Assisted and Automated Driving @ PORSCHE

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Agenda

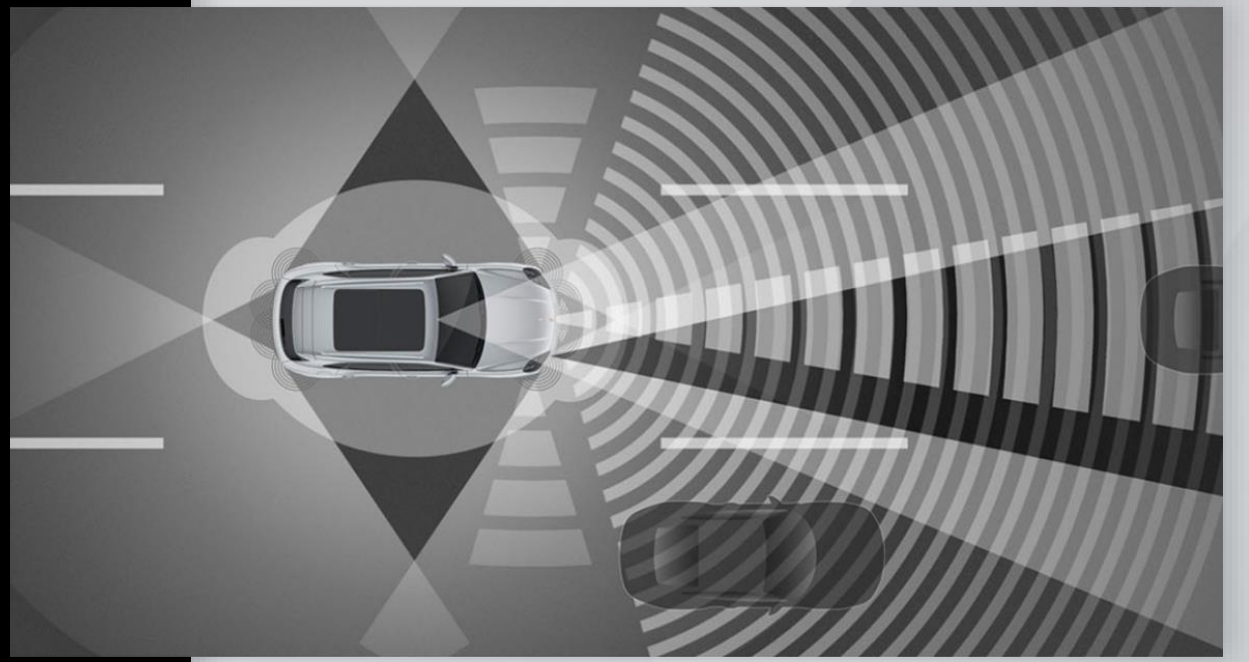
1 Automated Driving vs SDV

2 Roadmap and trends

3 Scalable L2++/L3 architecture

4 Development framework

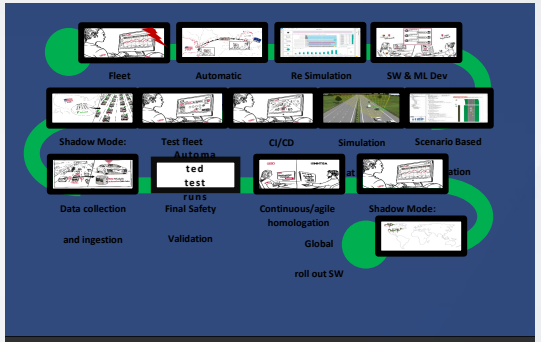
5 On the role of AI



Automated Driving and Software-Defined-Vehicle (SDV) have a mutual relationship

Driver Experience, Digital Cockpit and Automated Driving are the top drivers of SW complexity

SW complexity demands of L2++/L3/L4 automation mandates scalable HW and SW architectures



AD mandates a seamless closed loop dev&ops chain

Big Data Loop and AI offer amazing opportunities, mandates integration of vehicle&cloud, safety standards for AI

- Automated Driving mandates a scalable hardware and software approach
- Capabilities of SDV are inevitable to handle complexity and life cycle demands
- Potential of AI to be used extensively, price of AI is storage&compute performance, safety standards are mandatory

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PORSCHE Portfolio and Innovation Drivers

CV

PHEV

BEV

A Porsche will always be a driver’s car

Assisted&Automated Driving supports safety as well as comfort in everyday situations

