Powering Innovation That Drives Human Advancement

# 云端海量、精确感知仿真 助力智能驾驶安全

Frank Xu

2025.5.20

# Ansys AVxcelerate

## 智能驾驶仿真解决方案

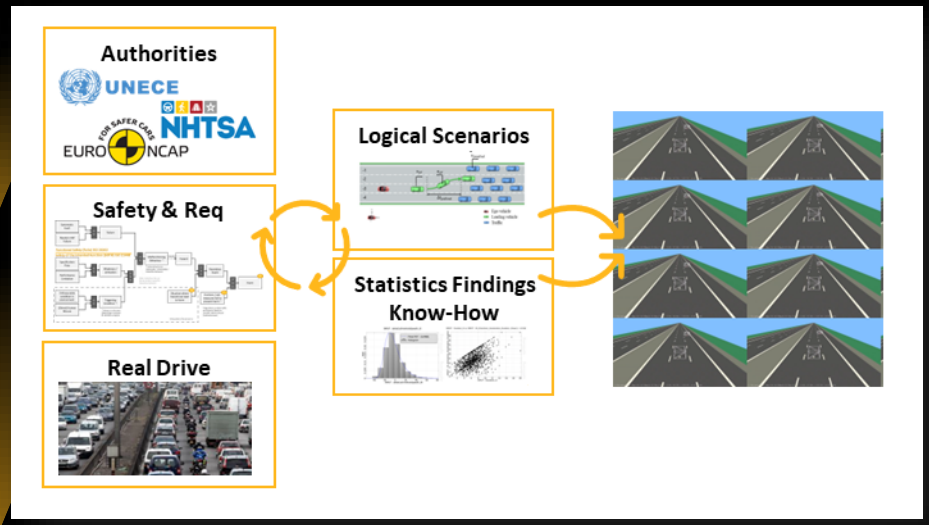
### AVX产品

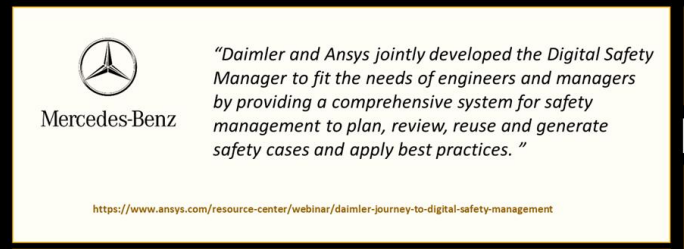
- **Autonomy** 云端海量场景仿真分析方案
- **Sensor** 物理级传感器感知仿真方案
- **Headlamp** 车辆灯光系统仿真解决方案

### 价值

- 帮助欧洲OEM量产L3高速自动驾驶项目及R157认证
- 帮助欧洲OEM获得ENCAP五星认证
- 帮助欧洲OEM改进L2+智能驾驶系统研发流程及R171、R152、ISO 26262等认证。
- 极大提升智能驾驶系统安全性
- 极大提升智能驾驶研发效率，缩短研发周期
- 突破感知仿真瓶颈
- NVIDIA Omniverse深度合作

