

Quantifying Simulation Quality

From synthetic to real, from academia to industry

Day 2

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Sep 10-11, 2024
Düsseldorf, Germany



Hochschule Düsseldorf
University of Applied Sciences

HSD



Association for Standardization of
Automation and Measuring Systems

SimCERT and ASAM Quality Checker

It has been a long journey already

https://www.simcert.org

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Claims – and Facts

?! Did you ever wonder what might be left of an environment simulation offering after you have gone through all the marketing claims and have tried to apply them to your actual task?

Did you ever consider rating simulation solutions vs. your requirements and found yourself creating lengthy performance and compliance tables?

Did you ever try to answer the *build-or-buy-question* by yourself?

If your answer to any of these questions is YES you should be pleased to see our *SimCert* initiative. We aim to look into the details of environment simulation solutions and we want to give you a clear indication of expected performance for the most frequent applications in ADAS and Autonomous Driving context. We do this by rating simulation solutions as an independent and impartial player.

Our goal? Enabling you to perform an informed choice when it comes to identifying the solutions that fit your needs:

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- CARLA Simulator ★★★★★
- SCANeR studio ★★★★★

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Categorizing X-scope Traffic Simulation

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Quantifying Simulation Quality – GSVF 2021

At GSVF 2021 we had a great discussion at a round table moderated by Alexander Braun, Hochschule Düsseldorf University of Applied Sciences, and Marius Dupuis, SimCert. Its subject: "Quantifying Simulation Quality"...

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Simulation Synchronization

Synchronizing multiple components that belong to a simulation system may range between trivial and tricky. In this post, we will shed some light on the basic methods and technologies...

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Simulation Timing

In this post, we will explain our understanding of simulation frames and their correlation to the real-world's linear time we all live in...

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<https://doi.org/10.2352/EI.2022.34.16.AVM-110>
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Paving the way for certified performance: Quality assessment and rating of simulation solutions for ADAS and autonomous driving

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Abstract

Simulation plays a key role in the development of Advanced Driver Assist Systems (ADAS) and Autonomous Driving (AD) stacks. A growing number of simulation solutions addresses development, test, and validation of these systems at unprecedented scale and with a large variety of features. Transparency with respect to the fitness of features for a given task is often hard to come by, and sorting marketing claims from product performance facts is a challenge. New players – on users' and vendors' side – will lead to further diversification.

Evolving standards, regulatory requirements, verification and validation practices etc. will add to the list of criteria that might be relevant for identifying the best-fit solution for a given task. There is a need to evaluate and measure a solution's compliance with these criteria on the basis of objective test scenarios in order to quantitatively compare different simulation solutions. The goal shall be a standardized catalog of tests which simulation solutions have to undergo before they can be considered fit (or certified) for a certain use case.

Here, we propose a novel evaluation framework and detailed testing procedure as a first step towards quantifying simulation quality. We will illustrate the use of this method with results from an initial implementation, thereby highlighting the top-level properties Determinism, Real-time Capability, and Standards Compliance. We hope to raise awareness that simulation quality is not a nice-to-have feature but rather a central aspect for the whole spectrum of stakeholders, and that it needs to be quantified for the development of safe autonomous driving.

The number of situations which have to be mastered by modern ADAS and AD systems can hardly be estimated. The range of miles required for proving that a system is operating safely has reached the order of billions [3] – although a distinction has to be made between the total number of miles which are statistically required for proving the safety of a system under normal operating conditions and the subset of relevant miles which comprise all situations a system is expected to handle safely.

Whatever the exact number of miles or situations, the order of magnitude alone and the potential risk involved in creating edge cases in the real world leave no other method but to supplement proving ground and road tests by simulation-based testing on a massive scale. Various research projects for enabling highly automated driving (HAD) have incorporated this principle into their methodologies [4, 5].

But whereas it is guaranteed that physics in real-world testing are correct per se, hardly any formal and commonly agreed processes exist today to prove that a stimulus originating from simulated components provides physically correct input to the SuT or that a specific simulation solution fulfills its intended purpose in general. Unless this problem is solved, an envisaged virtual homologation of vehicles equipped with ADAS and AD functions will not be possible [6].

