
- First markets will be US & Europe
- Passenger cars first

Reality in 2022

- Blend of ADAS, AV roadmap through 2030+
- China will be an early powerhouse
- Broad set of use cases beyond automotive

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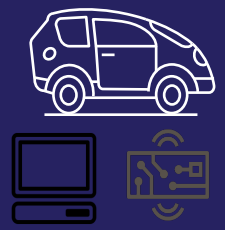
Understanding Autonomous Driving Challenges

Global Reach, Hyperscale, Unlimited Scenarios

Data Collection & Ingestion
Globally Distributed Fleet
100's of PB of test data
Offline/Online Ingestion
Data pre-processing

Data Enrichment & Labeling
Managing 1000's of labelers
Diversity of labels: 3-d BBoxes, temporal contexts
Semantic Segmentation
Sensor fused ground truth

Model Development, Training, & Deployment
Perception, localization, prediction, & motion
1000's of training nodes
Petabytes of Low latency storage
Larger networks, more of them and more data



Validation and Simulation
Replay of 10,000's of hours of data
Sensor Reprocessing and simulation
Vehicle dynamics, Scenario management
Millions of simulated miles
Closed and Open Loop SiL & HiL

Cost
Staff and expertise in demand
Huge compute and storage costs
Investments need to make a business case

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Autonomous Driving Data Drive Development

Adopted from the ASAM Standard for Data Driven Development and Validation

1

2 Data Collection, Data Ingest, and Data Enrichment

3 Data Labeling

4 Machine Learning for Model Development and Training

Model in the loop

5 Validation & Testing in Cloud *SiL Simulation*

V-Model SW Unit verification

ASAM OpenDRIVE®
ASAM OpenSCENARIO®
ASAM OSI®

SiL – Software-in-loop

6 Autonomous Vehicle Data Framework

7 AD Development Workspace → AD Software Stack integrated into Hardware

V-Model SW Integration & Testing

8 Qualification on AD Platform *HiL Simulation* → Qualification in Cloud "Soft HiL/Shift Left"

V-Model: HW Reprocessing/Data Replay

Soft-HiL Qualification Test

Qualification in the Vehicle Test Drive

HiL – Hardware-in-loop

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Autonomous Driving Data Framework (ADDF)

Data Repositories, AV pipelines, High Performance, Foundational Deployments

Search, analysis, visualization, and consume the drive log and test data by development, test, and deploy teams

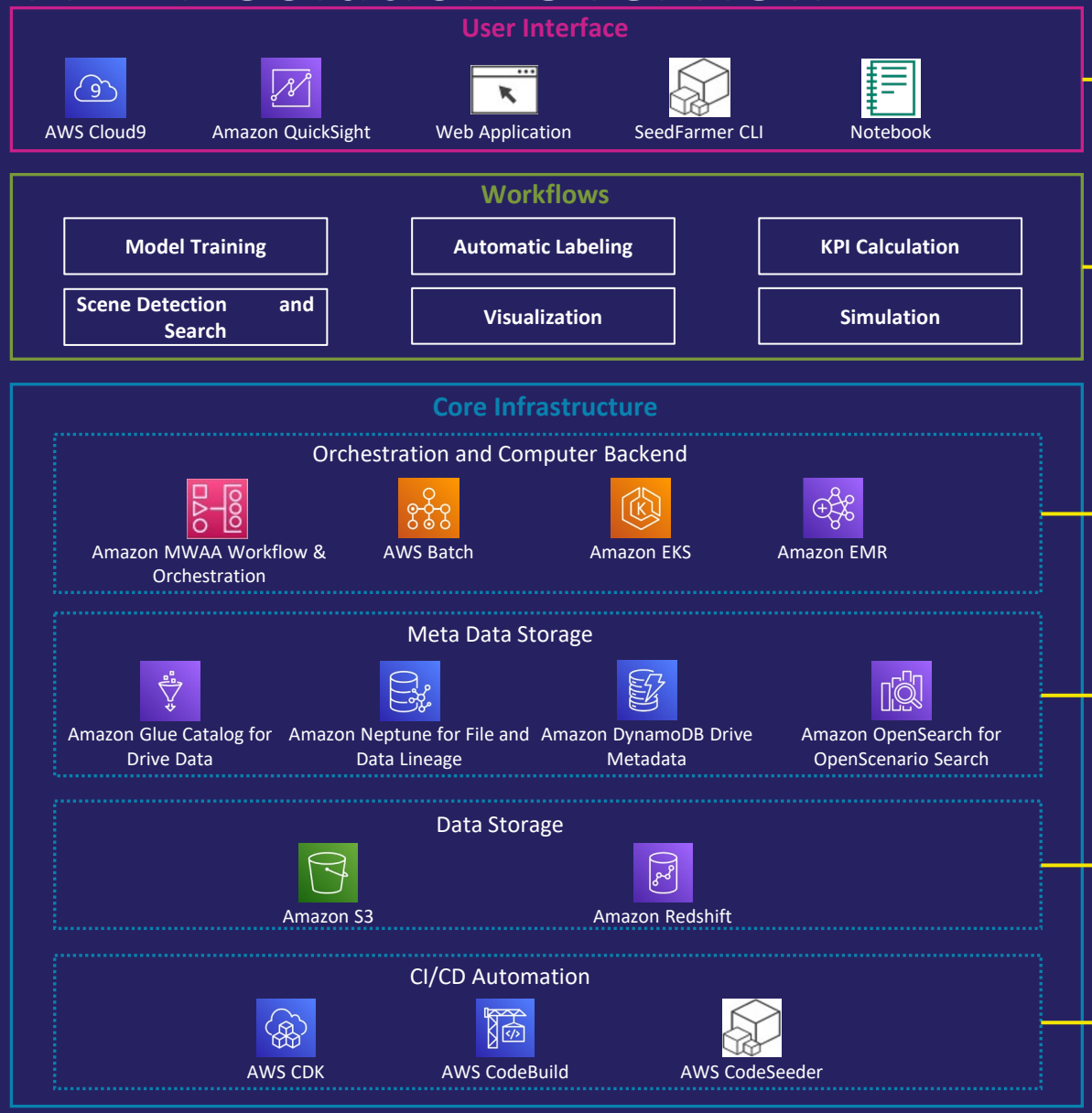
Big data repository for drive logs and test results used for AV development and archived drive data for compliance (ISO 26262)