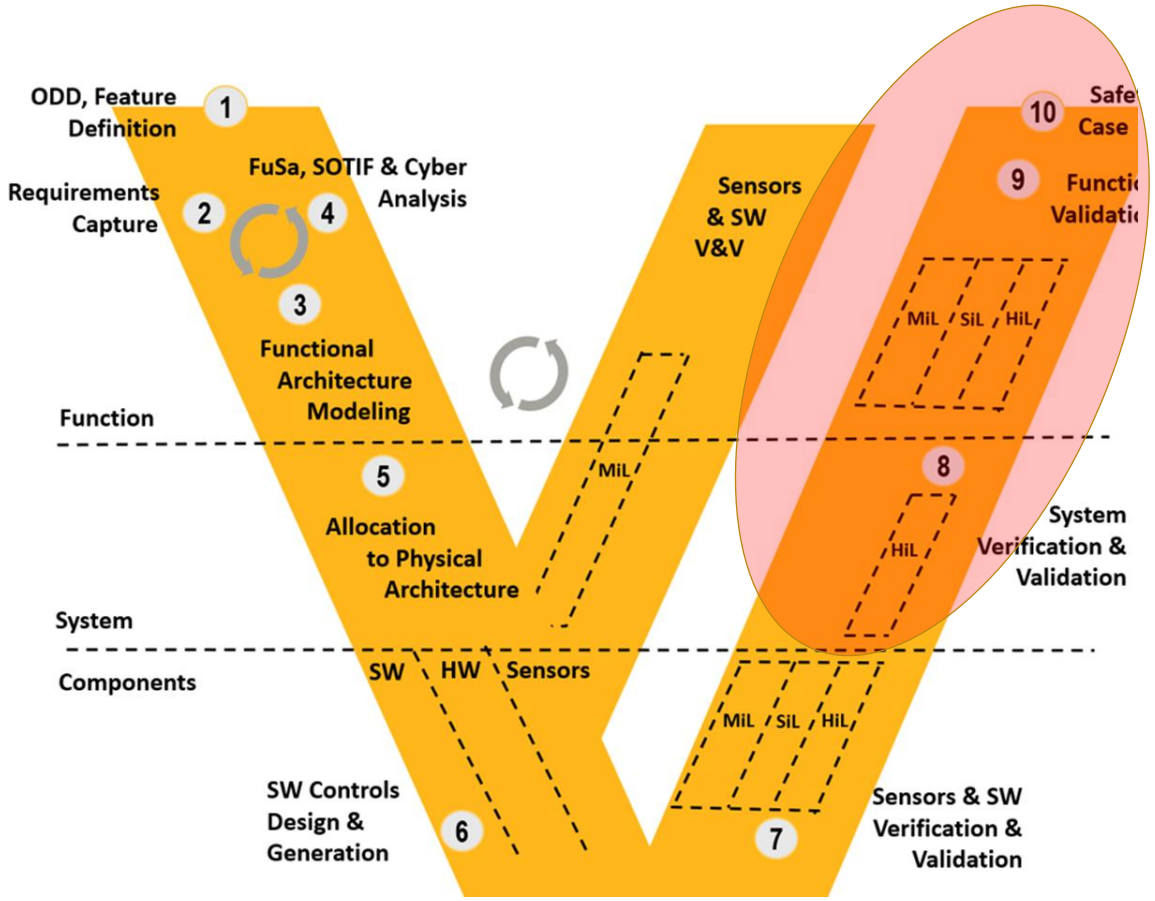
### 项目



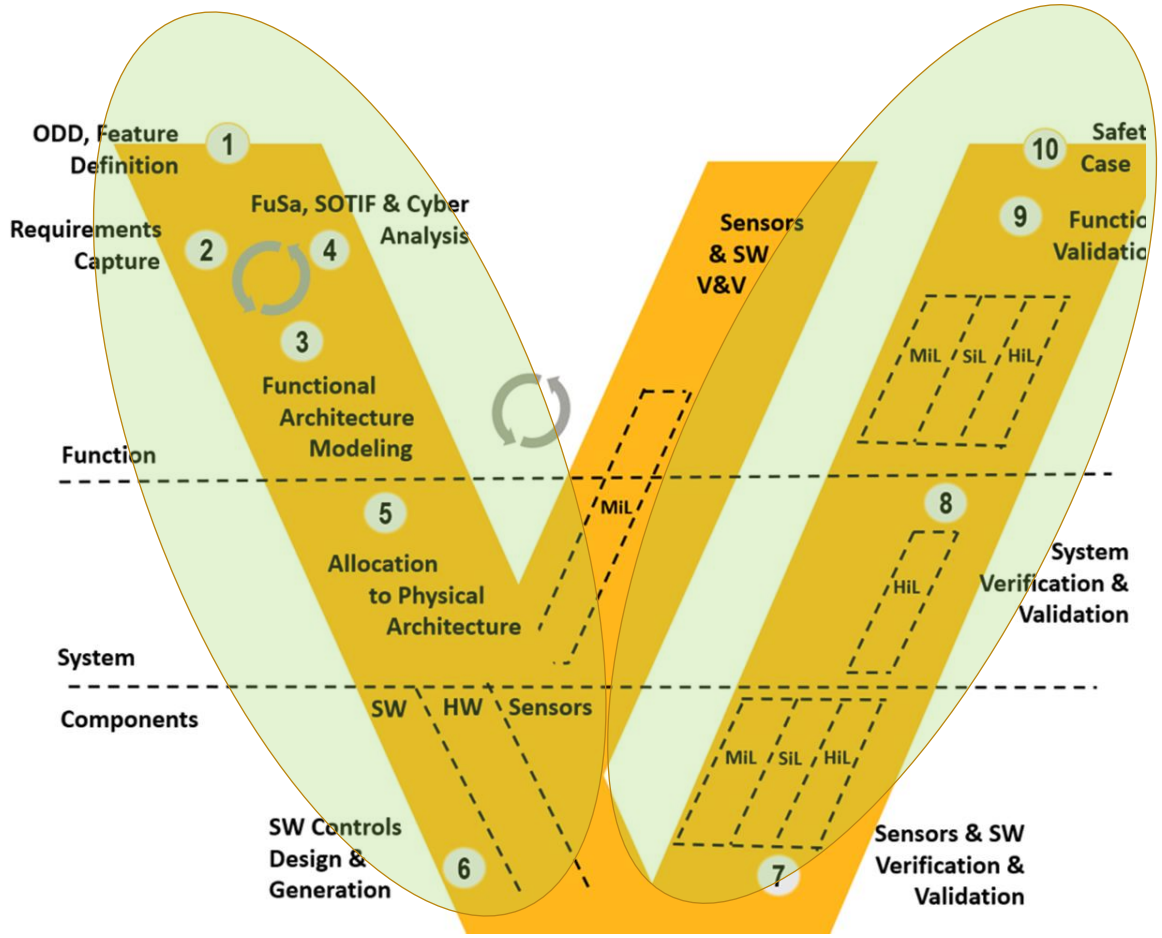



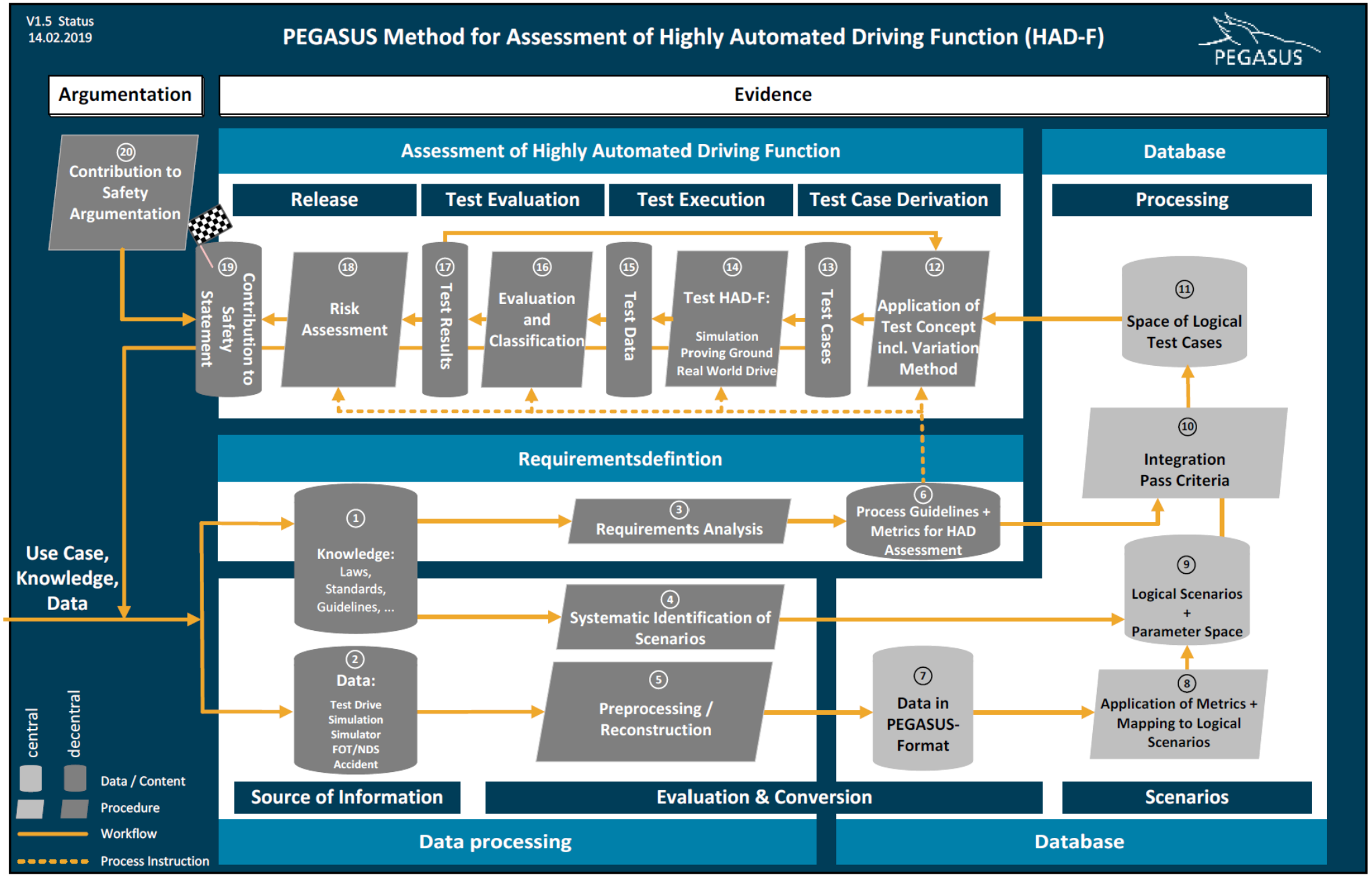



# Now




# Future





# Agenda

01 **Ansys AVxcelerate产品**

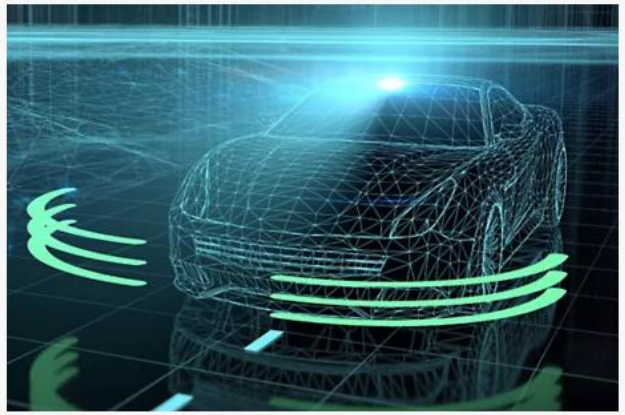
02 客户的价值

03 **产品功能介绍**

04 现有客户及项目

05 **总结**

# Ansys AVxcelerate产品介绍



## Ansys AVxcelerate Autonomy

ANSYS AUTONOMOUS VEHICLE SIMULATION


## Ansys AVxcelerate Sensors

ANSYS AUTONOMOUS VEHICLE SIMULATION

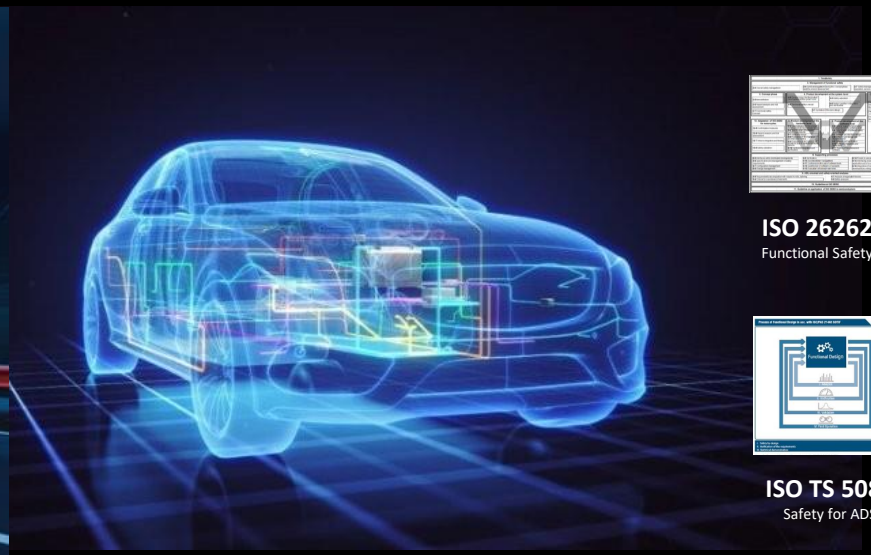
## Ansys AVxcelerate Headlamp

ANSYS AUTONOMOUS VEHICLE SIMULATION

# Growing complexity in Automotive ADAS & AV

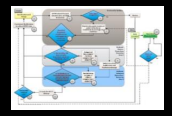
**Operational Design Domain (ODD)**

**Software Defined Vehicle (SDV)**
**Sensors | Compute | Redundancy**



**Regulation, Ratings and Safety Standards**

**ISO 26262**
Functional Safety



**ISO 21448**
SOTIF

**UNECE R157**
ALKS

**New NCAP 2026**

**New FMVSS**

**ISO TS 5083**
Safety for ADS

**ISO PAS 8800**
Safety of AI

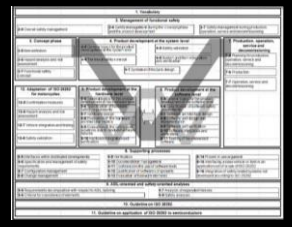
**GSR II**
Safety Evaluation of Autonomous Products

**UL 4600**
Safety Evaluation of Autonomous Products

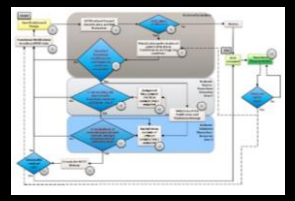
**Industry best-practice**
**Traffic law**
**NCAP Rating**
**...**

Performance improvement in time and cost along with proof of safety can only be achieved using **structured approach**, accurate, statistical and efficient simulation