The Goal

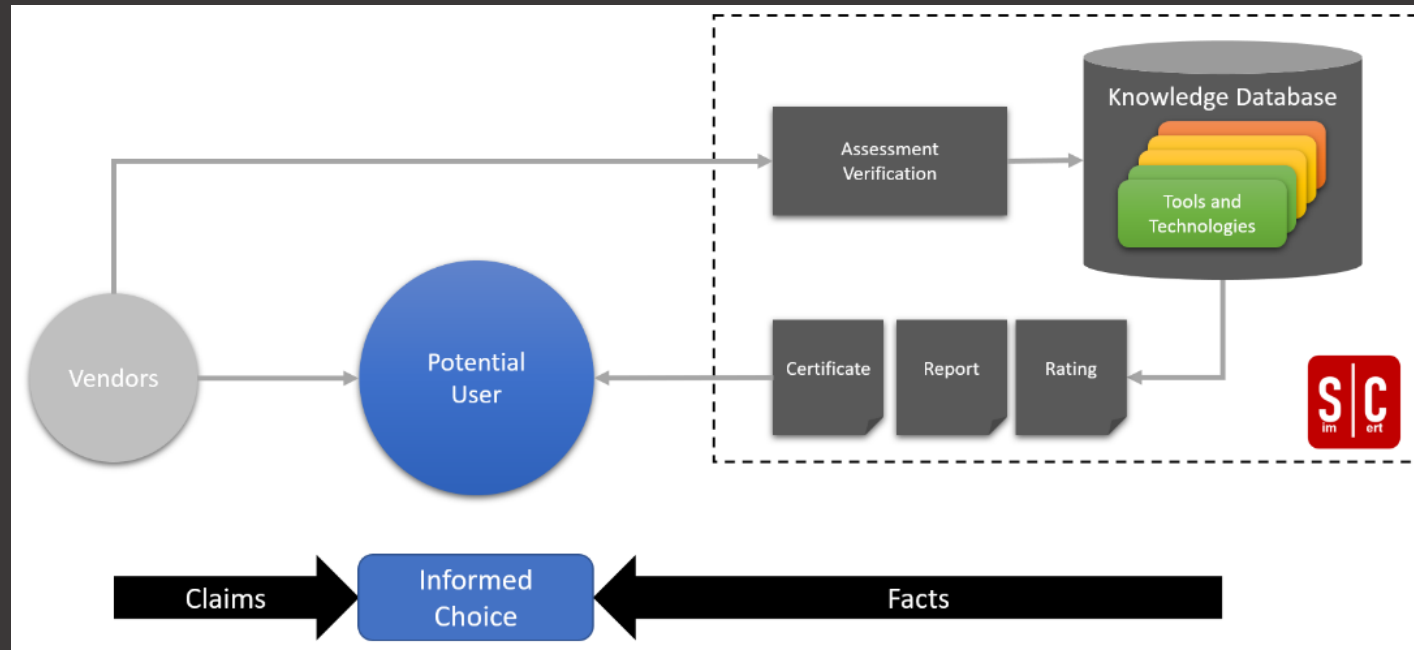
Simulation solutions come with a broad range of components, features, tooling, interfaces etc. For a function or system developer whose task is to ensure that the SuT performs as intended within its operational design domain (ODD), it might require in-depth knowledge of simulation technology in general and the

Quantifying Simulation Quality – GSVF 2021

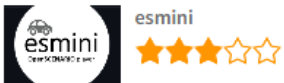
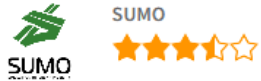
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Round table in Graz, September 02, 2021 (source: Virtual Vehicle)