Enable diverse processing pipelines for downstream user groups and globally distributed compute resources

Enable high performance throughput and latency needs of the downstream workloads

Enable immediate foundation deployment by building the framework with infrastructure as code

ADDF Solution Overview



User interface for code development (**AWS Cloud9**), KPI Reporting (**Amazon QuickSight**), Web Application for Scenario Search and Visualization, Deployment tool (ADDF CLI) and Modeling (Jupiter Notebook)

Three Pre-built workflows include Scene Detection and Search, Rosbag file visualization, and Simulation with EKS. Three additional workflows on roadmap: Model Training, Automatic Labeling and KPI calculation

Orchestration service is **Amazon MWAA** with flexible computer backend (**AWS Batch, Amazon EKS** and **Amazon EMR**)

Meta data storage includes **AWS Glue Data Catalog** for drive data, **Amazon Neptune** for file and data lineage, **Amazon DynamoDB** for drive metadata, **Amazon OpenSearch** for OpenScenario Search

Amazon S3 is the data storage for the raw data and **Amazon Redshift** is the data storage for numeric sensor data

CI/CD automation leverages **AWS CDK**, **AWS CodeBuild** and AWS CodeSeeder

AV Solution Approach using Open Standards

Customer OEMs & Tier 1s

System Integrators

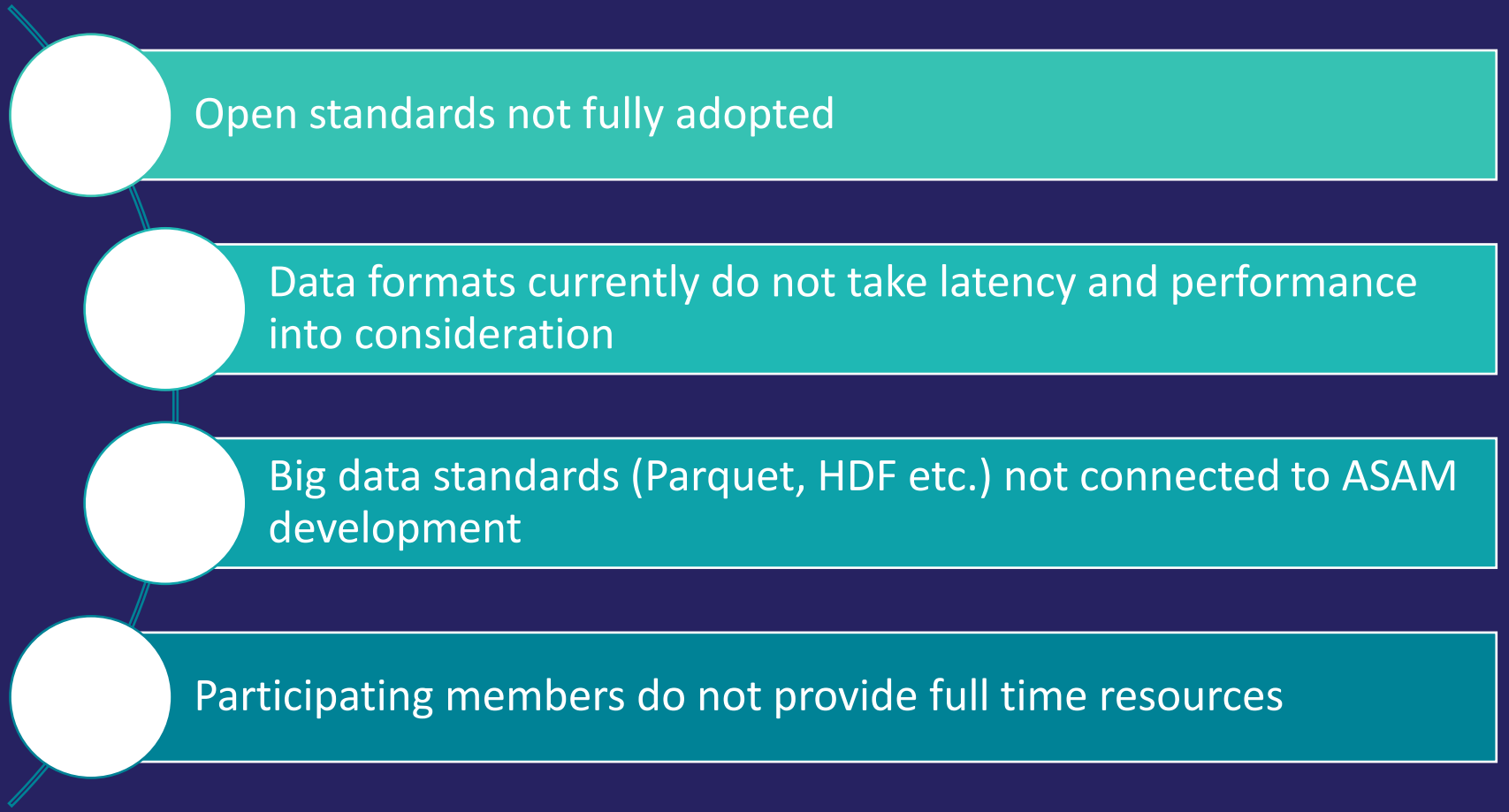
accenture · KPIT · Capgemini · DXC TECHNOLOGY · TCS TATA CONSULTANCY SERVICES · aws professional services