Performance Car

Excite with driving fun

Self driving remains the **focus for Porsche**

Daily Driver

Assure customer satisfaction

Automated Driving as **helpful feature** in the daily use

PORSCHE ADAS/AD roadmap

Automated Driving (Level ≥ 3)

2009	2014	2016	2017	2024	…
				Hands Free Driving Hwy	Hands Free Driving Hwy
			Intelligent Park Assist	Intelligent Park Assist	Intelligent Park Assist
			Emergency Assist	Emergency Assist	Emergency Assist
		Porsche InnoDrive	**Porsche InnoDrive**	Porsche InnoDrive	Porsche InnoDrive
		Traffic Jam Assist	Adap. Cruise Assist	Adap. Cruise Assist	Adap. Cruise Assist
	Lane Assist	Lane Assist	Lane Assist	Lane Assist	Lane Assist
ACC	ACC	ACC	ACC	ACC	ACC
Safety (NCAP)	Safety (NCAP)	Safety (NCAP)	Safety (NCAP)	Safety (NCAP)	Safety (NCAP)
Panamera Gen 1	Macan	Panamera	Cayenne	Macan	






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Automated Driving with great benefits - Level 5 not in scope for Porsche

Level 1 › Level 2 › Level 3 › Level 4 › Level 5

Level 2++

- Human-like driving
- Hands-off (some markets)
- Urban areas
- **Hands Off**

Level 3 / Level 4

- Level 3: Stringent takeover requirements
- Level 4: Relaxed takeover requirements
- Eyes-off / Mind-off (side activities)
- **Eye Off/Mind Off**

Level 5

- Loose items, no safety belt, always&everywhere ODD not realistic in owned vehicles
- **Robotaxis no option for Porsche by now**

Automated Driving trends

Level 1 › Level 2 › Level 3 › Level 4 › Level 5

Bottom Up Scalable L2++/L3/L4

Top Down L4 to ??

cruise

WAYMO

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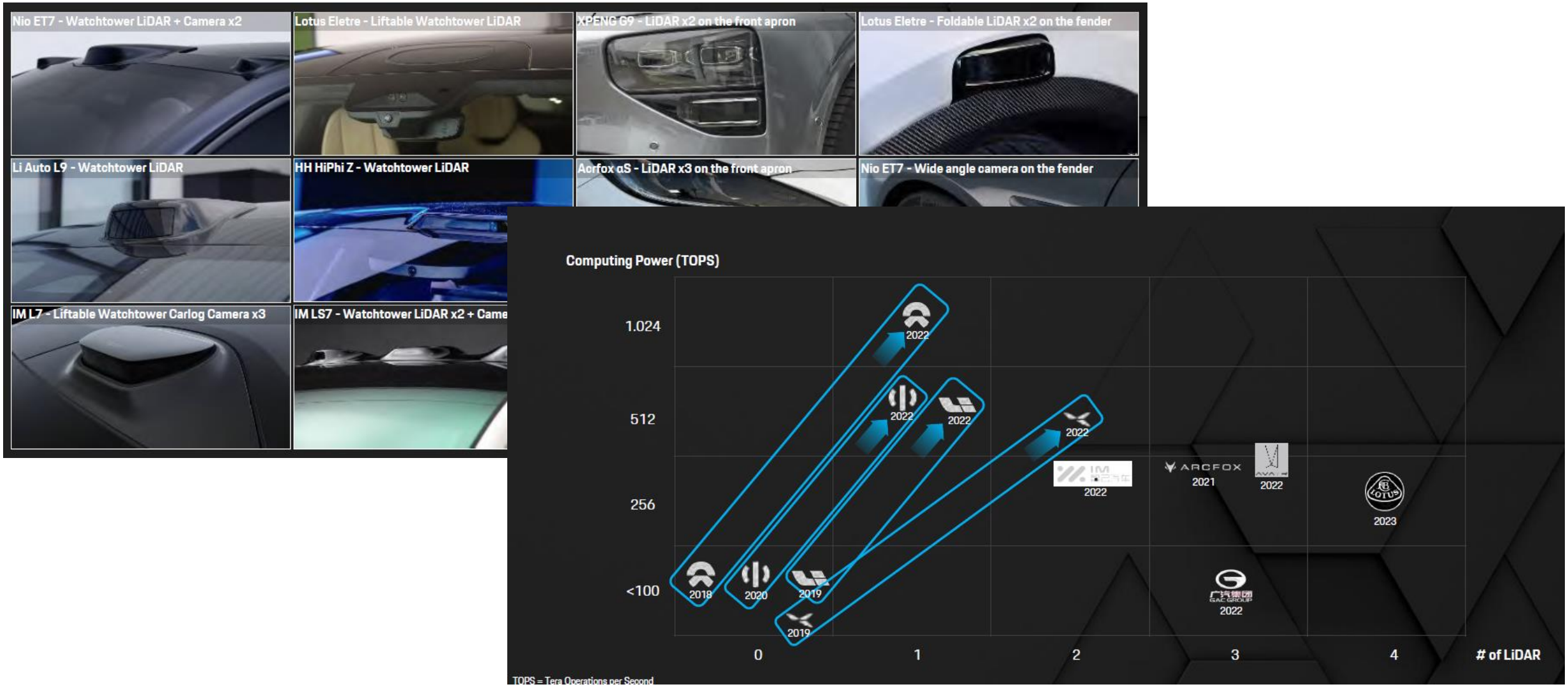
China: Hardware TOPS and Number of LIDARS Represent the „New Horsepower“



