Testing in the Google car era
Are we ready?

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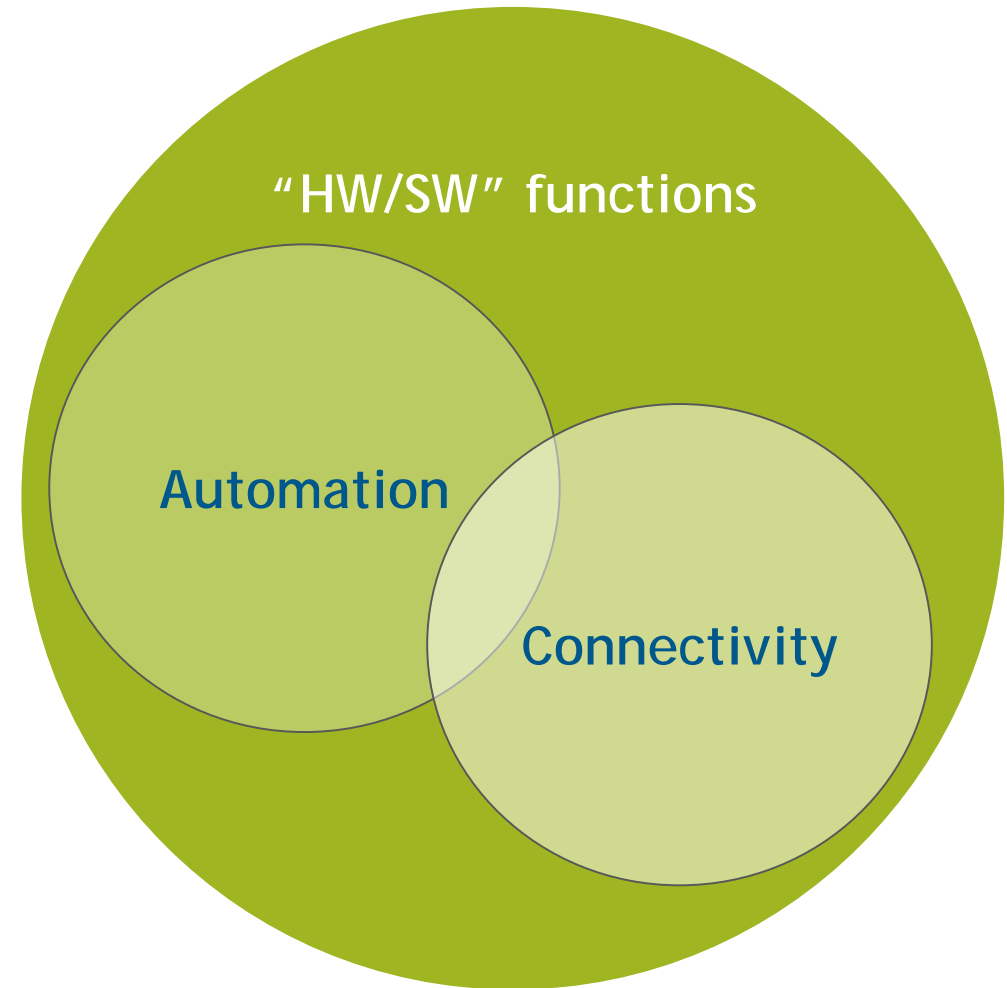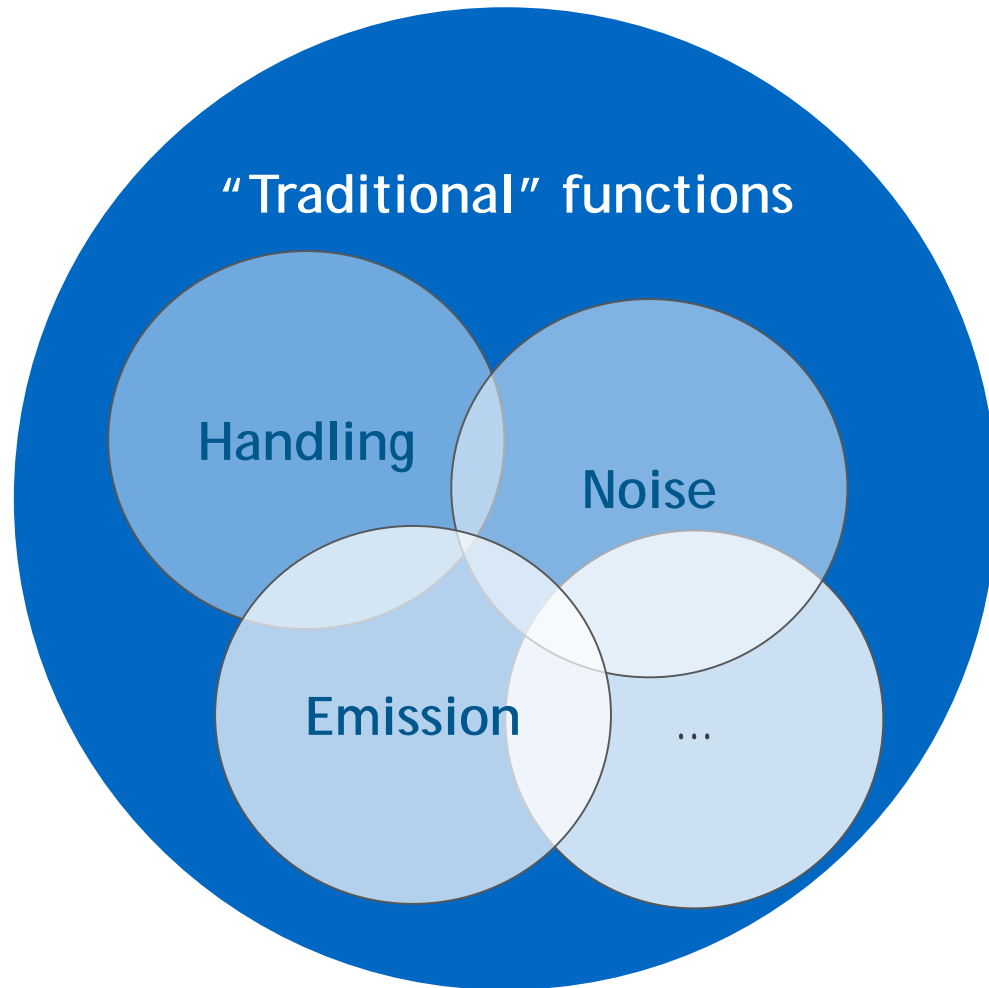# The vehicle we will be (are) testing

