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Automating ADAS/AD validation

A structured approach to study SOTIF risk

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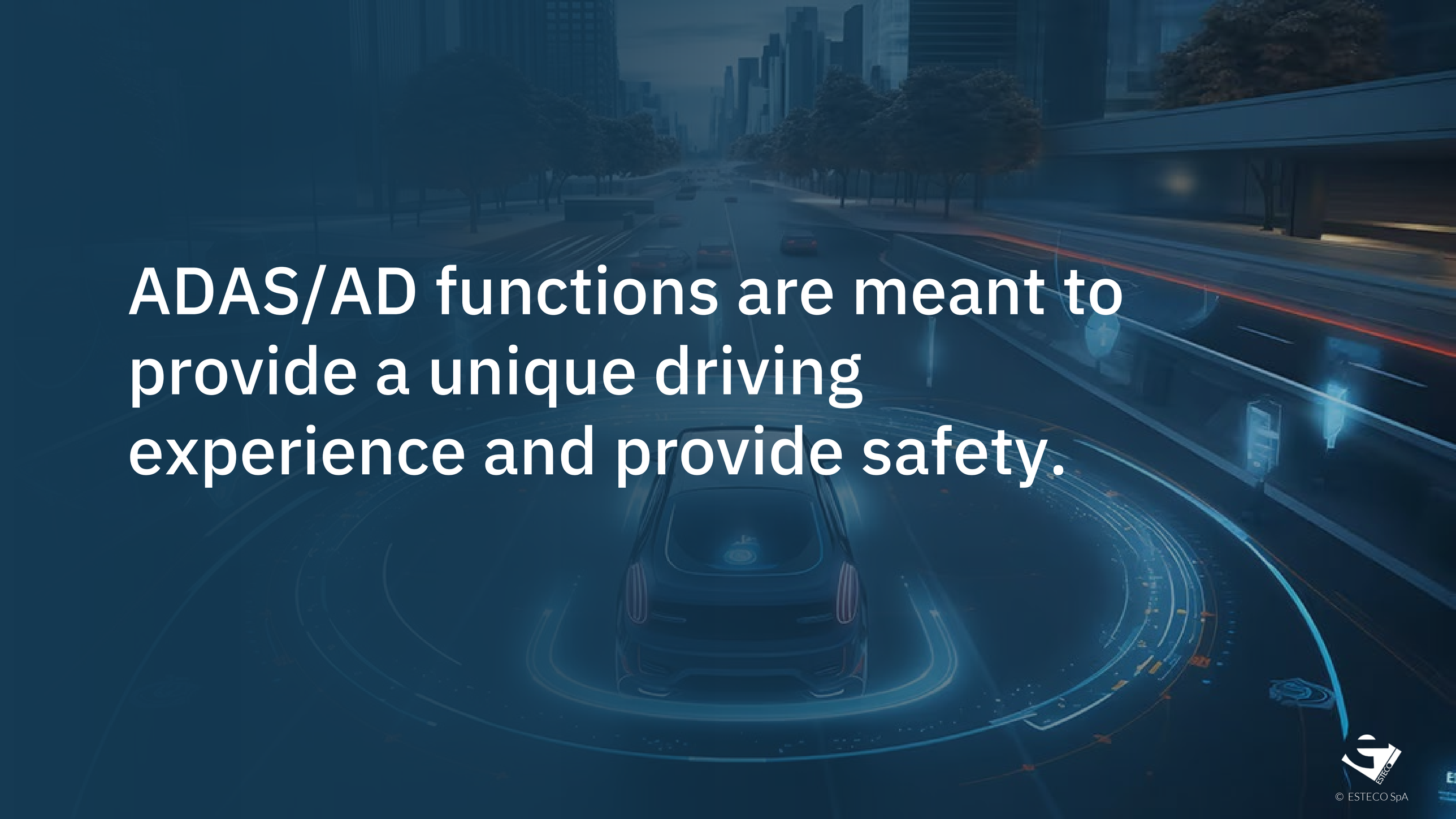

ADAS/AD functions are meant to provide a unique driving experience and provide safety.

How to validate such functions?