# Growing complexity of regulation and standards for AV



**ISO 26262**
Functional Safety



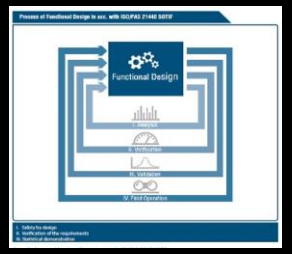
**ISO 21448**
SOTIF

**UNECE R157**
ALKS

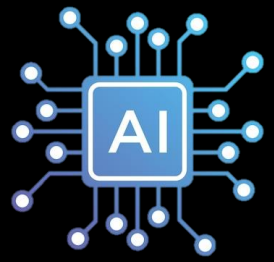
**EURO NCAP**

**NHTSA**

**FMVSS 127…**




**ISO TS 5083**
Safety for ADS




**ISO PAS 8800**
Safety of AI

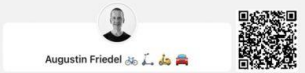
**UL 4600**
Safety Evaluation of Autonomous Products

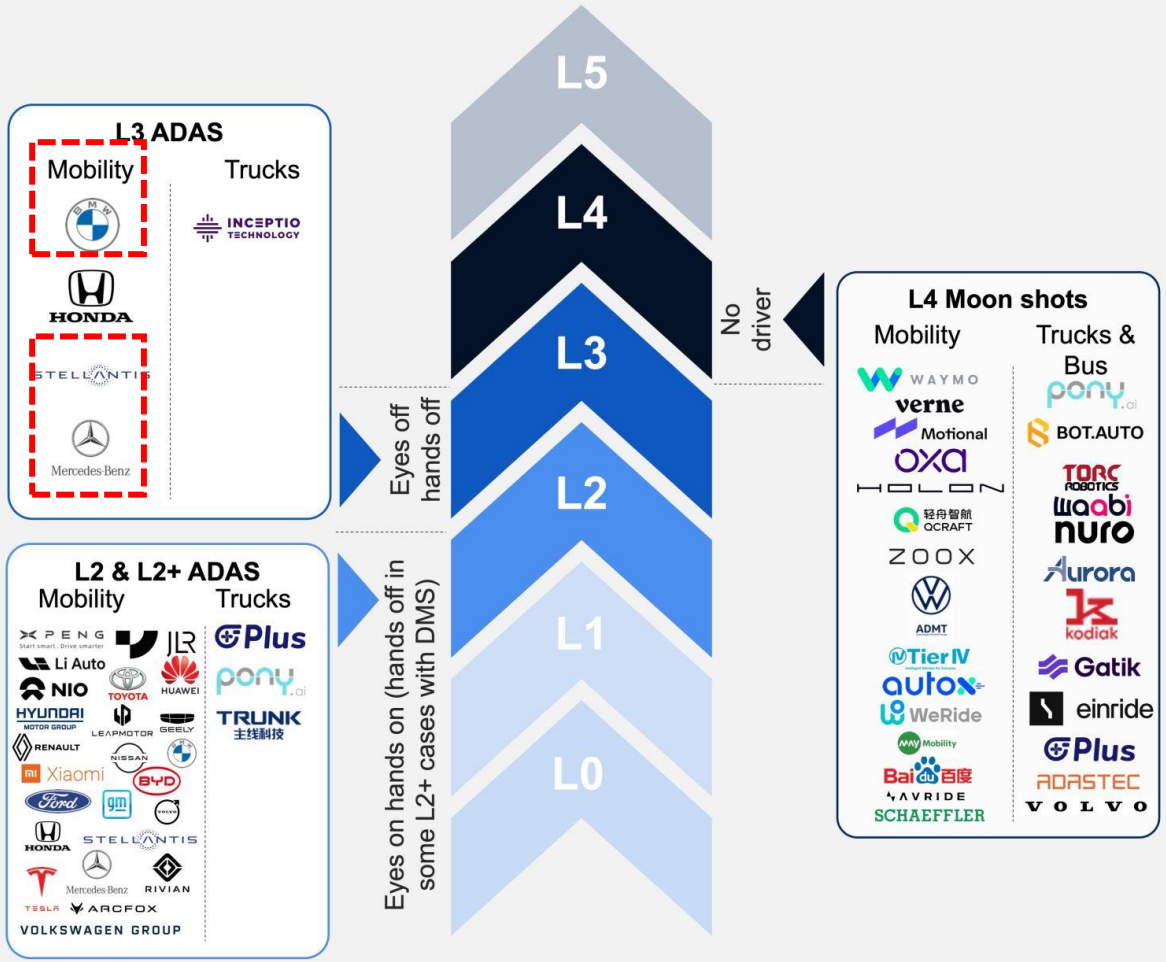
European Commission

**GSR**
Safety Evaluation of Autonomous Products

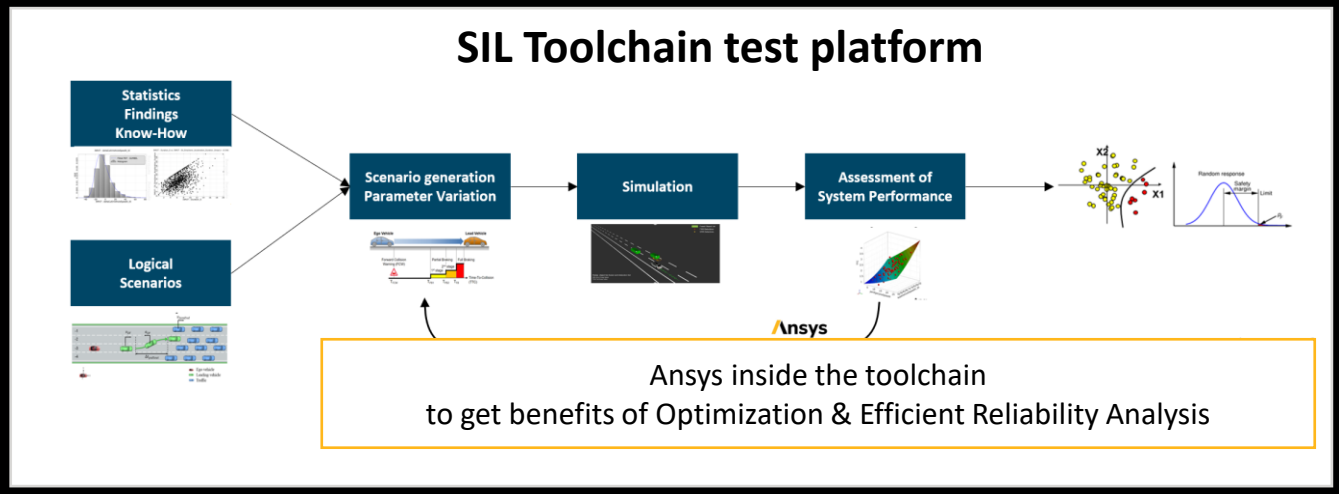
**Industry best-practice**
**Traffic law**
**…**

# PATHS TOWARDS L4 IN MOBILITY & TRUCKING




# Mercedes S-Class & EQS **L3 approval** - using Ansys


KBA real world test drive: ~50 h and ~1500 km only thanks to evidences from simulation

## Delivering Quantified Business Impact

**$10^{-9}$**

Determine risk per scenario class for very low probability of failure

**1000x**

Massive reduction of scenario to be simulated per class

**90%**

Simulation time saving lead to strong cost saving

*Ansys contributes the certification of Mercedes S-Class & EQS level 3 as one of the validation pillars*