Autonomous

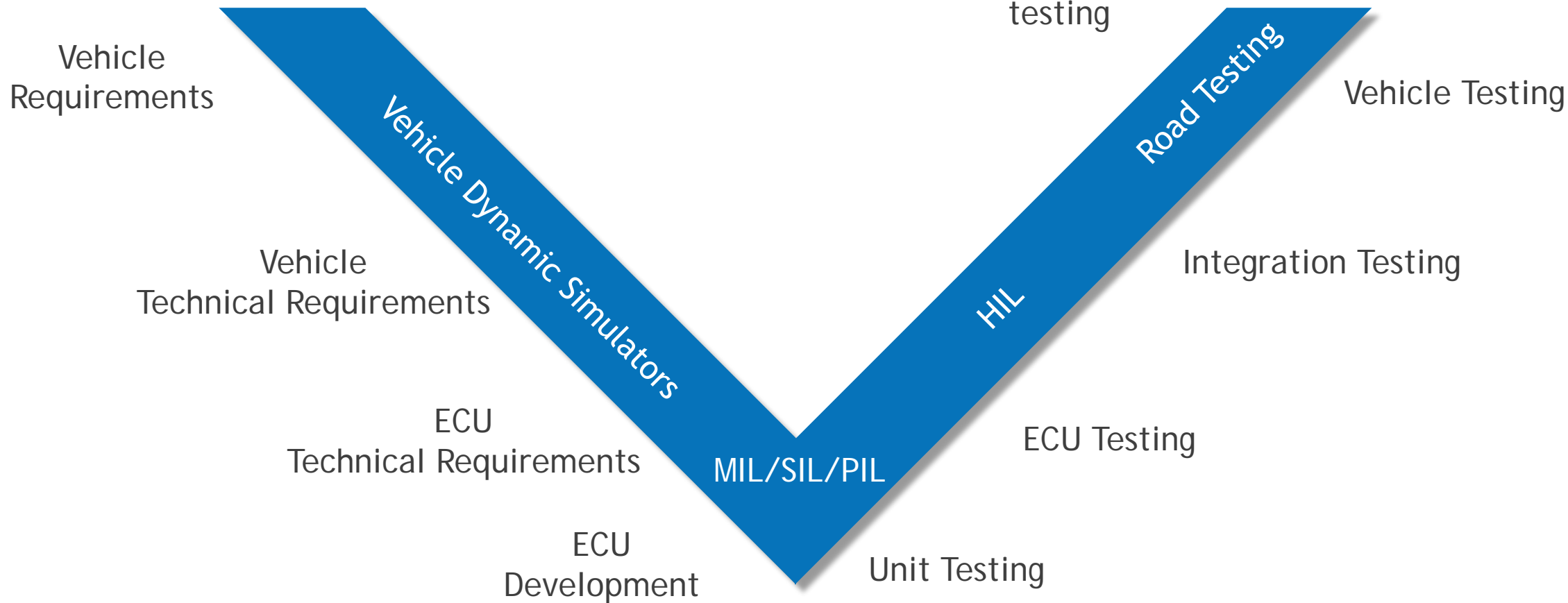**Connected**

HW/SW correct functionalities are crucial for the correct behavior of Google car-like vehicles

We shall be testing for...

