



# Credibility of toolchains and simulation

What's needed for Credible Safety Assessments



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# What the Auditor Needs?

The Type-approval authority shall assess the documentation package to show that "The System":

- (a) Is designed and was developed to operate in such a way that it is free from unreasonable risks for the driver, passengers and other road users within the declared ODD and boundaries;
- (b) Respects, under the performance requirements specified elsewhere in this UN Regulation;

3.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave to mitigate or avoid hazards which can have a bearing on the safety of the driver, passengers and other road users.

3.5. Safety management system (Process Audit)

3.5.1. In respect of software and hardware employed in "The System", the manufacturer shall demonstrate to the type approval authority in terms of a safety management system that effective processes, methodologies and tools are in place, up to date and being followed within the organization to manage the safety and continued compliance throughout the product lifecycle (design,

4.2. Simulation tool and mathematical models for verification of the safety concept may be used in accordance with Schedule 8 of Revision 3 of the 1958 Agreement, in particular for scenarios that are difficult on a test track or in real driving conditions. Manufacturers shall demonstrate the scope of the simulation tool, its validity for the scenario concerned as well as the validation performed for the simulation tool chain (correlation of the outcome with physical tests). Simulation shall not be a substitute for physical tests in Annex 5 and Annex 6 to this UN Regulation.

4.2.1 The Type Approval Authority may verify the accuracy of simulation tools used by means of results from track and/or public road test performed under Annex 5 and/or Annex 6, and/or by performing additional tests where needed.

## Assessment methods

- Top/down hazard and safety analysis
- V&V plans including requirements and safety targets
- Management method to select scenarios and validation tool
- Analysis and metrics of reasonable coverage of verification plans
- Auditor SOTIF competence
- ...

## Safety Management

- Safety and Requirement management system
- Traceable from design to development process
- Interfaces between different development stages and departments

## Validation based on simulation toolchains

- Simulation tool and mathematical models in addition to proving ground, real world driving
- Proof validity and accuracy of simulation toolchain and simulation results

# What the Auditor Needs?



EU Regulation 2022/1426  
Type Approval of ADS & fully  
Automated Vehicles



**UNECE**

New Assessment Test  
Methods (NATM), WP.29

**PART 1**  
**TRAFFIC SCENARIOS TO CONSIDER**

1. Minimum set of traffic scenarios

1.1. Scenarios and parameters listed in point 1 shall be used, when these scenarios are relevant for the ODD of the ADS.

If the manufacturer deviates from the parameters proposed in point 1, the safety performance metrics and inherent assumptions used by the manufacturer shall be documented in the documentation package. The performance metrics and inherent assumptions chosen shall demonstrate that the fully automated driving system is supported by in-service monitoring data.

1.2. Parameters to be used for the lane change

1.2.1. The

3. Components of the credibility assessment framework and related documentation requirements

3.1. The credibility assessment framework introduces a way to assess and report the credibility of M&S based on quality assurance criteria where the levels of confidence in the results can be indicated. In other words, the credibility is established by evaluating the following M&S influencing factors that are considered as main contributors for M&S properties and therefore for the overall M&S credibility: (a) M&S management; (b) team's experience and expertise; (c) M&S analysis and description; (d) data/input pedigree and (e) verification; validation, uncertainty Characterisation. Each of these factors indicates the level of quality achieved by M&S, and the comparison between the obtained levels and the required levels shall determine whether the M&S is credible and fit to use for virtual testing. A graphical representation of the relationship between the components of the credibility assessment framework is shown below.

## Assessment methods

- Scenario-based approach based on relevant situations from real world capture
- Shared scenario catalogue (OEM/Auditor) as basis for validation and safety assessment
- Auditor SOTIF competence

## Safety management

- Certificate of compliance for SMS
- Proof that safety concepts implemented and validated by testing and documented

## Credibility Assessment of toolchains

- Focus testing tools and environments regardless ADS performance
- Validation of virtual toolchains and reliability of results
- Credibility of models and correlation to real-world

See also:

Interpretation of EU Regulation 2022/1426 on the Type Approval of Automated Driving Systems

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# Talking about Credibility

## General

The credibility can be achieved by investigating and assessing five properties of Mod

- (a) capability – what can the M&S do, and what the risks are associated with it;
- (b) accuracy – how well does M&S reproduce the target data;
- (c) correctness – how sound & robust are M&S data and algorithms;
- (d) usability – what training and experience is needed.
- (e) fit for purpose – how suitable is the M&S for the ODD and ADS assessment.