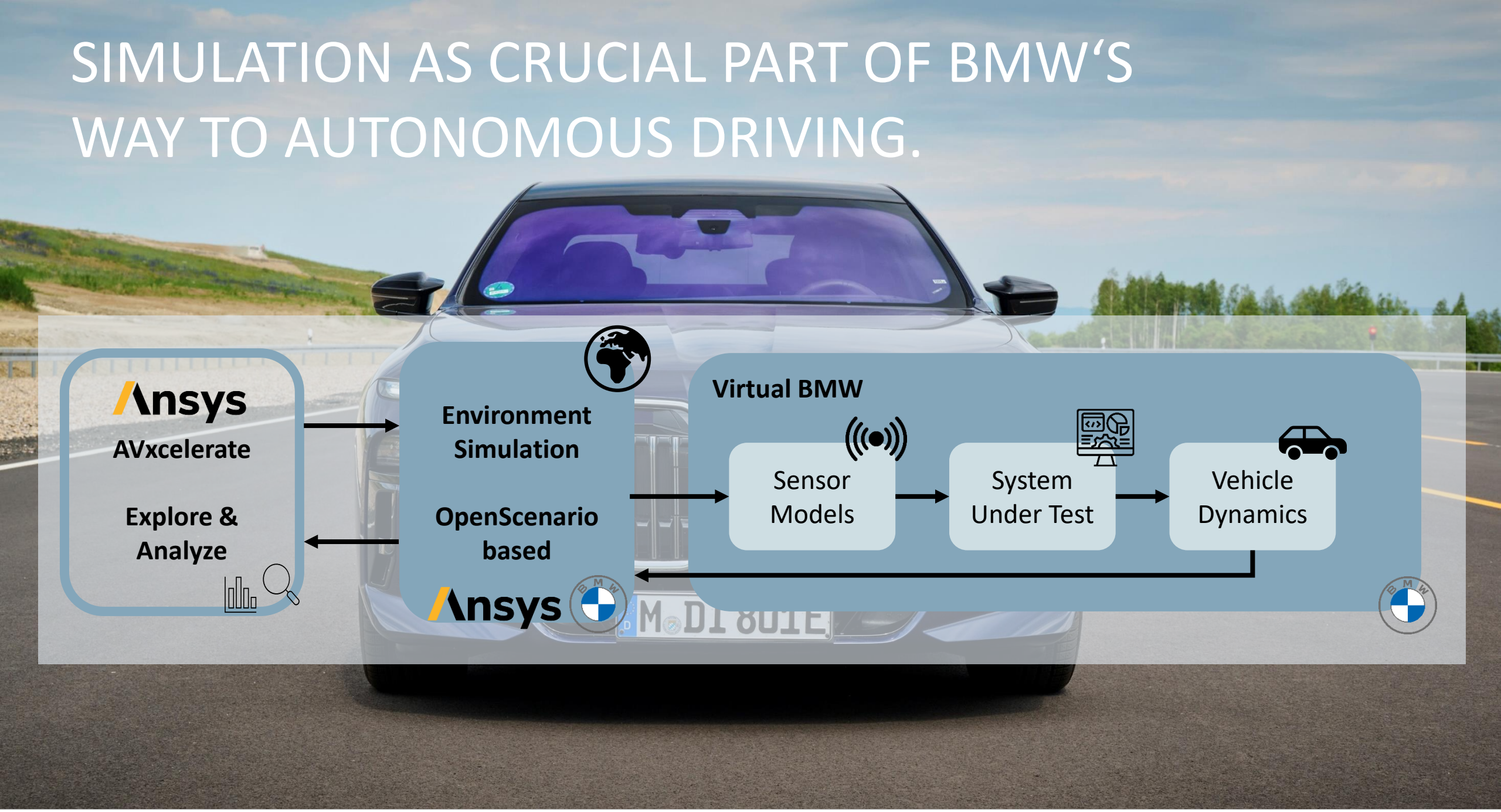
# Ansys Delivers Unique Value to ADAS & Autonomous Systems Customers

Ansys customers can efficiently develop and validate autonomous software with the ensured level of safety required by their clients

Co-developed with the BMW Group, Ansys AVxcelerate Autonomy's expansive scenario variation management capabilities **create a flexible, high-performance virtual environment.**

BOSCH
SONY
Mercedes-Benz
NVIDIA
Valeo
Continental
FLIR
Volkswagen
ZF
onsemi
STELLANTIS

# SIMULATION AS CRUCIAL PART OF BMW'S WAY TO AUTONOMOUS DRIVING.



Powering Innovation That Drives Human Advancement

# NCAP

Powering Innovation That Drives Human Advancement

# Scenario-based testing using AVxcelerate Autonomy

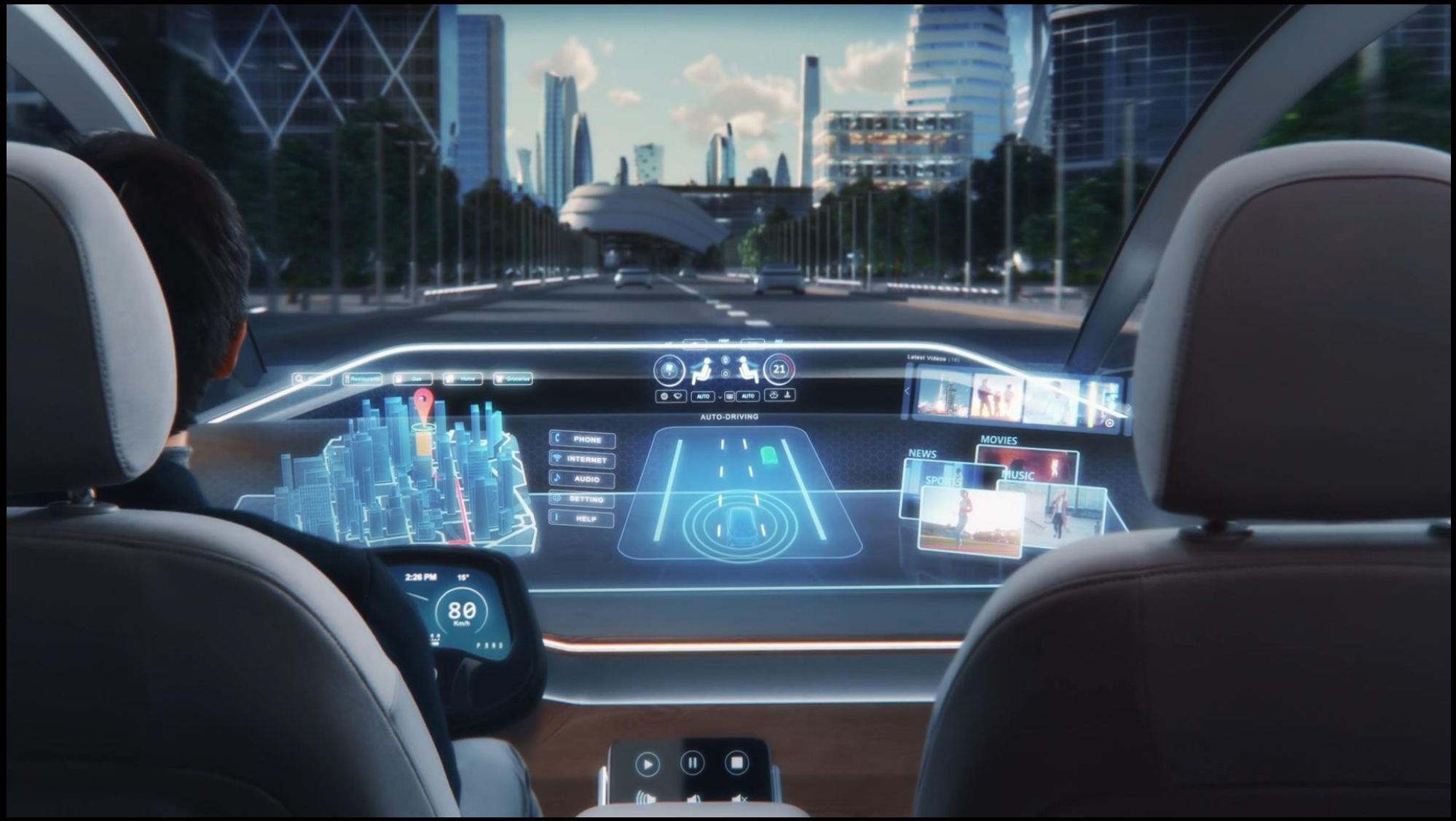
# What engineering challenges does AVxcelerate Autonomy address?

- **Scenario-based testing, up to L2+/L3/L4 validation**
  - Creation of concrete scenarios from logical scenarios and user-defined variations
  - Scalability for the variation of logical scenarios
    - Simulate 500K+ variations per logical scenario
    - Simulate a total 100M+ concrete scenarios from 200+ logical scenarios

- **Regulation testing (UNECE R157, FMVSS, NCAP, …)**

- **Toolchain integration**
  - Scenarios re-usable from 1 simulation software to another
  - Allow openness and flexibility for customisation and CI/CD integration

# AVxcelerate Autonomy Product Overview Video



Powering Innovation That Drives Human Advancement

# AVxcelerate Sensors

# AVxcelerate Sensors

Test & Validate Sensor Perception for Autonomous Vehicles

Ansys AVxcelerate Sensors provides best in class sensor digital twin models for highly accurate simulations to test sensors & autonomous systems including perception algorithms.

**100x**

Reduction in development time and cost due to virtual drive simulation

**Increased Safety**

Hi fidelity physics-based sensor models that mimic real life conditions

## Multi Sensor Simulation/Credible Sensor models

- Radar, Camera, Lidar, Thermal Camera

## Real-Time Physics-based sensors

- Validation using full physics; dielectric & spectral light properties
- Comprehensive simulation of corner/edge cases

## Scenario variation for ODD coverage

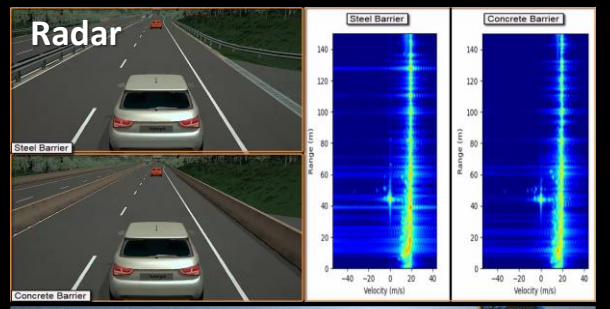
- Open or Closed Loop simulation for sensor and perception validation