"Traditional" functions
- Handling
- Noise
- Emission
- ...

"HW/SW" functions
- Automation
- Connectivity
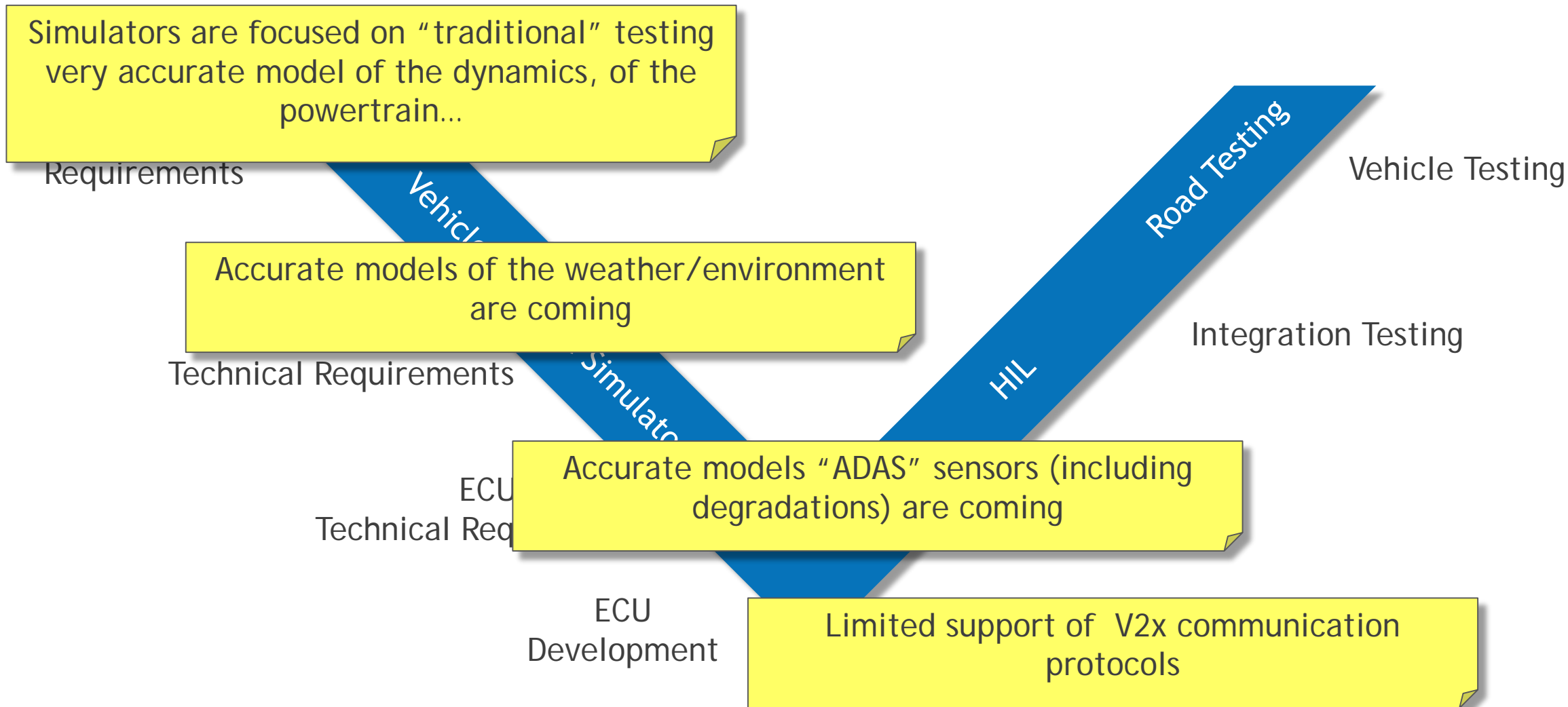
The current testing tools & their limits