\* M&S – Modelling & Simulation



Credibility comprises the objective and subjective components of the believability of a source or message.

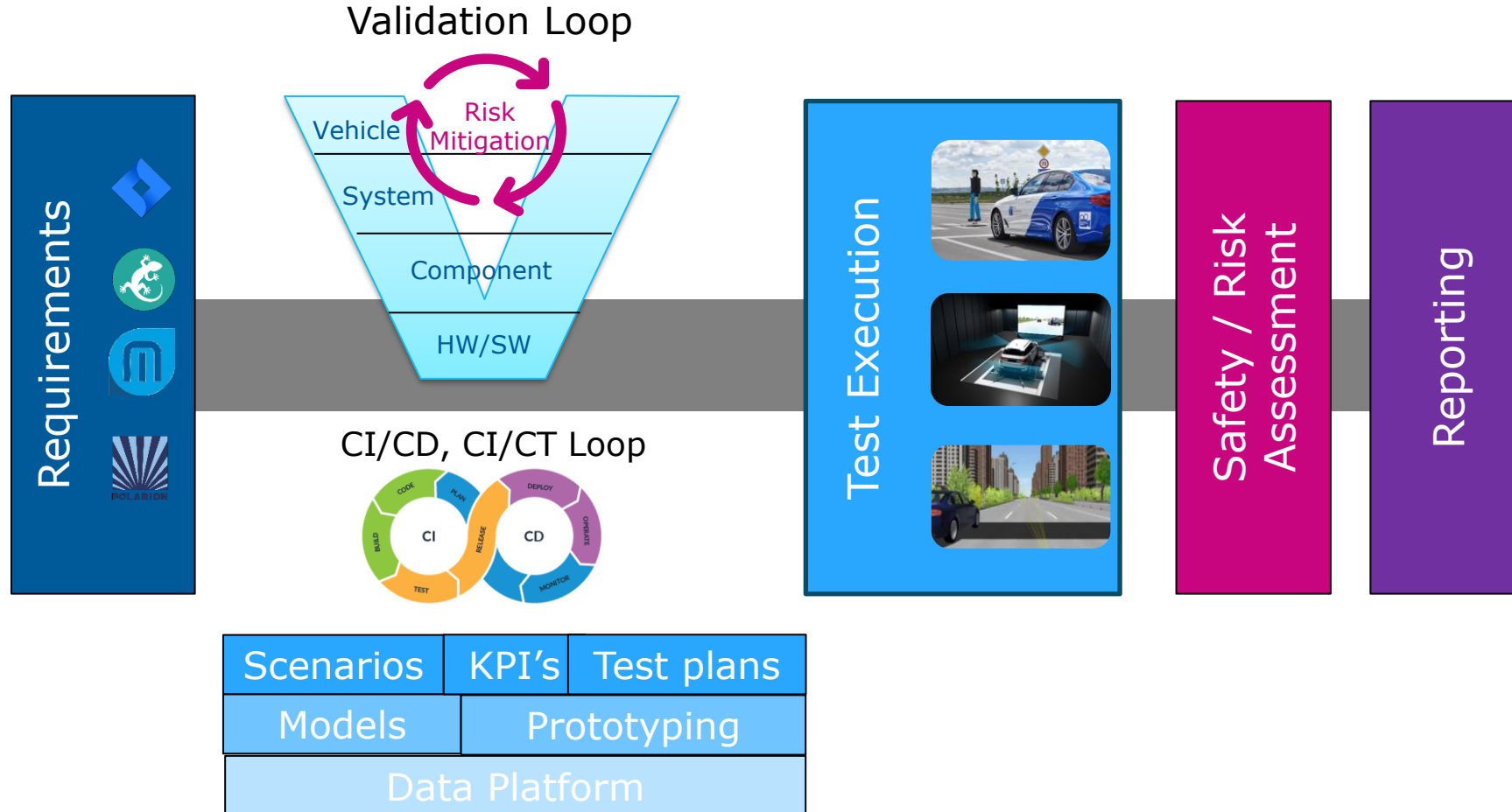
Credibility has two key components - **Trustworthiness and Expertise**