- Tight timelines
- Operational Design Domains offering an infinite number of scenario
- SOTIF: the vehicle function shall be able to handle critical conditions for the ODD they intend to cover but how to do you address this?
- SDV: post-production updates (also related to ODD evolutions) and evolving algorithms require a robust and repeatable validation process

Road testing only is not an option

- Tight timelines
- Expensive
- Risky
- Not repeatable
- Limited coverage

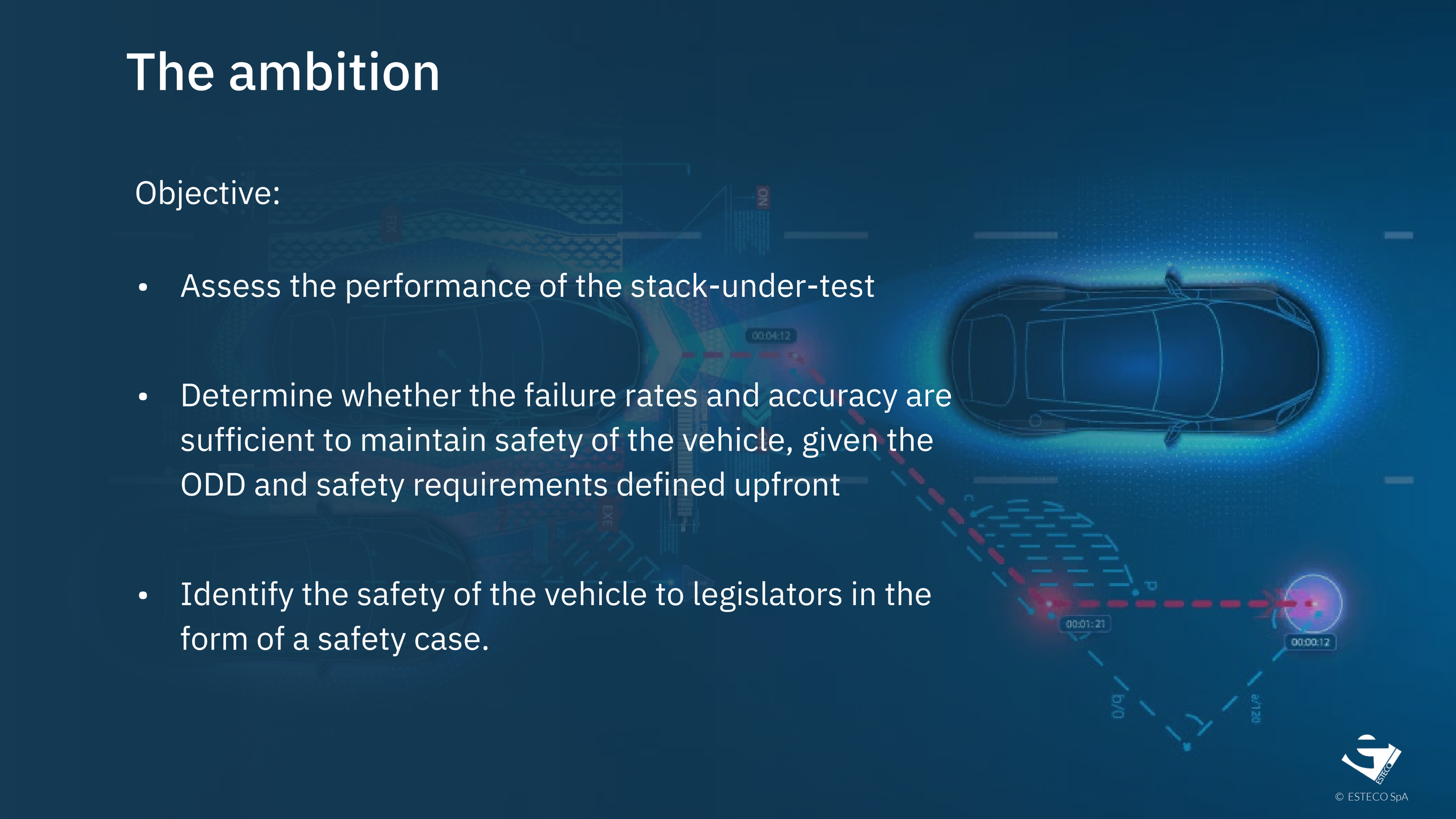
And here comes the suppliers...