Customer features of Level 2++ function
Strategic partnership between VW Group and Mobileye

urban | everywhere | highway

intersection left / right

traffic light

follow navigation

near cut-in

highway access / exit

traffic rules

roundabout

dynamic objects

bottlenecks

lane change

- The **L2++ Driving system based on the Supervision™ technology** enables convenient and predictive hands-free longitudinal and lateral control of the vehicle in highway, interurban and urban driving
- The availability and performance of the respective features depend on the availability of REM™ (Road Experience Management™) data and legal requirements in the respective countries

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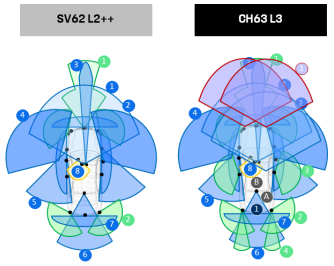
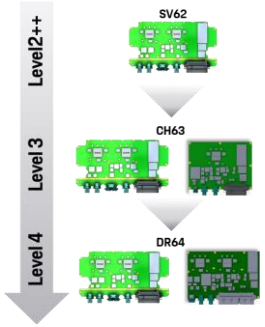
Complexity mandates a synergetic development
Scalable level 2++ & Level 3 & Level 4 sensor set & compute platform

Modular, scalable ADAS/AD Architecture

sensors



ECU



functions

The cross-brand use of Mobileye functions enables maximum synergies in ECU & function development, requirements, failure detection, simulation, PMT, V&V etc.

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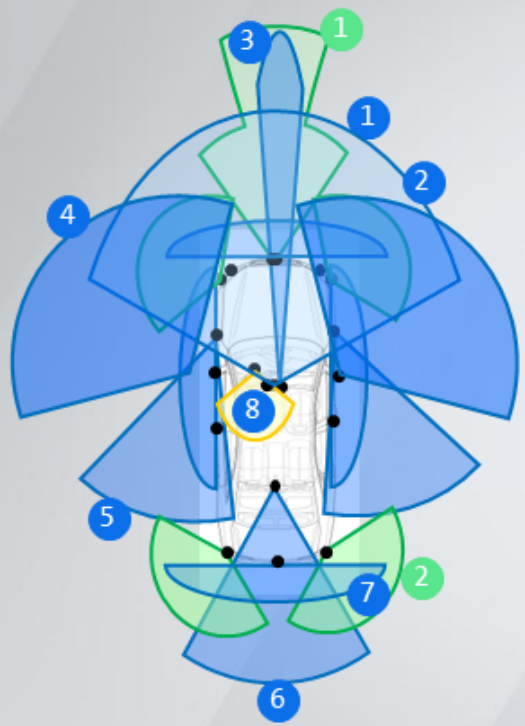
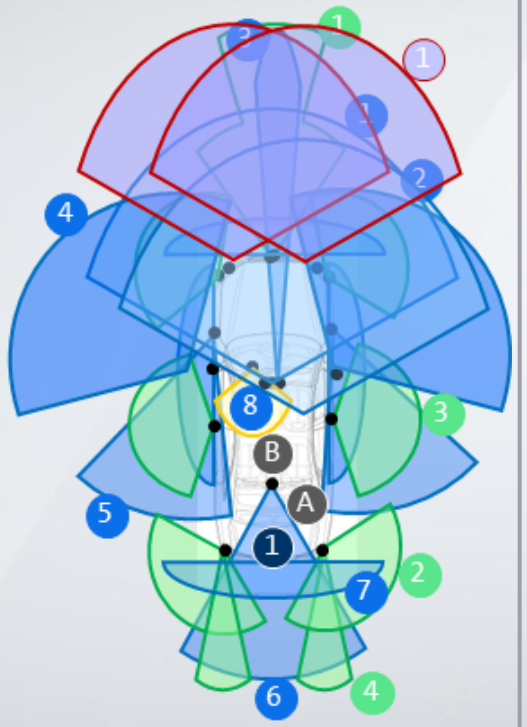
Synergistic development L2++/L3: Sensors and ECU