Latest Reviews - Traffic / Scenario Simulation

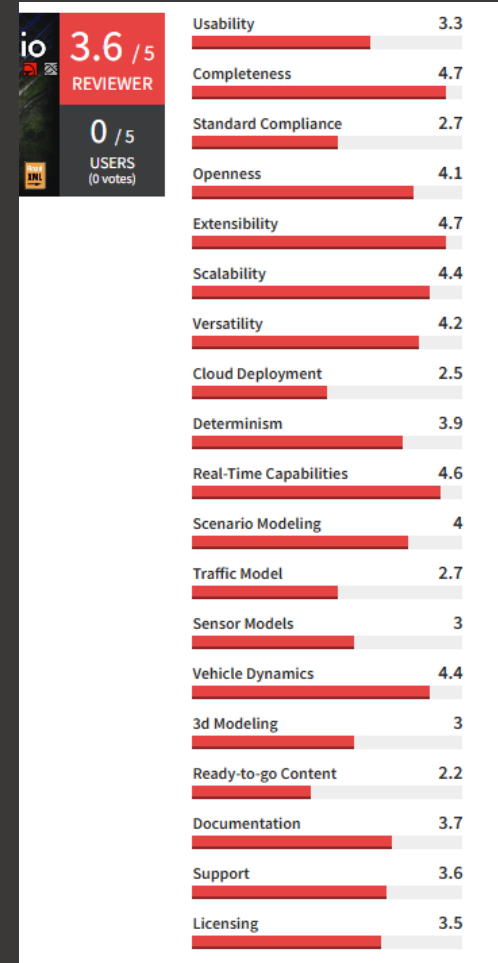


PROS

- Highly versatile product with lots of functionality (even in excess of what is relevant for our rating, see below)
- User-friendly operation across various modules by integrated GUI
- Easy and very illustrative configuration of sensors etc.
- Good extensibility by user-modules, scripts, plug-ins etc.
- Traffic simulation encompasses the most relevant types of entities (cars, trucks, pedestrians etc.)
- Quite intelligent and autonomous behavior of traffic participants with considerable means for driver model configuration
- Various fidelity levels of vehicle dynamics (from simple to multi-body model)
- Good scalability by modular design
- Sensor modeling across the full range from perfect object sensors to physics-based sensors in all relevant technologies
- Fully deterministic operation of the core physics elements may be configured
- Training material (videos, tutorial) available
- Online documentation
- Mature product with installations across various deployments
- Flexible licensing schemes

CONS

- Documentation not completely up to date and with some legacy content
- Synchronization concept across multiple modules not fully intuitive for the unexperienced user (but effective nevertheless)
- Scenario modeling relies to a substantial part on user-defined scripting
- Traffic module does not provide track-bound elements (train, tram etc.)
- Support of OpenSCENARIO or comparable standards is missing
- Cloud operation possible, but full orchestration of cloud instances with corresponding data management not yet available from within the product

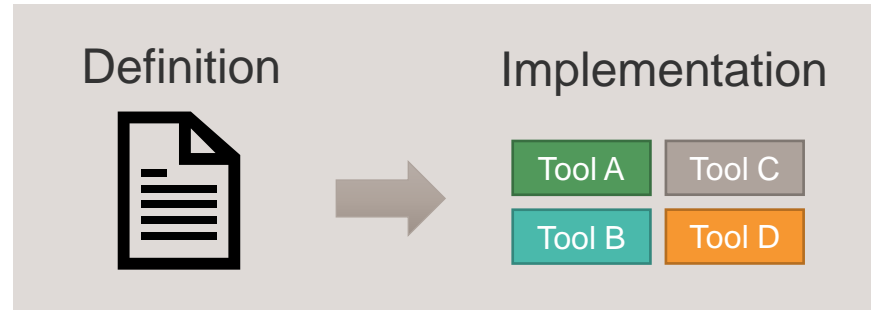


What is the correlation with ASAM?

Quality!