- Synthetic data is the holy grail... but how good are the sensor models / how realistic is the scenario?
- HIL solutions to use the real sensor?
- We can do it all

The ambition

Objective:

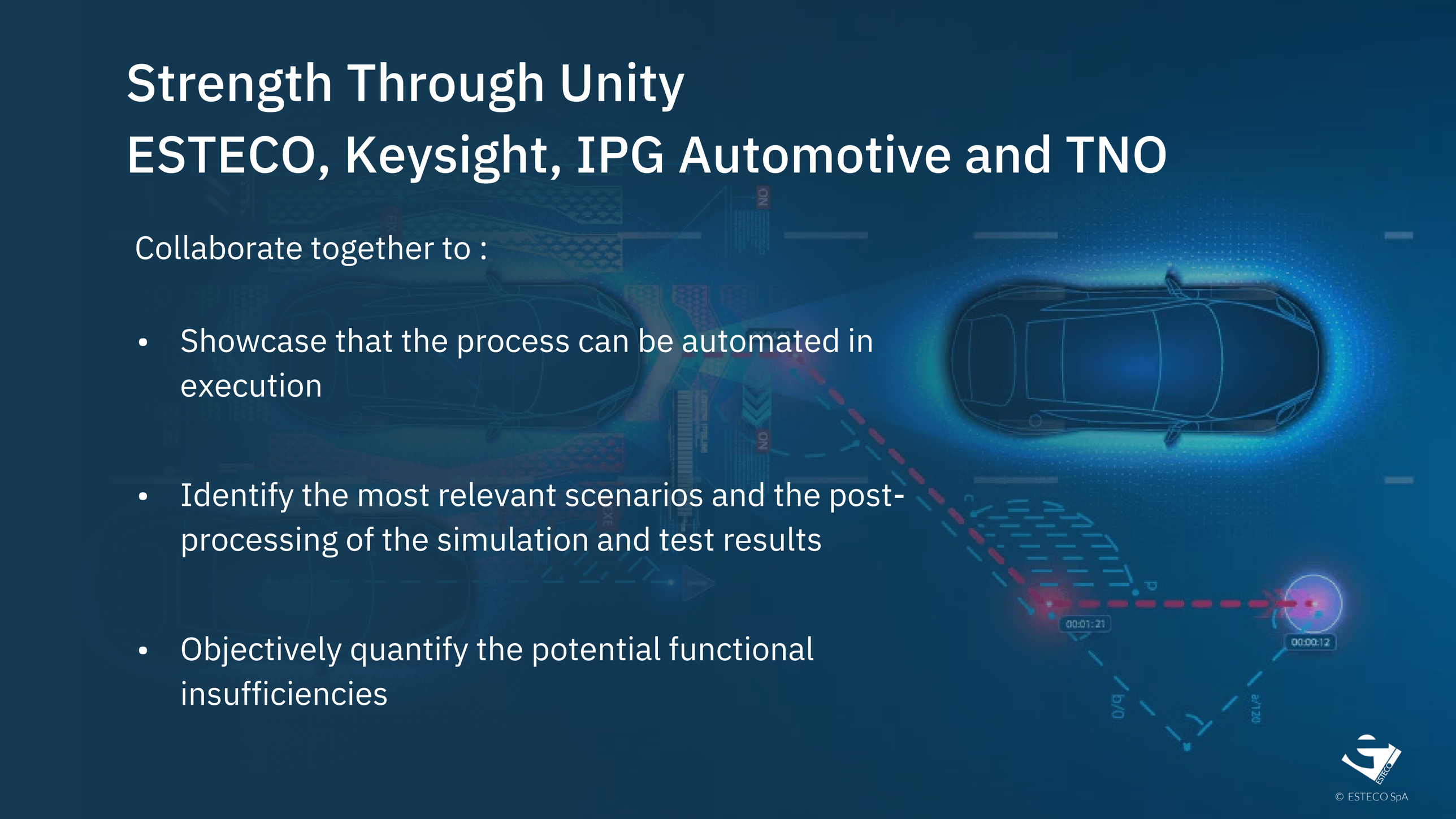
- Assess the performance of the stack-under-test
- Determine whether the failure rates and accuracy are sufficient to maintain safety of the vehicle, given the ODD and safety requirements defined upfront
- Identify the safety of the vehicle to legislators in the form of a safety case.