SV62 L2++



CH63 L3



Base comfort features

Mandatory safety features

Highway only

Full ODD Hands-off

SuperVision™ 62

11V + 5 Radars

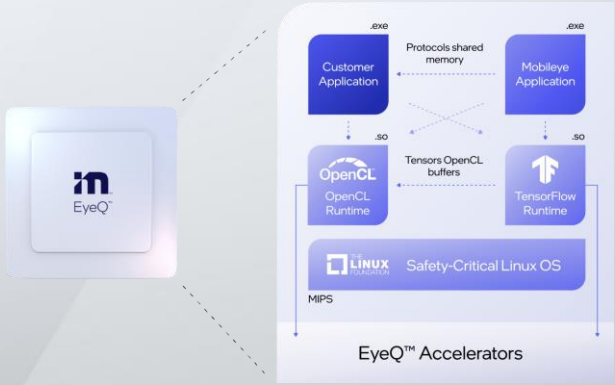
Traffic jam pilot

Highway

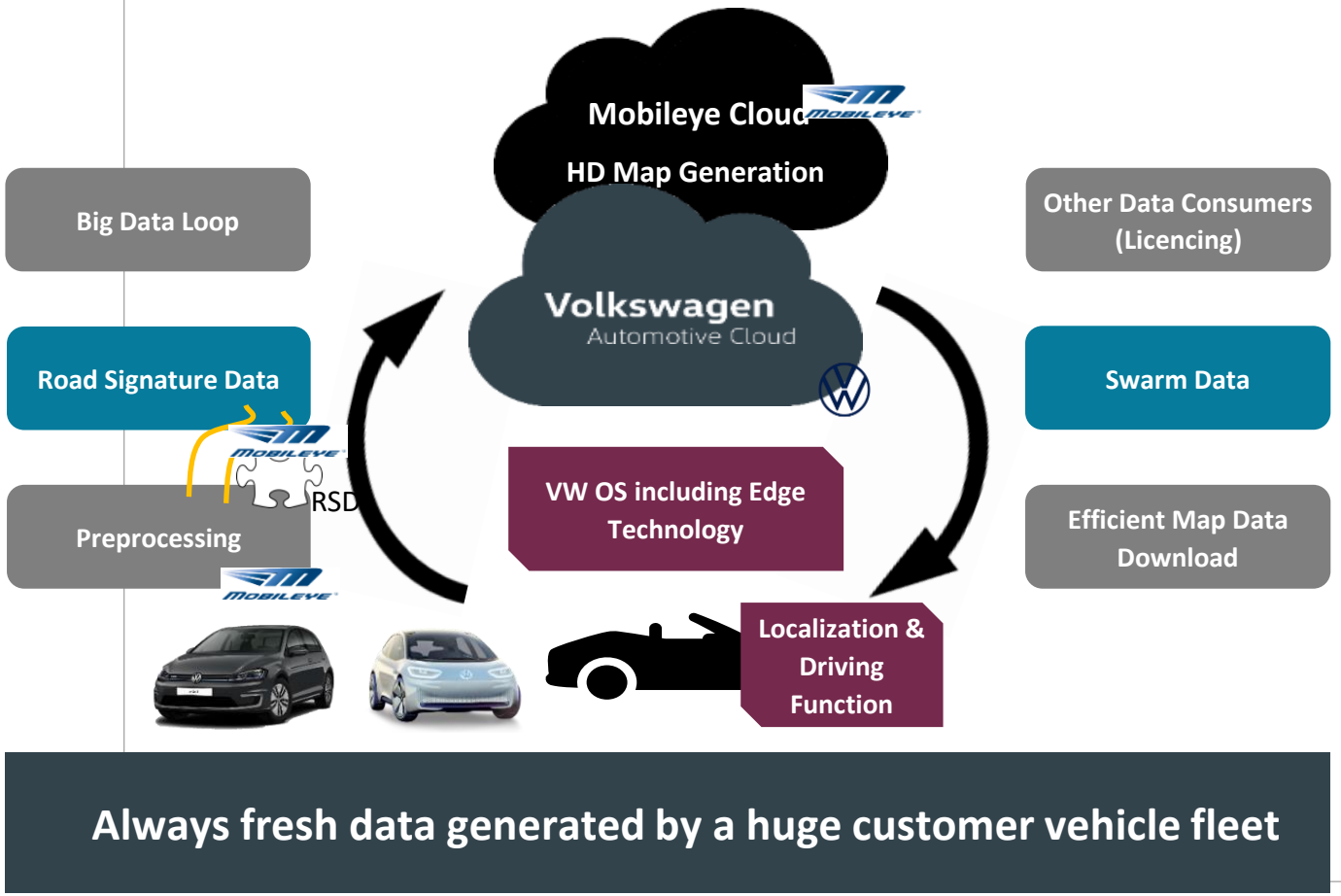
Chauffeur ™ 63

11V + 1/2Lidars + 10 Radars

Fall back ready user



Closed Loop Map Data



Onboard preprocessing to generate data in the front camera for upload

Efficient transfer of reduced data objects to minimize connectivity cost

Vehicle localization vehicle in map provides electronic horizon to driving function

- **Blueprint for region specific solutions**

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How are ADAS/AD functions developed, verified and validated?

Meeting Customer&Market Requirements

Functional Safety FuSa & Safety of the Intended Functionality SOTIF

Regulations

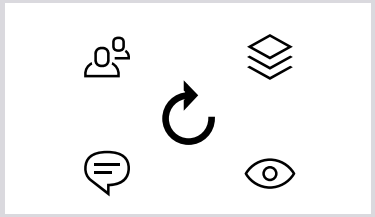
Test Planning & Test Infrastrucure

Review