## Driving Simulator Agnostic

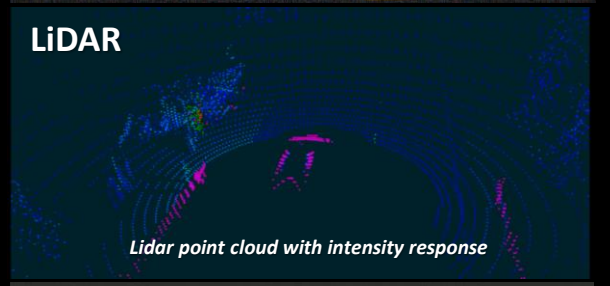
- Easy integration with off-the-shelf connectors
- APIs for openness

## Process ready

- HiL support capabilities and experience
- SiL HPC & cloud execution



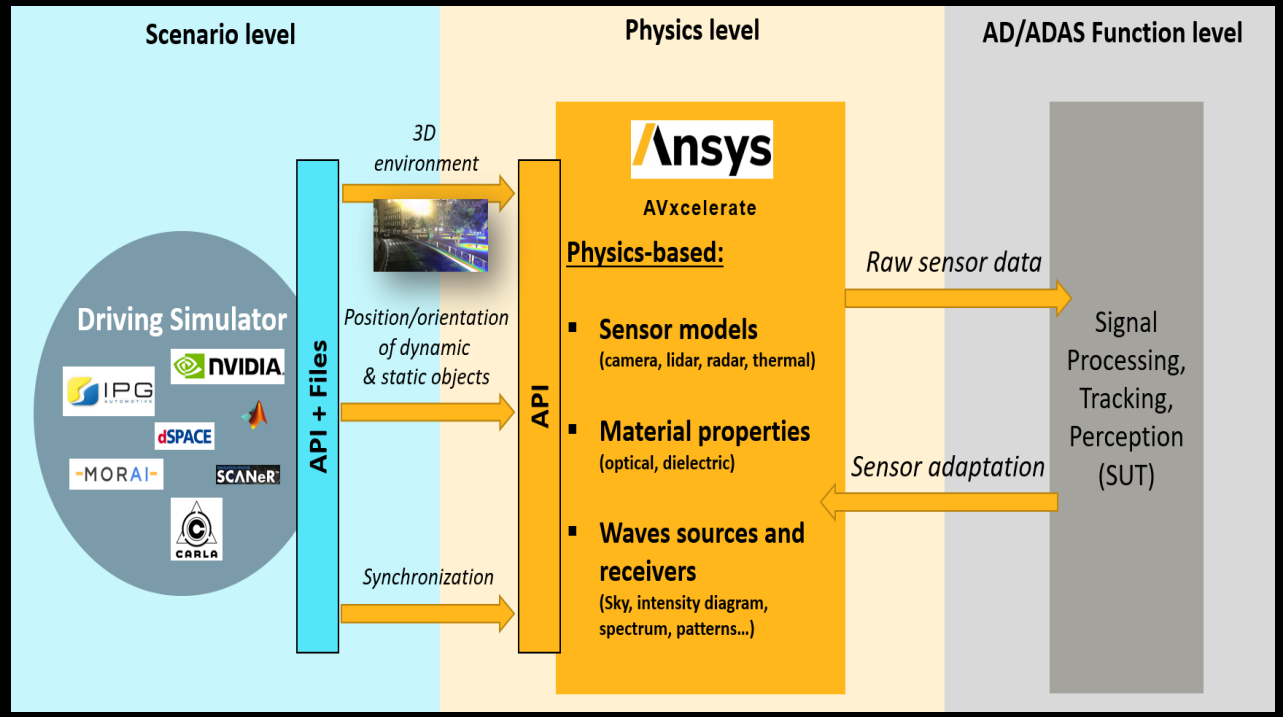


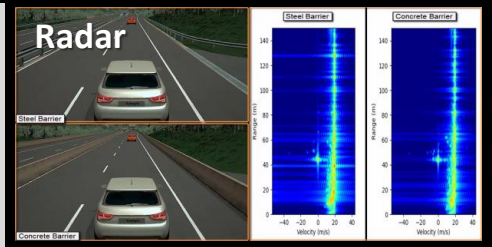


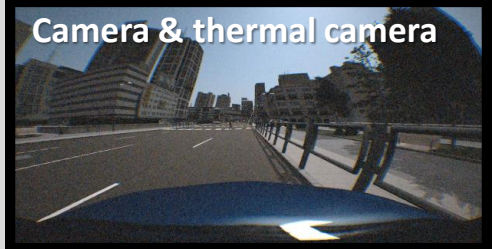

# Hi-fidelity Physics-Based Simulation with Traceability (ISO26262)

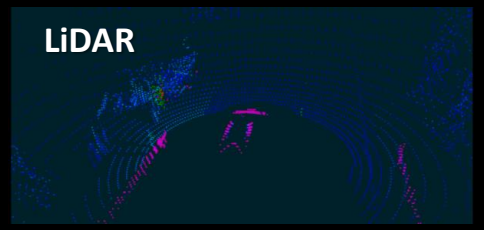
**Ensure continuous performance and reliability of AD software.**

Continuously run campaign of million scenario variations on cloud while keeping track of reliability analysis results.



# Strategic collaboration Ansys + NVIDIA for Autonomous Vehicle simulation

"The combination of our partnership with Ansys solves problems for our customers neither one of us could do alone, bringing solutions that would have been impossible otherwise. We're at a point now where we're about to simulate environments at a million times higher performance than something we were able to do 10 years ago. A million times. Cars haven't improved by a million times. Nothing's improved by a million times. By partnering with Ansys, we can solve problems a million times better, and that is completely transformative for our customers."

**Jensen Huang**
**CEO, NVIDIA**

https://www.ansys.com/campaigns/nvidia

## Ansys and NVIDIA Collaborate on Building a High-Fidelity AV Sensor Simulation Toolchain

*Autonomous vehicle developers can use Ansys sensor models with NVIDIA DRIVE Sim to accelerate AV development and validation.*

Today, Ansys and NVIDIA, two powerhouses in high-performance computing and AV simulation, announce their collaboration to accelerate AV development.

Autonomous driving mandates rigorous requirements on sensor modeling, prototyping, and testing. With simulation, AV developers can virtually prototype sensors, understand the strengths and limitations of each sensor modality, and identify optimal configurations for specific AV applications.

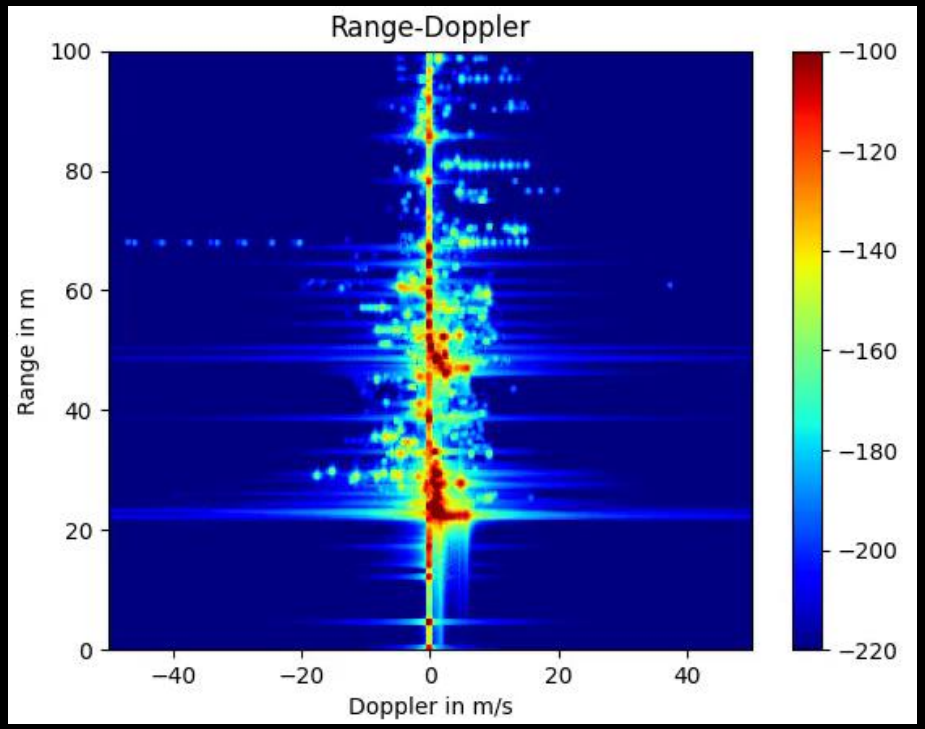
NVIDIA DRIVE Sim on Omniverse is a scalable, physically accurate, open, and modular AV simulation platform. NVIDIA's core technologies of RTX, Omniverse, and artificial intelligence (AI) are exposed for partner integration through a powerful and standardized API.