Strength Through Unity
ESTECO, Keysight, IPG Automotive and TNO

Collaborate together to :

- Showcase that the process can be automated in execution
- Identify the most relevant scenarios and the post-processing of the simulation and test results
- Objectively quantify the potential functional insufficiencies



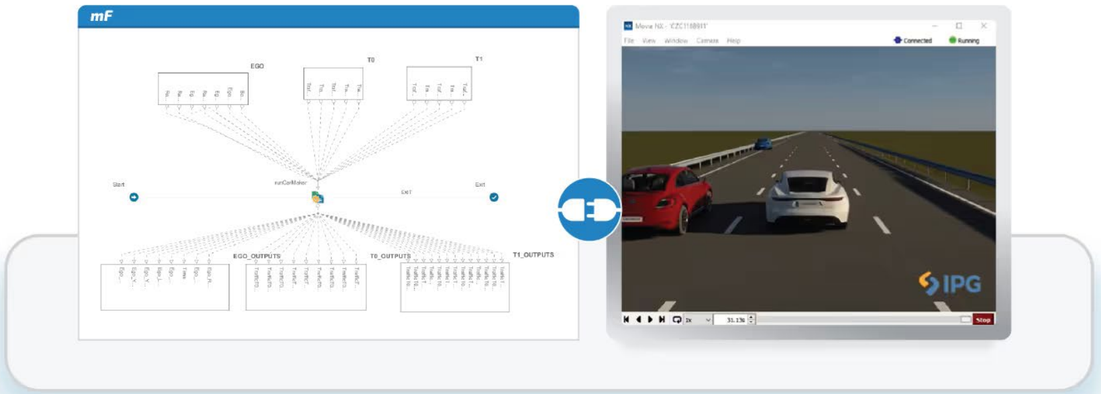
The process

- Identify the relevant scenarios that should be tested based on the vehicle's ODD
- Define the parameters of interest for the tuning of the vehicle function
  - Interdistance, overlap, velocity, relative velocity, acceleration
  - Define parameter statistical distribution which is based on real driving experience
- Build synthetic data reflecting those scenarios
- Analyze the data lake generated from the testing and simulations and produce safety and performance metrics