Requirements

Concepts

Architecture



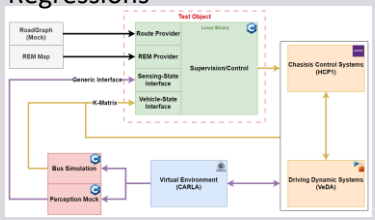
MiL & SiL & HiL

Functional value chains

Virtual value chains

Variants

Regressions



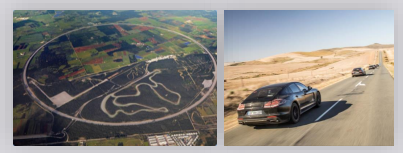
Prototypes

Test libraries

Objective validation

Prototype&Field Test

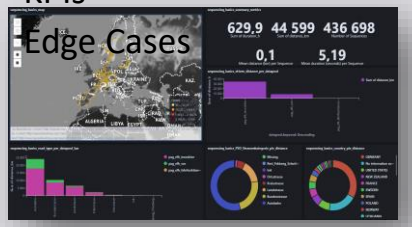
Worldwide test campaigns



Data Collection&Analytics

ODD Coverage KPIs

Edge Cases



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Validation and Verification need completely new approaches

Test track and public road validation

> 3 billion km ?

New Virtual Methods

Rapid prototyping, digital twin

Driving simulator

Resimulation

Data driven V&V & Big Loop

» 100+ prototypes running for 100+ years

» Data Driven Engineering

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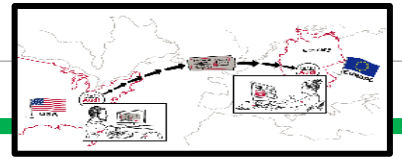
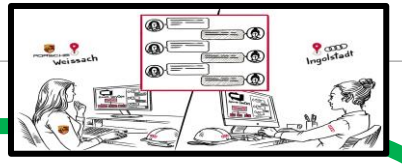
AD Life Cycle Management – User Journey