*Run large-scale, physically accurate multi-sensor simulation with NVIDIA DRIVE Sim.*

https://www.ansys.com/blog/ansys-and-nvidia-collaborate-on-building-a-high-fidelity-av-sens

# Real-life perception radar edge-case

## NVIDIA Omniverse to AVxcelerate Sensors




Reproduce edge-case situation where wall (mirroring) appear as ghost targets

Powering Innovation That Drives Human Advancement

# User Cases

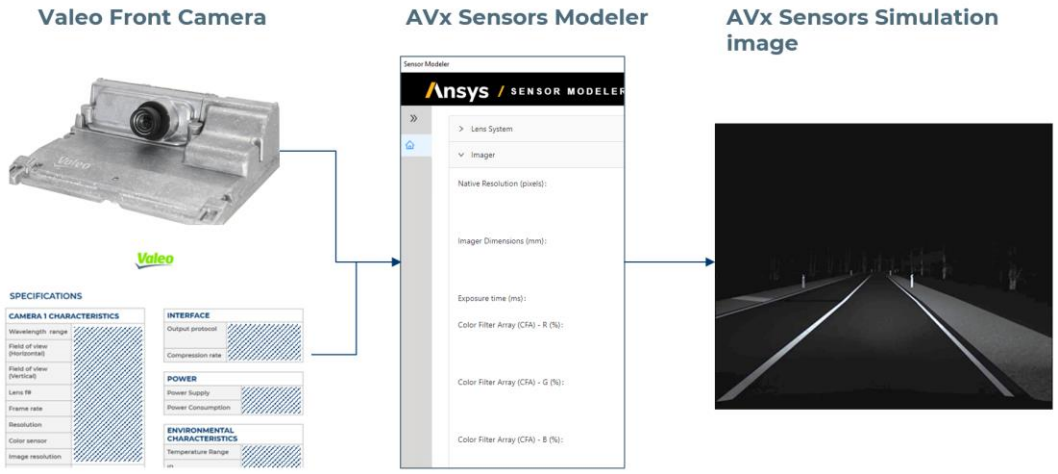
# Valeo – Enable robustness testing of ADAS Camera + Radar

*Joint cooperation with IPG CarMaker*

**Challenge** Accelerate access to higher level of autonomation by testing the challenging edge case scenarios for sensors

**Solution** Apply Ansys AVxcelerate Sensors (Camera, Radar, LiDAR) in order to extend existing CarMaker driving scenarios

**Benefits** Enable much more virtual scenario and bring significant contributions to Valeo business growth




"Valeo is a world leader in ADAS, and simulation plays a key role in the design and validation of our products. The collaboration between Ansys AVxcelerate Sensors and IPG CarMaker allow us to accurately simulate the physical properties of our components in combination with real-time system behavior, including vehicle dynamics. This will help us to go even further in the verification and validation of new and innovative ADAS and AV features."

**Joachim Mathes, CTO of Valeo's Comfort and Driving Assistant Business Group.**


[Ansys and IPG Automotive Accelerate Autonomous Vehicle Path-to-Market for Automobile Manufacturers]

# Integration of Virtual Prototype into ADAS Software Development Flow

## Engineering Goals

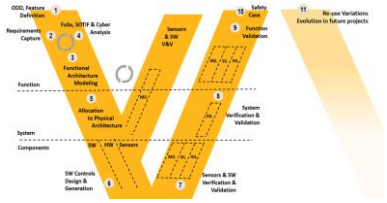
- Enable **closed loop virtual prototyping** and **test multiple driving scenarios** for sensor and software design.
- **Meet both safety and performance requirements**, with **full traceability** to requirements and **system architecture design.**
- Design architecture and software in a consistent model based end-to-end workflow.

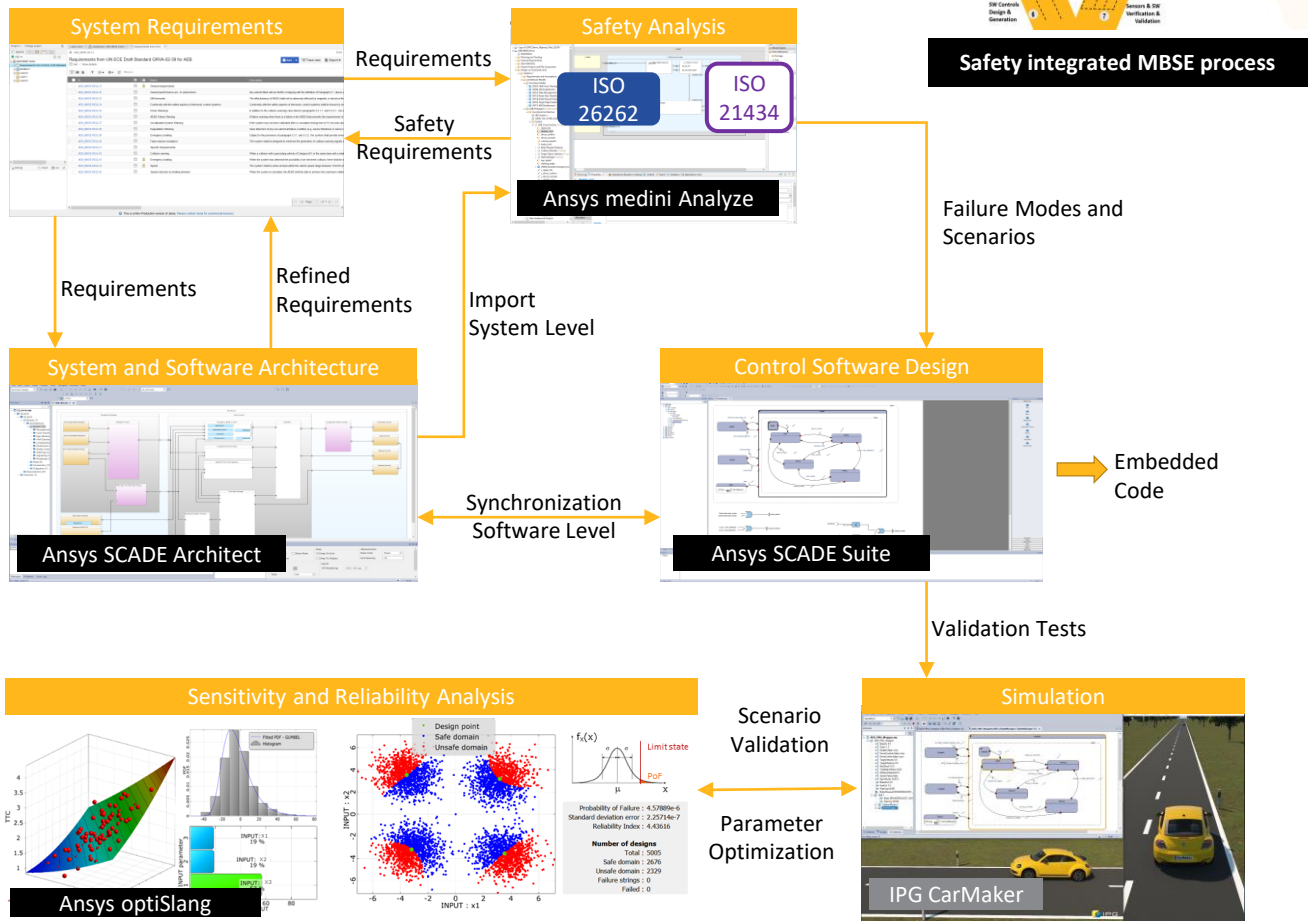
## Solution

- **Design modular and multi-level systems** with fully qualified code generation and one click, no-code AUTOSAR integration. *(SCADE Suite, SCADE Architect)*
- **Perform design, safety analysis and define safety requirements,** based on the same system architecture model. *(medini, SCADE Architect)*
- **Simulate driving scenarios** including sensors and embedded software in the loop (MIL) utilizing IPG CarMaker. *(Avxcelerate, SCADE Suite)*
- **Design space exploration, reliability analysis and scenario evaluation.** *(optiSLang)*

## Benefits

- Apply a rigorous **MBSE development process,** easy transition between design phases and levels, and **enhanced collaboration between functional silos.**
- **50% faster and higher quality** embedded code development.
- **Meet mandatory safety certification requirements** faster and at lower cost.
- Create **robust product understanding** through scenario simulation, **early in the development process.**
- **Allow for efficient ADAS-function testing, verification and certification.**



# Physics-Based Sensors for Industry Leading Driving Simulator IPG Maker

## Engineering Goals

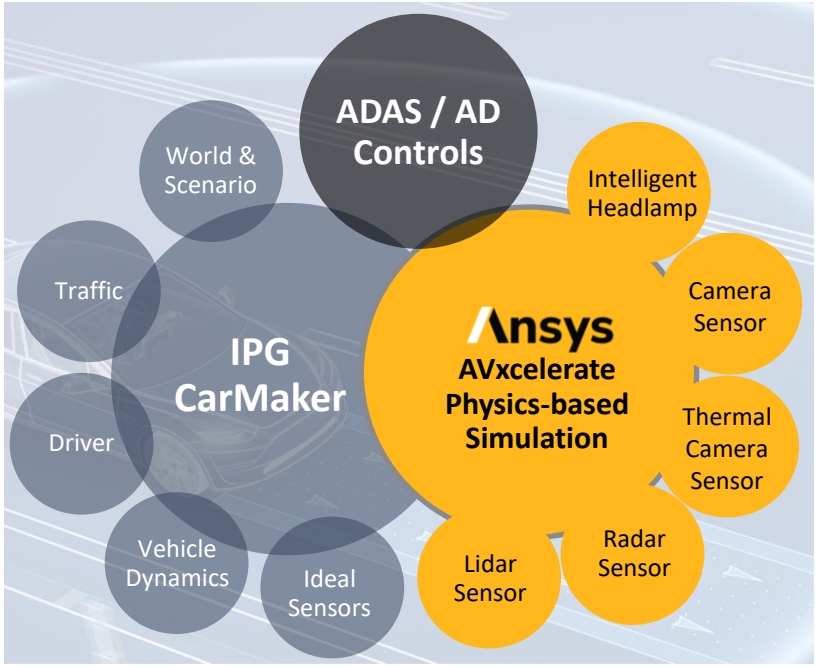
- Perform detailed sensor simulation **on a driving scenario with a driving simulator** for vehicle dynamics, track and scenario creation.
- Perform both open and **closed-loop simulation** to integrate vehicle control and sensor control **(Ex: Camera Exposure, Radar Modes and Lidar Scan Patterns)**.
- Real-time simulation for **HiL testing** for perception hosted on real ECU.
- Detailed sensor simulation based on solving physical equations.