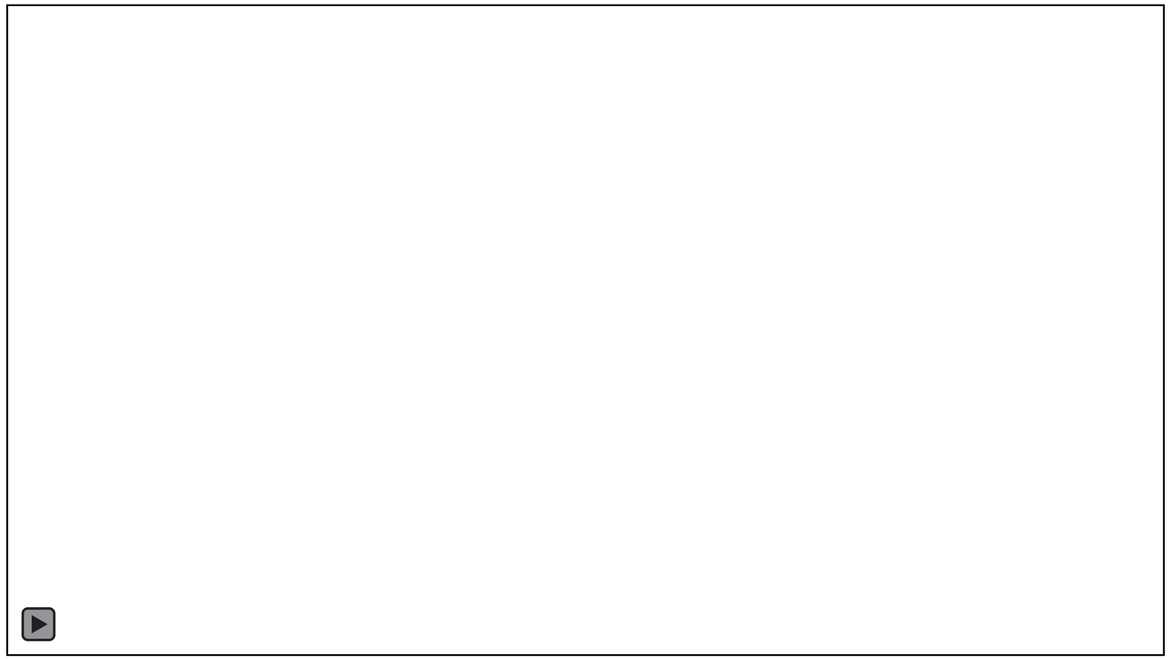
The process: ESTECO + IPG Automotive

modeFRONTIER is coupled with CarMaker by IPG Automotive:

- Modifies a set of input parameters that are critical for the scenario
- Triggers the generation of scenarios in IPG CarMaker each representing a unique combination of parameters
- Enables the efficient exploration of a vast scenario space



The process: ESTECO + IPG Automotive



A simple scenario is considered:

- 1 ego vehicle driving on its lane equipped with a radar sensor
- 2 target vehicles cutting in and cutting through in front of the ego vehicle

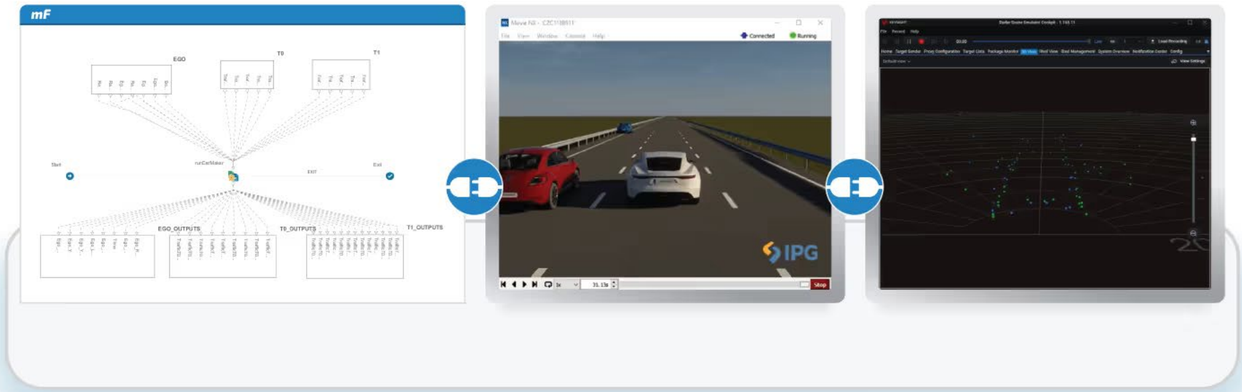
The perception quality attributes for both target vehicles are:

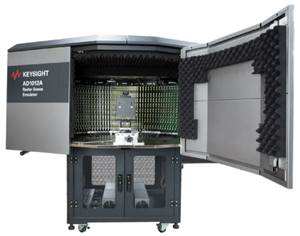
- Object presence
- Object type
- Lateral and longitudinal position
- Lateral and longitudinal velocity

But how to take advantage of the real radar sensor?