Trustworthiness - based on subjective factors but can include objective measurements, such as **reliability, transparency, responsibility**

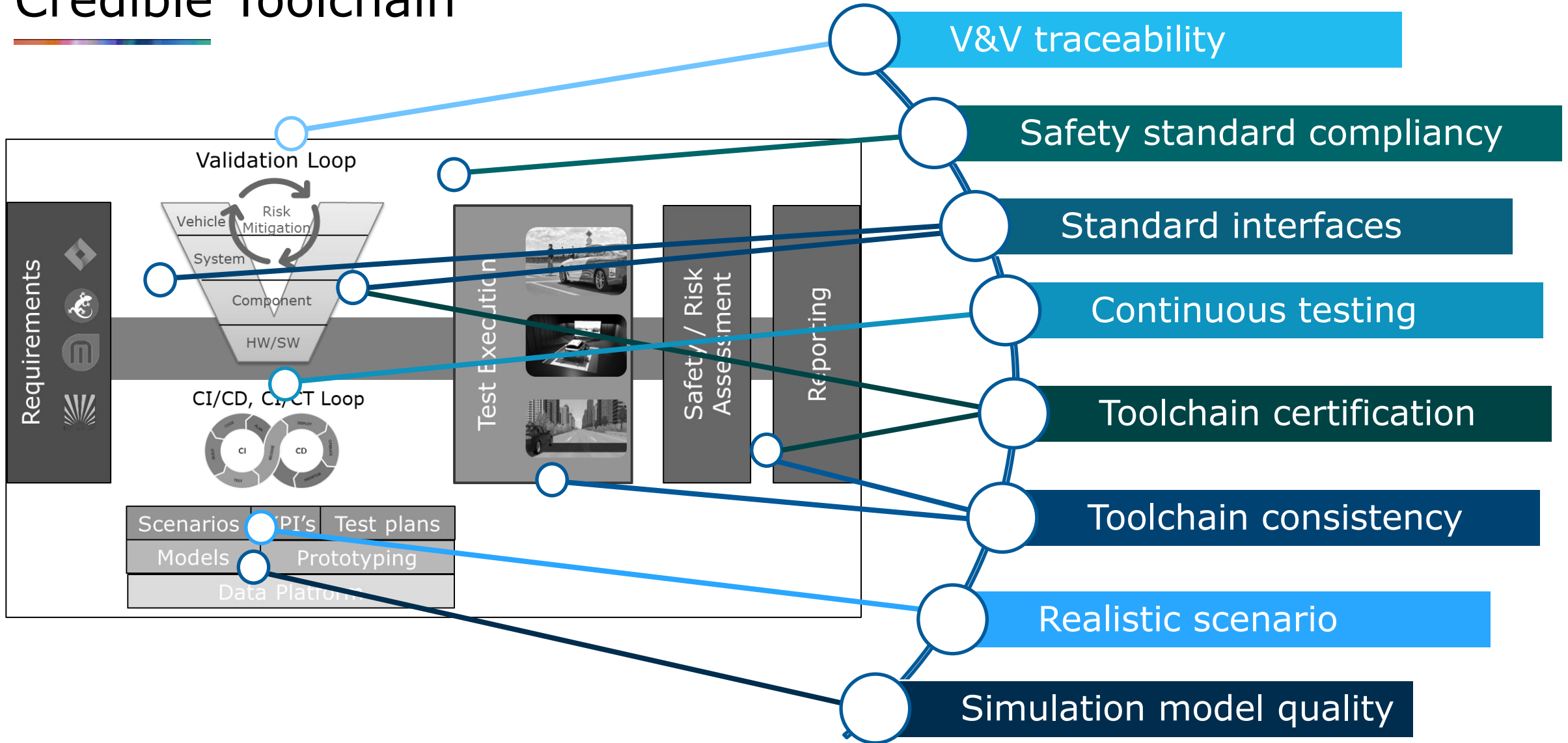
Expertise – also subjectively perceived but includes objective characteristics of the source or message, such as **certification, information quality**