## Solution

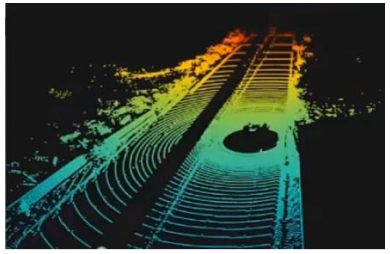
- Detailed sensor simulation based on solving physical equations within solvers running in co-simulation with leading Driving Simulator **IPG CarMaker**. *(AVxcelerate)*
- **Robustness testing** on the sensor perception for SiL and HiL, on a test bench, on-premise clusters or in the Cloud. (*AVxcelerate*)

## Benefits

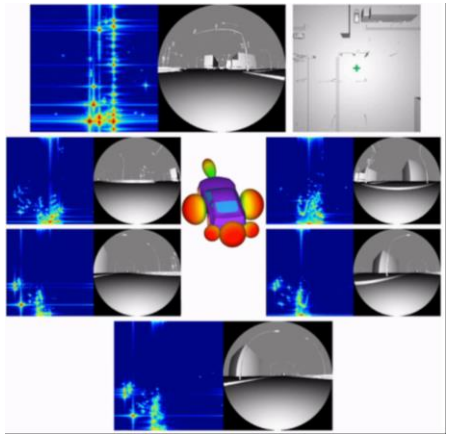
- **Provide camera, radar and lidar sensor experts the ability to simulate detailed and accurate physics-based sensor outputs for perception testing**.
- **Benefit of IPG vehicle dynamic model libraries, existing roads and scenarios of IPG CarMaker**.
- Off the shelf kinematic connectors, Ansys physics-based asset and automated asset preparation workflows.




Ansys Real-Time Camera simulation



Ansys Real-Time Lidar simulation



Ansys Real-Time Radar simulation

# Real-Time Physics Radar for Edge Case Testing

## Engineering Goals

- **Test and Optimize Radar models and Radar signal post-processing** algorithms using simulation.
- **Identify** edge case scenarios and **evaluate** the system's performance in a timely manner.

## Solution

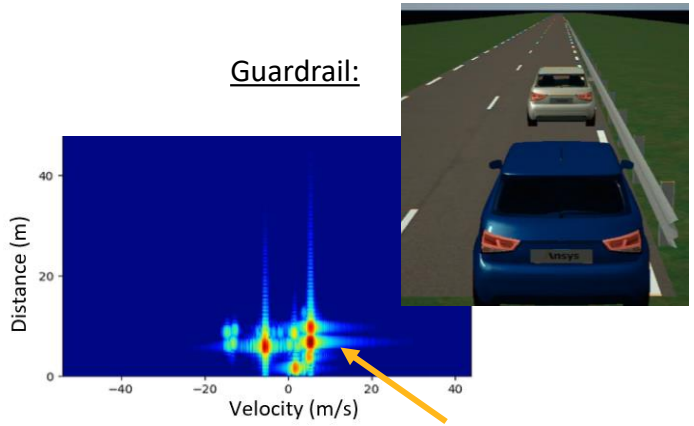
- **GPU based Real-time physics-based simulation** for in-depth analysis and **edge case detection**. (*AVxcelerate*)
- **Modular closed loop** simulation approach with **Open API** for scripting and automation. (*AVxcelerate*)
- **Physics-based sensor model** → raw signals, multi-bounces, micro-doppler effect, dielectric material properties effects, etc. (*AVxcelerate*)

## Benefits

- **Sensor and signal post-processing optimization** – early detection of edge cases and validation with highly reliable physics-based simulation.
- **Increase variability of driving conditions** under which the system behavior is analyzed.
- **Reduce** the amount of real-testing – enable millions of **virtual** kilometers to be driven daily.

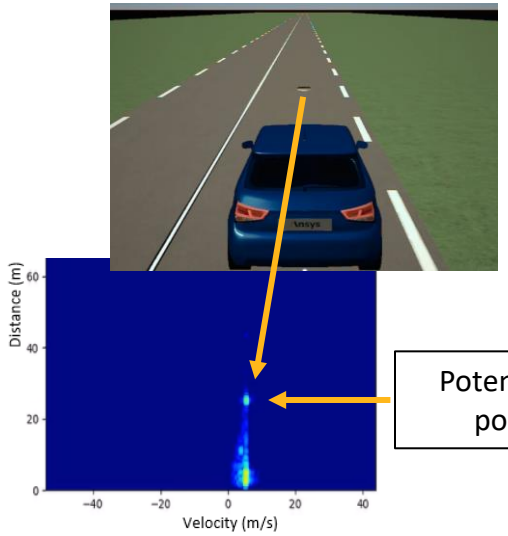
Examples of scenarios where the radar perception could create false positives:

Guardrail:



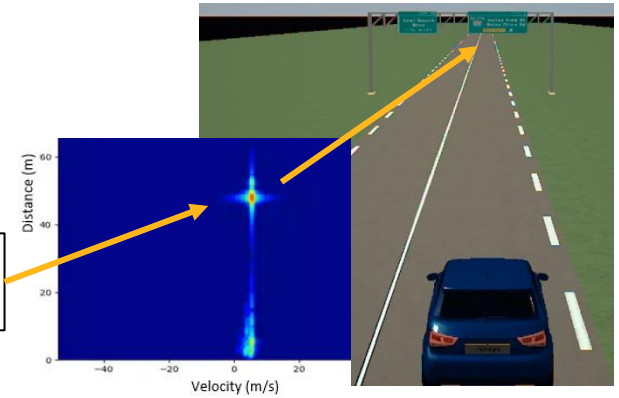

Multiple reflections

Manhole:




Potential false positives

Metallic Traffic Sign:



# Automotive Radar Placement Verification and Optimization

## *Challenge*

- Fast design of millimeter-wave antenna array, such as the best selection of unit element, quick & accurate array modeling using FADDM technology.
- Ensure system robustness by virtually predicting placement effects and optimizing placement behind vehicle fascia.

## *Solution*

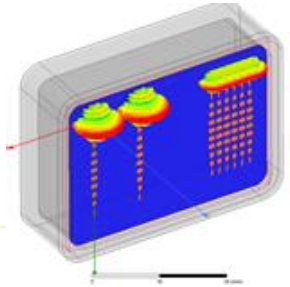
- **High-fidelity** – full physics-based RF modeling of 3D PCB layout & detailed antenna designs *(HFSS)*
- **Solve electrically large problems** – 3D components, Hybrid Simulations *(FEBI/FEM-IE/FEM-SBR+), Highly accurate asymptotic solver (HFSS SBR+)*
- **Performance & Optimization** – scalable HPC for faster analysis turnaround, strong Processing Integration & Design Optimization platform for Ansys/3rd tools *(HPC/optiSLang)*

## *Benefits*

- **Avoid ~$1M per re-testing** caused by fascia/bumper design change (*e.g.* reposition of radar in fascia or bracket geometry change)
- **Speed up** products design process and **save** 4 weeks in radar system production development cycle

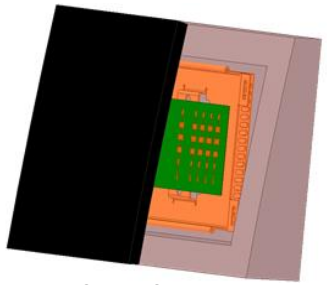
***mm*** ***Electrical Size of Analysis*** ***m***