Fleet Monitoring

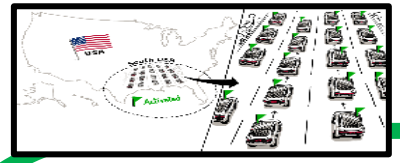


Automatic ticket system

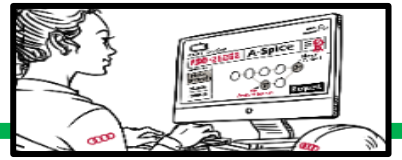
Re Simulation @ scale



SW & ML Dev Environment

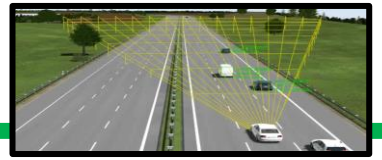


Test, eg Shadow Mode



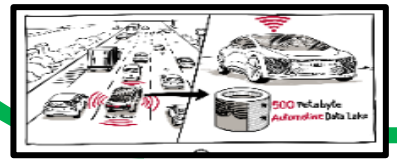
Test fleet OTA

CI/CD



Simulation at Scale

Scenario Based Validation

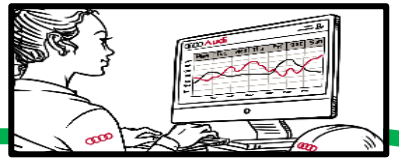


Data collection and ingestion

Automated test runs

Final Safety Validation

Continuous/agile homologation



Shadow Mode: Prod

Global roll out SW

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ADAS/AD Cloud Based Development Framework