Source: <https://en.wikipedia.org/wiki/Credibility>

# Credible Toolchain

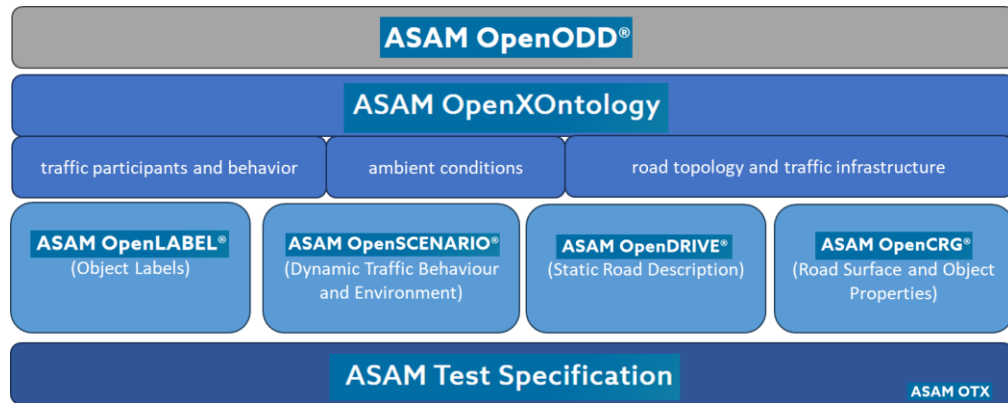


# Credible Toolchain



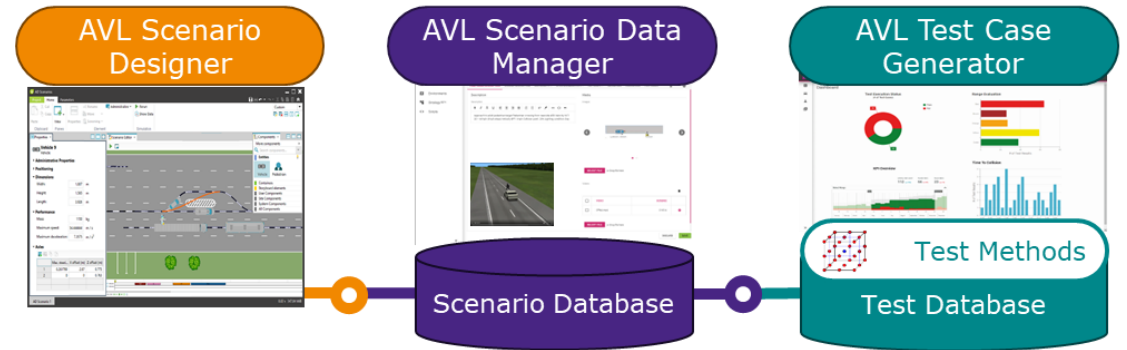
# Credibility by Standard Interfaces

- Enable interoperability, reusability, and comparability of validation data, tools and results
- Reproduce data setup and test results in different toolchains and platforms
- Facilitate cross-validation by homologation authority



AVL SCENIUS™

ASAM OpenSCENARIO® ASAM OpenDRIVE® ASAM OpenCRG®



Easy traffic scenario design, editing, parametrization and verification

Efficient and high-quality scenario handling guided by a standardized workflow

Optimized test planning with increased test performance and maximized test coverage