**FEM**



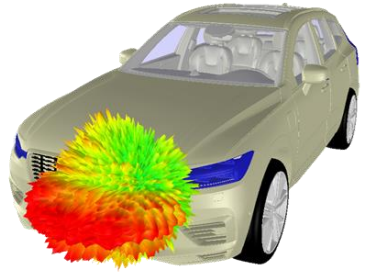
**Antenna in Package**

**FEM**

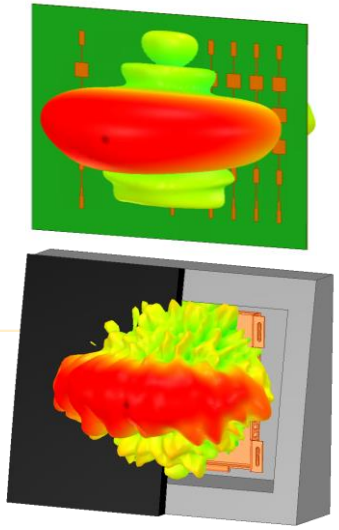


**Antenna and Package in Bumper Cutout behind Fascia**

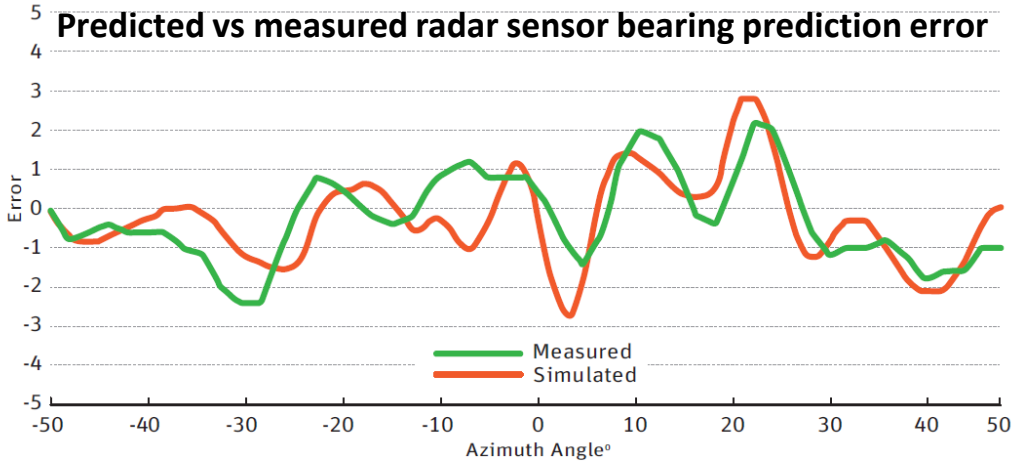
**SBR+**



**Full Bumper and Fascia with Antenna**



**Sensor transmit radiation pattern (top: free space, bottom: installed)**



# Safety Requirement Testing on a Complete Autonomous System

## Engineering Goals

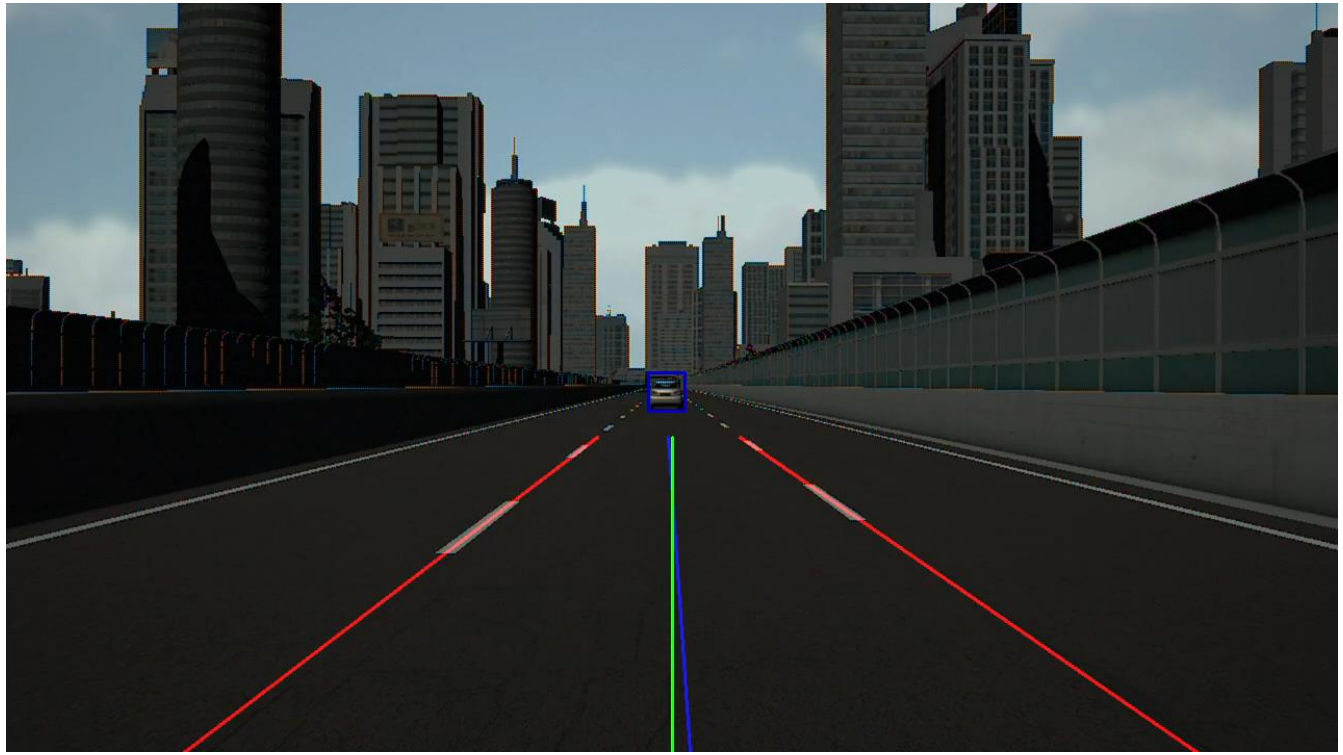
- Validate against requirements derived from **safety analysis**.
- **Reduce the time required** to test a wide variety of scenarios vs. real world testing.
- Simulate the **complete system**: closed loop model + vehicle dynamics + sensor + perception algorithm.

## Solution

- The **complete toolchain** is composed of *medini* (safety analysis), *AVxcelerate* (sensor simulation), *SCADE* (egocar's behaviour), any compatible driving simulator (car dynamics) and *optiSLang* (scenario variation).
- **Automate the Testing** of a wide variety of scenario's condition. *(optiSLang, AVxcelerate)*

## Benefits

- **Significant reduction in elapsed time** vs. physical testing.
- Easily change **systems' parameters and scenario conditions** to test a wide variety of scenarios to help meet test requirements.



**Closed loop control** of vehicle's motion based on camera perception: Lane keeping assist system (**LKAS**) and Automatic Cruise Control (**ACC**)

# Ansys AVxcelerate

## 智能驾驶仿真解决方案

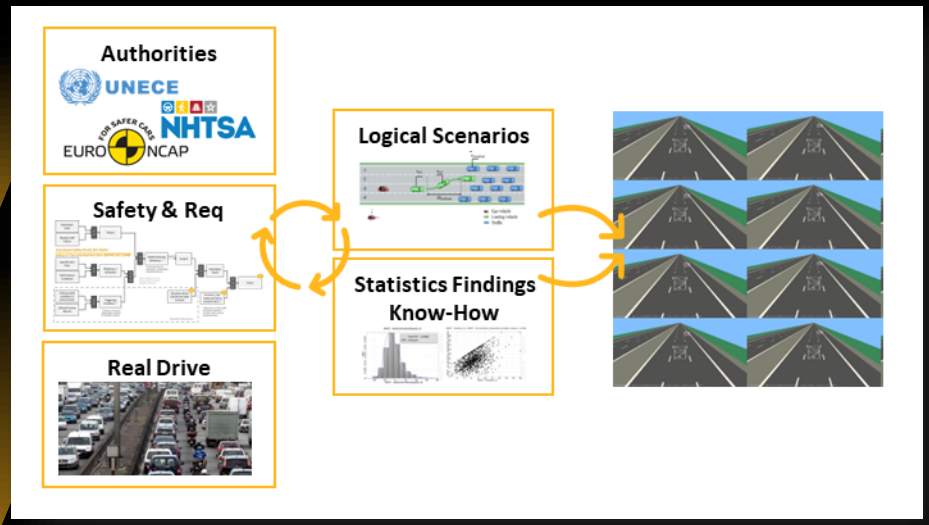
### AVX产品

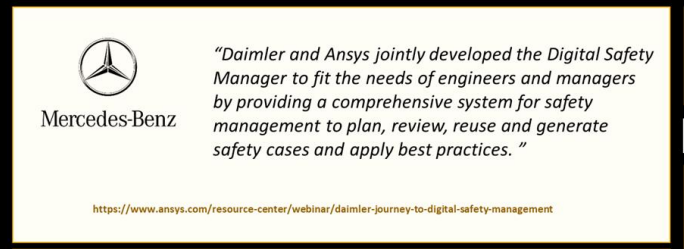
- **Autonomy** 云端海量场景仿真分析方案
- **Sensor** 物理级传感器感知仿真方案
- **Headlamp** 车辆灯光系统仿真解决方案

### 价值

- 帮助欧洲OEM量产L3高速自动驾驶项目及R157认证
- 帮助欧洲OEM获得ENCAP五星认证
- 帮助欧洲OEM改进L2+智能驾驶系统研发流程及R171、R152、ISO 26262等认证。
- 极大提升智能驾驶系统安全性
- 极大提升智能驾驶研发效率，缩短研发周期
- 突破感知仿真瓶颈
- NVIDIA Omniverse深度合作

### 项目






# QUESTIONS?

Ansys