Safety and Performance Management System

Monitoring: Data driven detection of critical scenarios and events

Control: Evaluation of incidents, deactivation of functions in the field

Safe, secure regulation/homologation consistent updates

Seamless, Scalable, Traceable and Automated

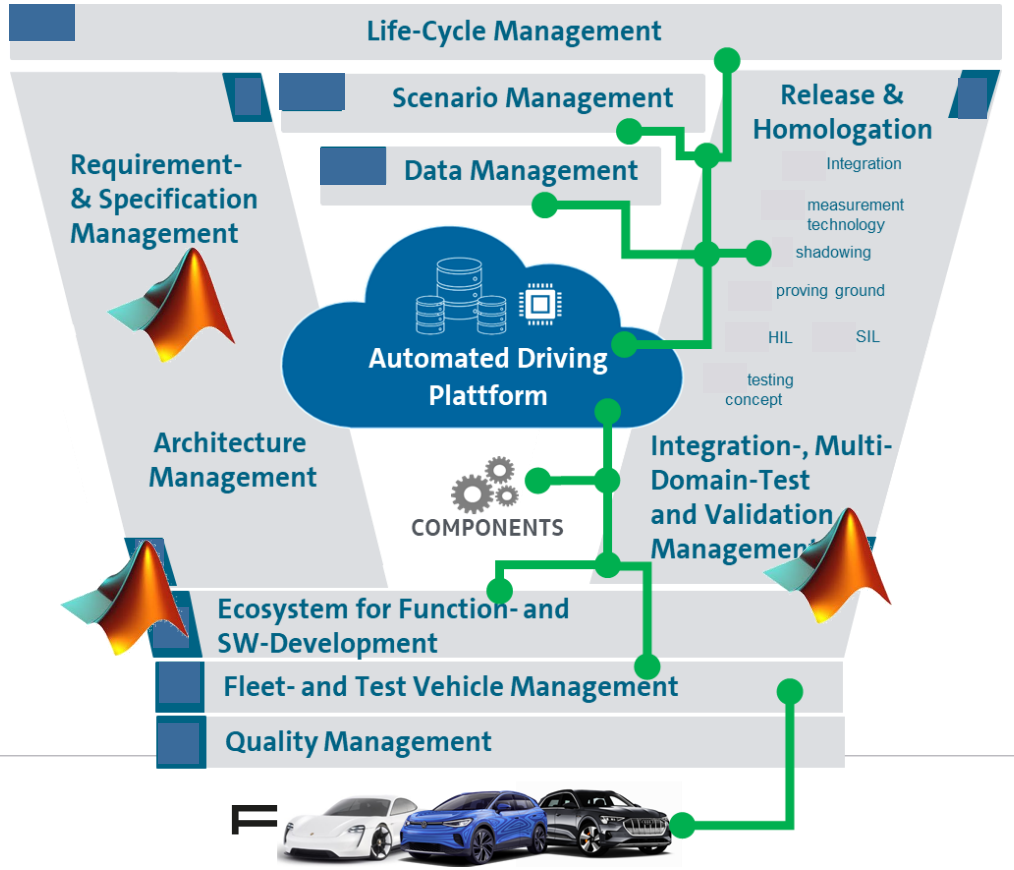
Safety&security oriented

End-to-end traceability

Event chain oriented

Scenario based

(Semi-)automated



Data driven

Validated simulation

Event chain oriented

Scenario based

(Semi-)automated

Reproduction&Regression

Homologation oriented

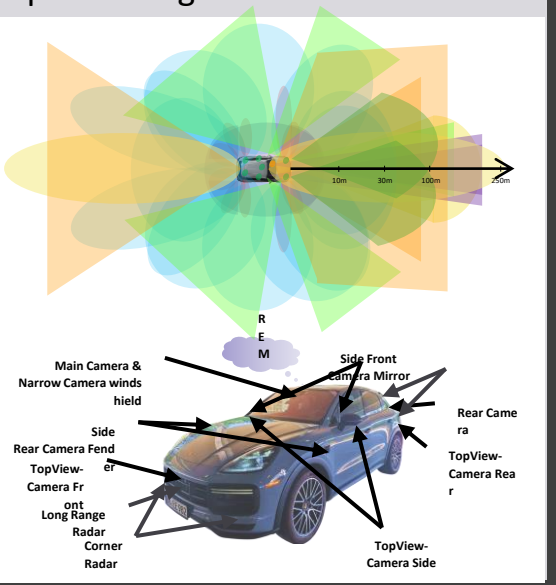
Virtual methods in ADAS/HAD development

Simulation methods and model quality are already established and have to be further improved

Test Planning & Test Infrastructure

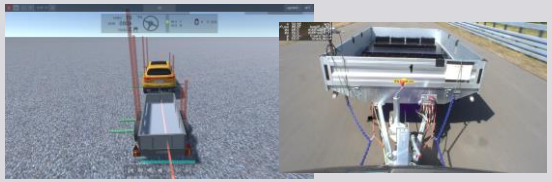
Concept Phase

- Increase of concept maturity
- Conceptual questions, eg sensor positioning



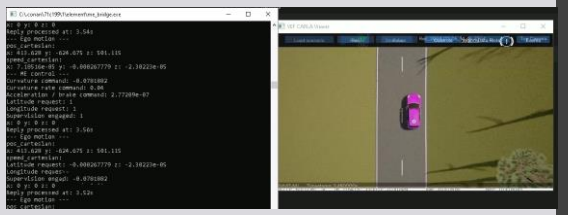
Virtual function development

- Virtual first-time application
- Virtual testing and test planning

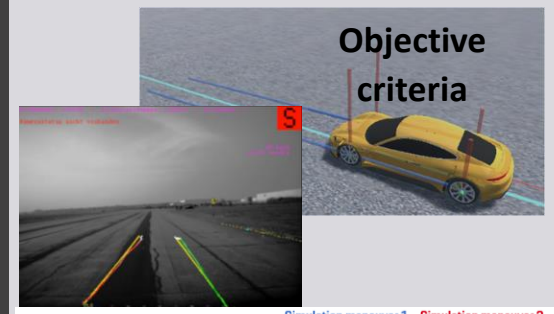


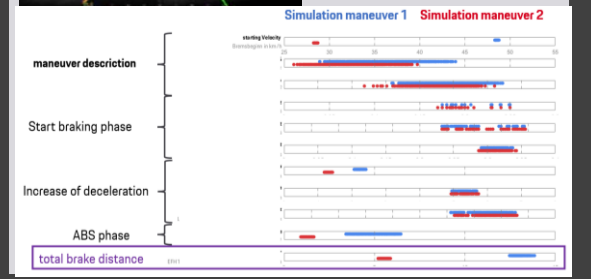
Virtual integration and test

- Virtual coverage of variants
- Resimulation (sensor data + SiL)
- Sensor models covering all sensing principles
- **Coverage of scenario catalog and homologation criteria**