The process: IPG + Keysight

- Keysight Radar Scene Emulator
  - Leverages echo emulation to generate realistic radar echoes, simulating complex environments
  - Creates a dynamic scene that models distance, velocity, and object size and classification
  - Enables full-scene modeling
- Keysight and IPG Automotive have integrated the Radar Scene Emulator with CarMaker's scenario simulation ability, enabling the generation of realistic radar reflection data for simulated traffic situations.
- Enables HIL testing where radar signals emulate actual driving environments while the vehicle and function run in simulation.
- **Co-simulation framework between CarMaker and the Keysight RSE, automated using modeFRONTIER.**





KEYSIGHT

The process: TNO

- TNO processes the produced data from
  - IPG CarMaker (ground truth data)
  - KeySight emulator (measurement data)
  - modeFRONTIER input parameters (scenario setup)

- Probabilistic physics informed model of the radar based system is build (calibrated based on the data available)

  ➢ Reliability of the system
    - Detection performance
    - Accuracy in positioning
    - Accuracy in sizing

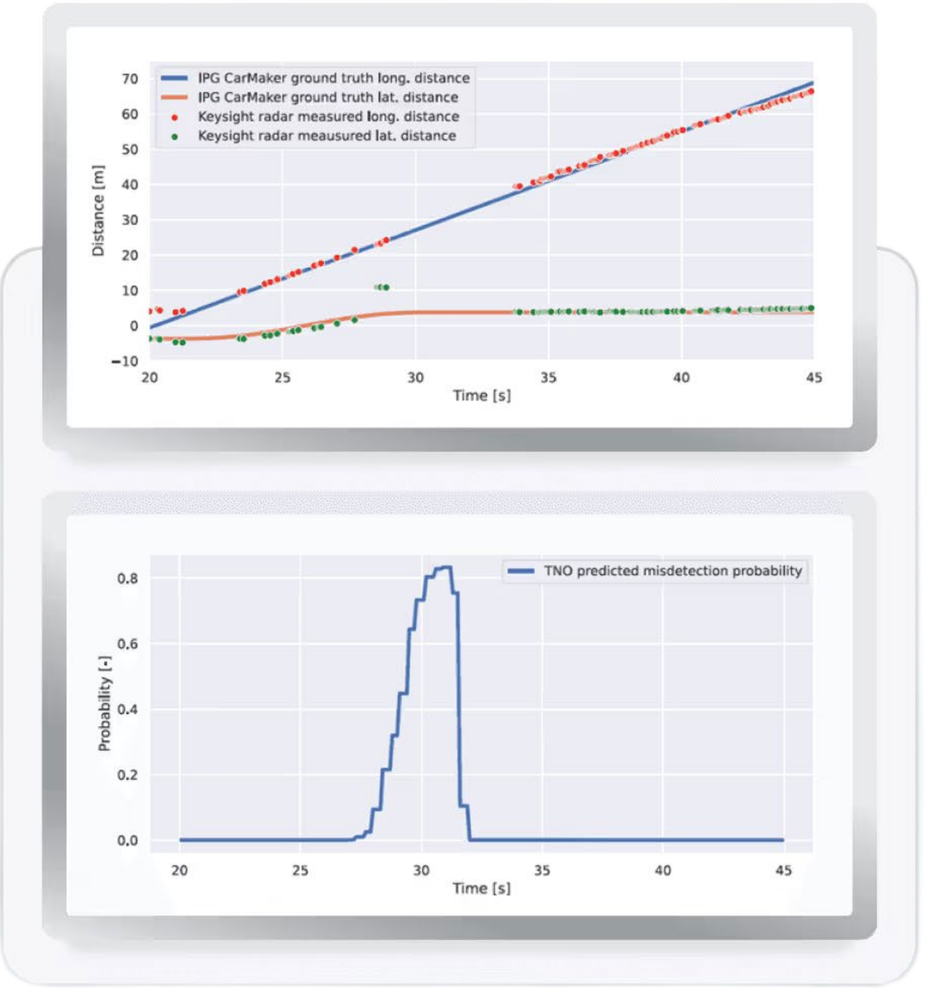
    All needed for safety assurance

  ➢ Failure contributing factors
    - Identification of effect of triggering conditions
    - Ensure coverage in the validation and verification process

The results

- A simple scenario is considered:
  - 1 ego vehicle driving on its lane equipped with a radar sensor
  - 2 target vehicles cutting in and cutting through in front of the ego vehicle

- The presence of a guard-rail could obfuscate the presence of a vehicle assuming the use of a radar sensor:
  - Well-known in the radar-sensing community
  - Could potentially result in false negatives, hence posing a safety hazard for ADAS and/or AD systems