Newer approaches can be used such as Vehicle-in-the-loop testing

Vehicle Requirements

Vehicle Dynamic Simulators

Vehicle Technical Requirements

ECU Technical Requirements

ECU Development

MIL/SIL/PIL

Unit Testing

HIL

Road Testing

Vehicle Testing

Integration Testing

ECU Testing

Simulators are focused on "traditional" testing very accurate model of the dynamics, of the powertrain…

Accurate models of the weather/environment are coming

Accurate models "ADAS" sensors (including degradations) are coming

Limited support of V2x communication protocols

Requirements

Vehicle Testing

Technical Requirements

Integration Testing

ECU Technical Req

ECU Development
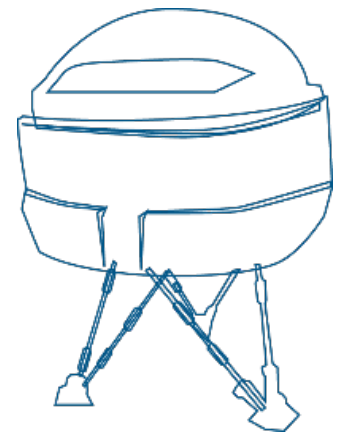
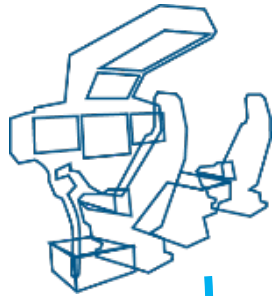Road Testing

HIL

Simulato

Vehic

5

The current testing tools & their limits

- Simulators are heavily used for virtual testing, but many activities are still addressed during road testing

- Enormous amount (several GB/min) of data shall be collected and post-processed in case of problems reported during autonomous vehicle testing

- Scenarios exist that are difficult to reproduce when testing connected vehicles

- Moreover, future legislation may require thousands of Km to be performed before allowing testing on public roads

- High costs/timings are incurred even before actually starting road testing

The current testing tools & their limits

- Simulators shall be refined to improve on few key elements: environment, sensors, connectivity

- Simulators shall become an accepted alternative to road testing also from the legislation standpoint

- There is an opportunity for certified simulators, where 1 Km of simulation is equal to 1 Km of road testing from technical and legislation standpoints

- How to reach certification?

- We do not need to reinvent the wheel, let's see what other domains are doing

Certified Flight Simulator Device

Certified flight simulators have been used for years in aerospace industry

One hour of activity in a flight simulator equals to one hour on real aircraft

Save time, save money and increase safety

Simulators must be qualified by national and international authorities

Qualification support tool is the enabling technology for OEM and simulator industries

Certification Process Pillars

All Flight Simulation Devices must be compliant with the regulations of the national and international authorities to operate

Validation tests

Compare objectively simulator and aircraft data to ensure that they agree within specified tolerances

Vehicle data will be objectively compared, based on specific automotive metrics

Systems

Motion, Visual, Sound, Vibration should be compliant with authorities requirements

Motion, Visual, Sound, Vibration will be compliant with EU/UNECE requirements

Objective tests

All simulated aircraft systems shall be tested using aircraft documentation

All simulated vehicle systems will be tested using vehicle documentation

Benefit of Certified Simulator Device

ACCURACY

Hardware-In-the-Loop ensures same performances of real aircraft while staying on ground

SAFETY

Up to 300 malfunctions and emergency procedures can be tested in a safe way

FLEXIBILITY

Training/testing can be executed at any time

EFFICIENCY

Simulators can be operative 24/7 and require few maintenance activities

COSTS

1000€ VS 8400€ for one hour training (Flight Simulator VS Real Aircraft)

TXT Qualification Support Tool

Qualification Support Tool is an application to manage the whole qualification lifecycle process

Analyses all parameters (aircraft/vehicle, motion, visual system, sound)

Complete qualification test guide (QTG) document is generated and exported for each authority

Platform independent, can be connected also to exiting simulators and scenarios

Drives simulators autonomously executing the requested maneuvers

Conclusions & way forward

- With current approaches, ADAS and autonomous vehicle testing is increasing time-to-market
  - Let's think about the 14.2 billion Kilometers of testing as stated by Toyota CEO

- From the technical standpoint, simulators are the only solution to reduce aggressively time to market

- From the legislation standpoint, simulators' use shall be regulated and approved by an external authority (EU/UNECE) to replace road testing as much as possible

- The way forward is the certification=homologation of simulators

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Politecnico di Torino and **TXT e-solutions** are facing together the Testing challenge in the Car Industry. Combining Polito methodological assets with TXT 30 years' experience in the avionic domain, they are shaping a redefined testing approach based on certified simulators fit for the Google Car Era.