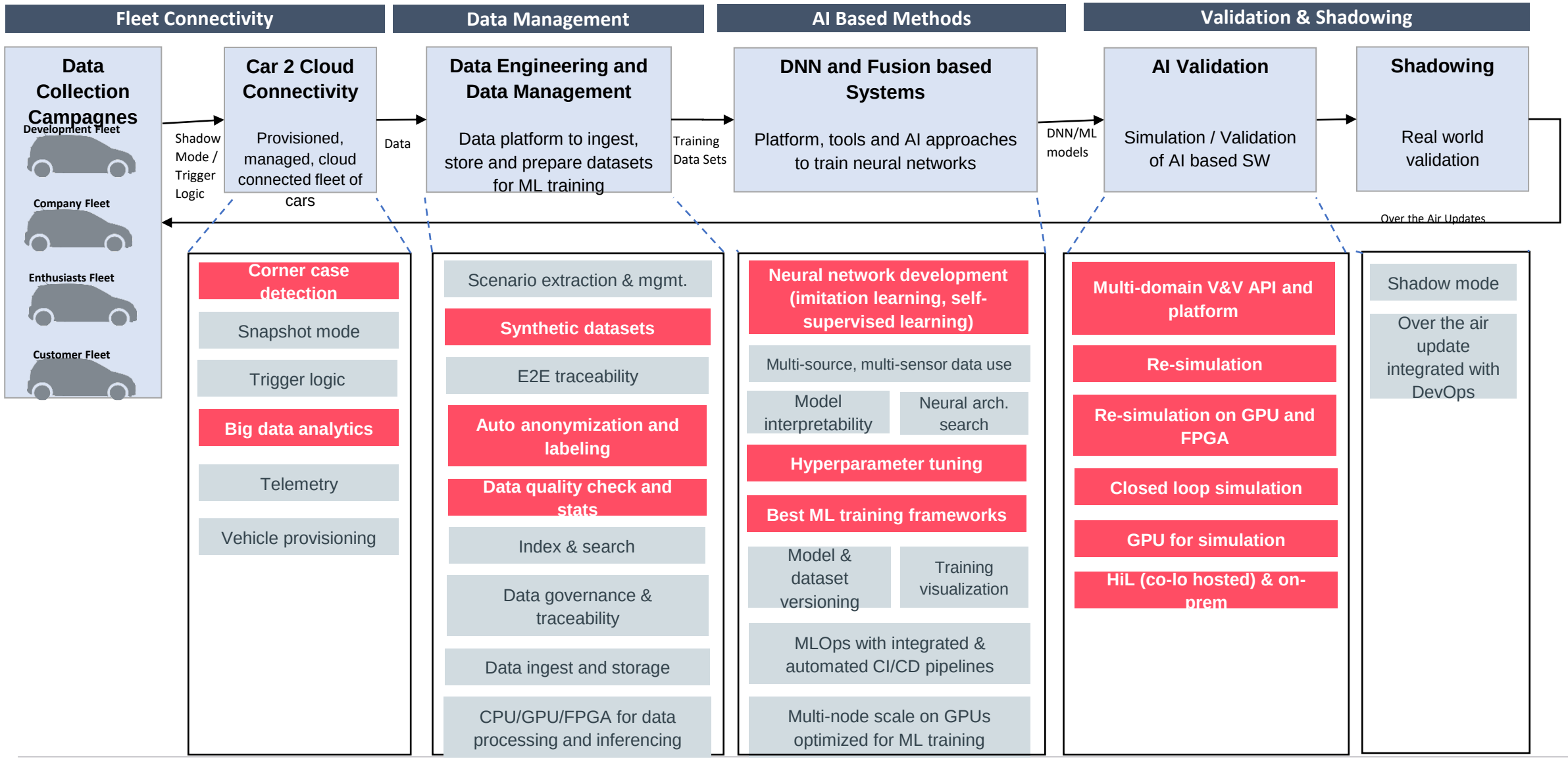


Data&model quality and objectivation of criteria (KPIs) + Homologation tests





Role of AI in the ADAS/AD Development and V&V Pipeline



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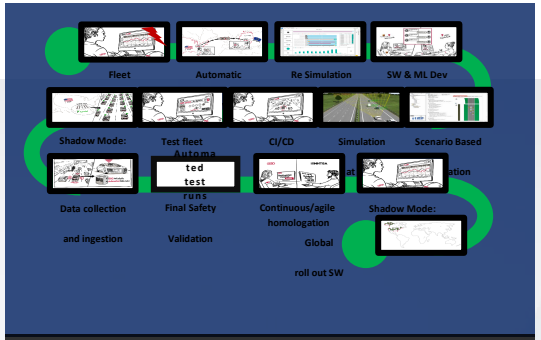
Conclusion

Driver Experience, Digital Cockpit and Automated Driving are the top drivers of SW complexity

SW complexity demands of L2++/L3/L4 automation mandates scalable SoC and SW architectures



AD mandates a seamless closed loop dev&ops chain

Big Data Loop offers amazing opportunities, mandates integration of vehicle&cloud

- Realization of AD requires high performance compute platforms incorporating SDV capabilities combined with sophisticated convential and AI signal processing and control
- AI offers widespread opportunities both in vehicle functions and development methods but:
  - Open Questions with regard to safety, freedom of interference, quality etc to be solved
  - Stepwise approach preferred over End-to end AI approach

- VW Group, PORSCHE and Mathworks established a long term partnership to push virtual development and V&V methods to a new level

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