AWS Partner Network

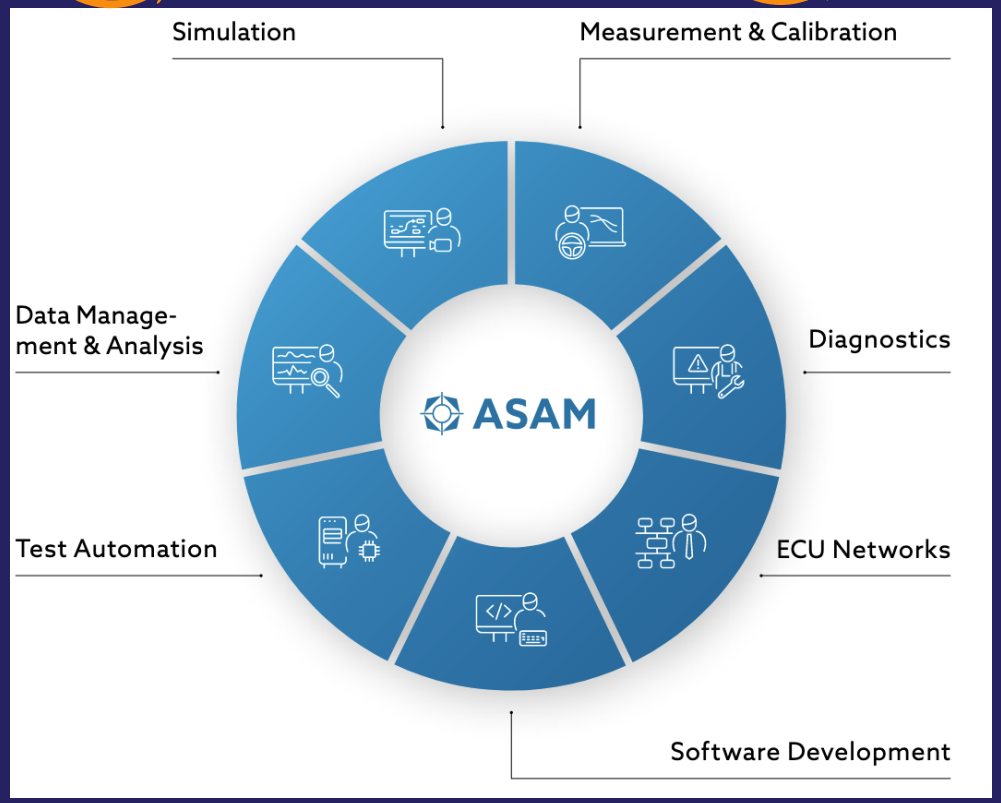
Data Collection Data Ingest Data Enrichment	Data Management Data Processing Data Analytics	Data Labeling	Validation Testing in Cloud (SiL)	Model Development & Training	Qualification in Cloud (Soft HiL)	Qualification on AD Platform (HiL)
			ASAM OpenDRIVE® ASAM OpenSCENARIO® ASAM OSI®	ASAM OpenDRIVE® ASAM OpenSCENARIO® ASAM OSI®	ASAM OpenDRIVE® ASAM OpenSCENARIO® ASAM OSI®	
b - plus Akridata™ AI Platform for Visual Data otonomo edgeconnex® aws	ADDF Capgemini DAS DXC Robotic Drive	Amazon SageMaker Ground Truth	IPG AUTOMOTIVE dSPACE aiMotive Elektrobit NVIDIA. HEXAGON	KPIT Amazon SageMaker Weights & Biases MathWorks	arm QNX AMI	

Simulation partner example

Gaps



How can AWS help?



Thanks