ASAM OpenXOntology

ASAM OpenODD®

ASAM Test Specification

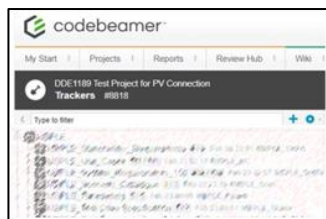


# Credibility by Traceability



AVL SCENIUS™

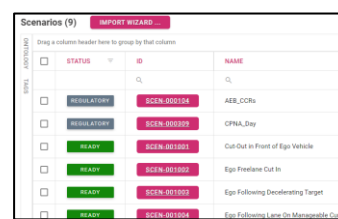
- End2End consistency and traceability for entire vehicle life cycle:
  - Requirements, Design, Development, V&V, Production, In-Use, Documentation
- Traceability
  - connects development process with safety argumentation
  - required for safety management and regulatory compliance
  - critical for risk assessment and mitigation
  - makes validation process transparent, consistent and reproducible
  - ensures communication and collaboration among the stakeholders



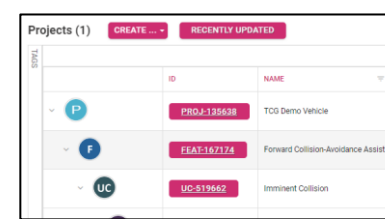
Requirement ID's



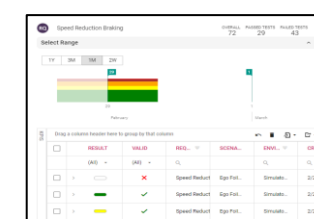
Scenario tagging sequences



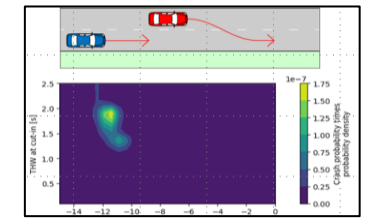
Scenario ID's



Test plans/cases ID's

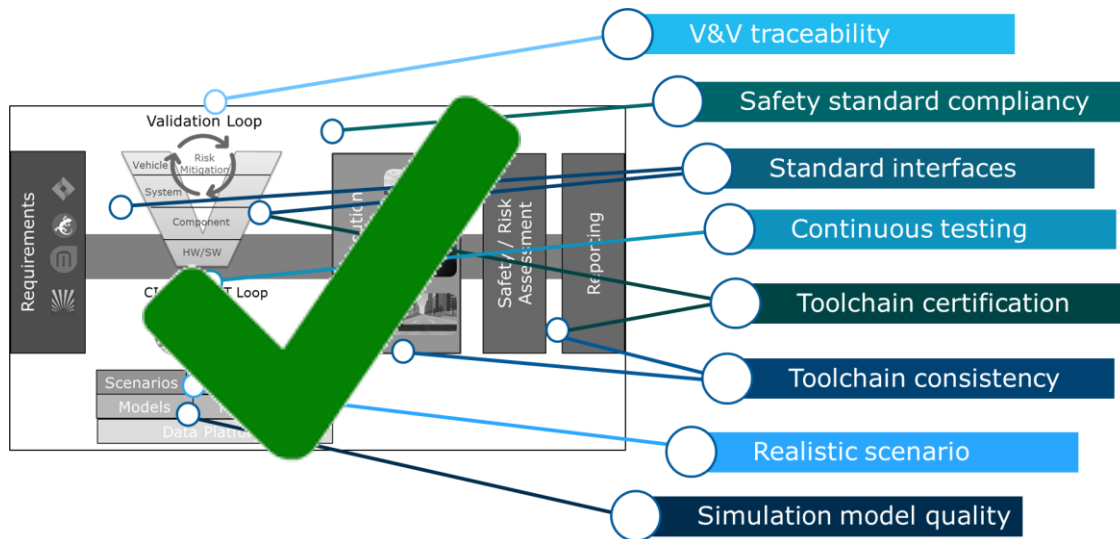


Test data/KPI's ID's



Safety/risk argumentation

# Takeaways



- Credibility of safety validation toolchain is a required key element for safety management and type approval of autonomous vehicles.
- The successful proof of toolchain credibility requires implementation of many different aspects which involving detailed tool and process know-how.
- Ready-made toolchains already come with built-in solutions and are prepared for immediate use.

Thank you



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