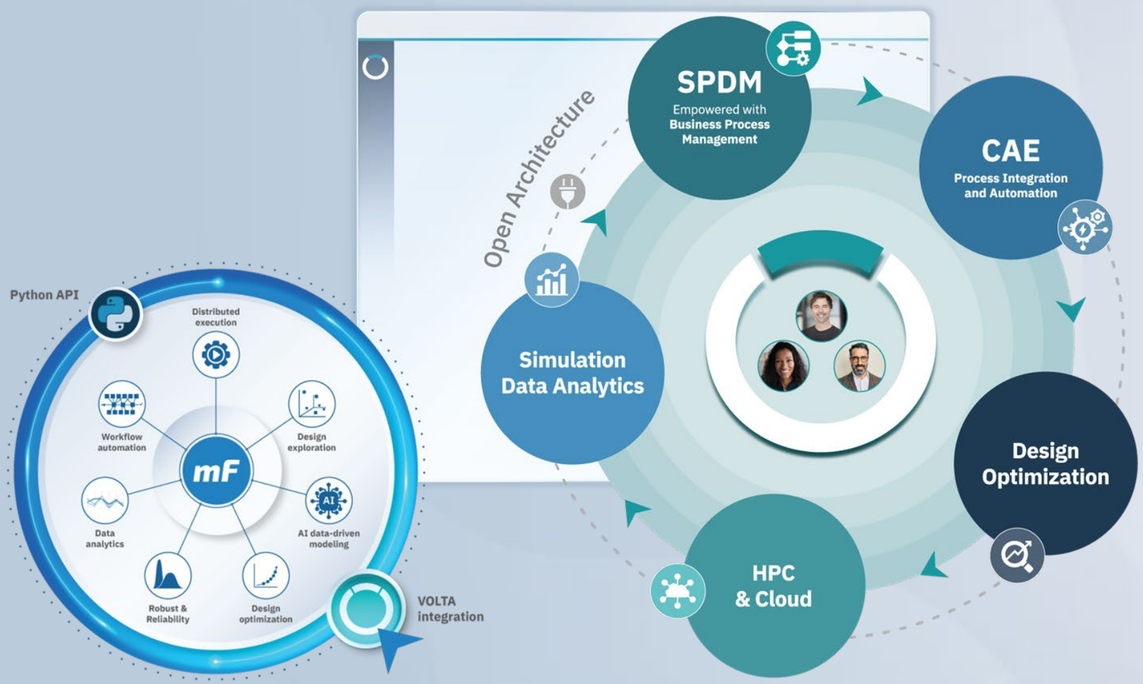
Next steps

- Select additional insufficiencies (e.g., reflections from the road surface, or object fusing during cut-in/cut-out maneuvers)
- Extend the probabilistic model with further data from the pipeline

- Consider real vehicle dynamics of the ego vehicle
- Consider vehicle function to consider ego vehicle reaction (this use case did not consider the vehicle function actuation)
  - Automate optimisation loop to identify critical test cases based
  - Quantify vehicle risk performance

- Collaborate in an enterprise environment where each actor can contribute while maintaining its IP and where data can be versioned and traced

Connect to VOLTA digital engineering platform



Scale modeFRONTIER usage across teams for collaborative MDO. VOLTA provides user with features related to:

- Collaboration.
- Distributed execution of designs.
- Traceability of optimization results.
- Connectivity with your digital thread (PLM/MBSE environments).

Conclusions

Using ESTECO technology together with IPG Automotive, Keysight, and TNO, you are able to deliver efficient, accurate, and comprehensive virtual testing and validation solutions for function development.

This synergy allows automotive OEMs and Tier 1 suppliers to:

- Shorten development cycles through front-loading testing and validation in virtual scenarios, minimizing physical prototype costs and delay.
- Objectively quantify the level of risk of the vehicle and consider the function proposed.
- Optimize the resource usage (such as experts, track and open road testing).
- Estimate the value on how good the function is and identify which are the critical test cases.
- Explain how the results have been achieved in a transparent manner towards the certification authority.

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Thank you

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