Creating strong standards

Our goal

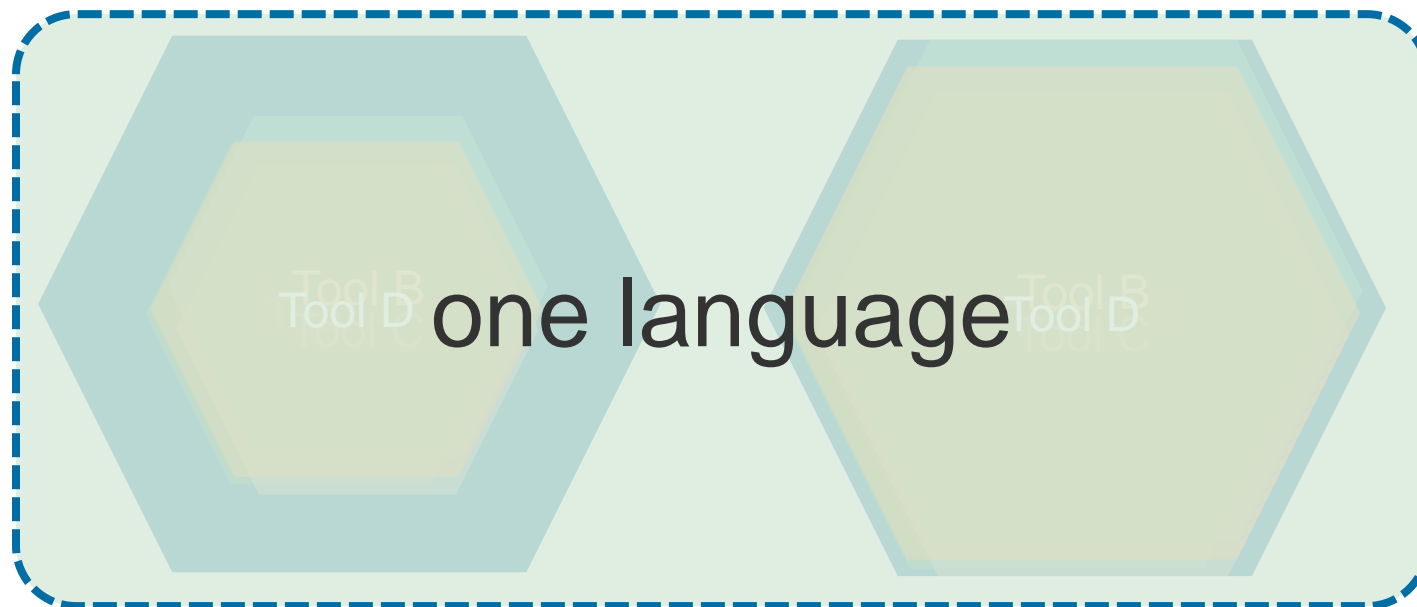


Strong emerging standard
(moderate but consistent adoption rate)



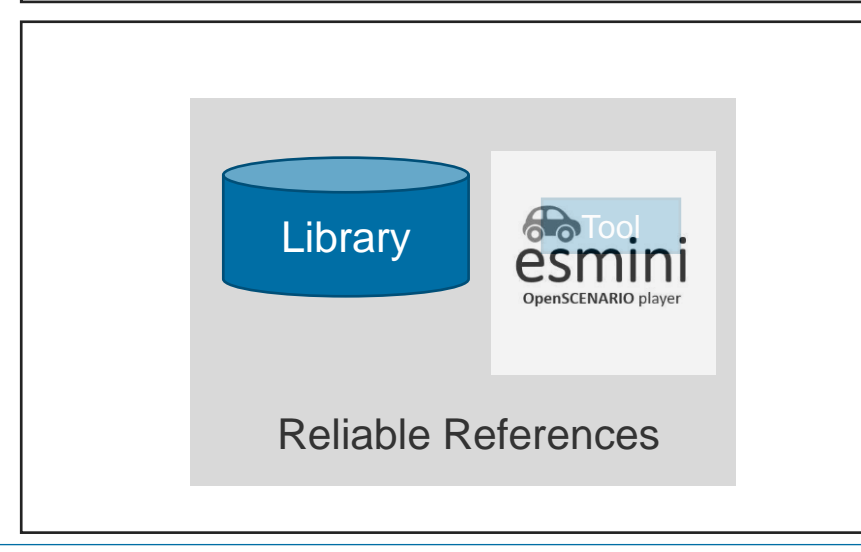
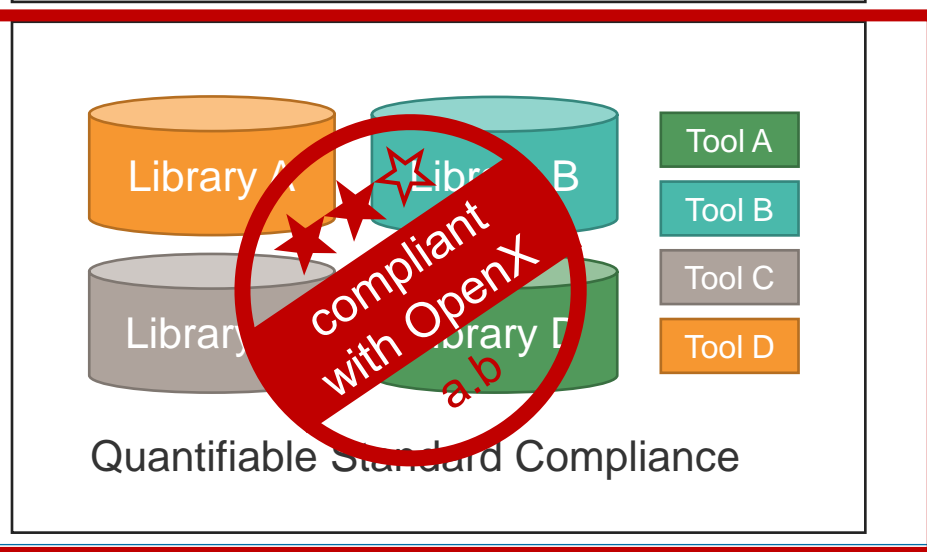
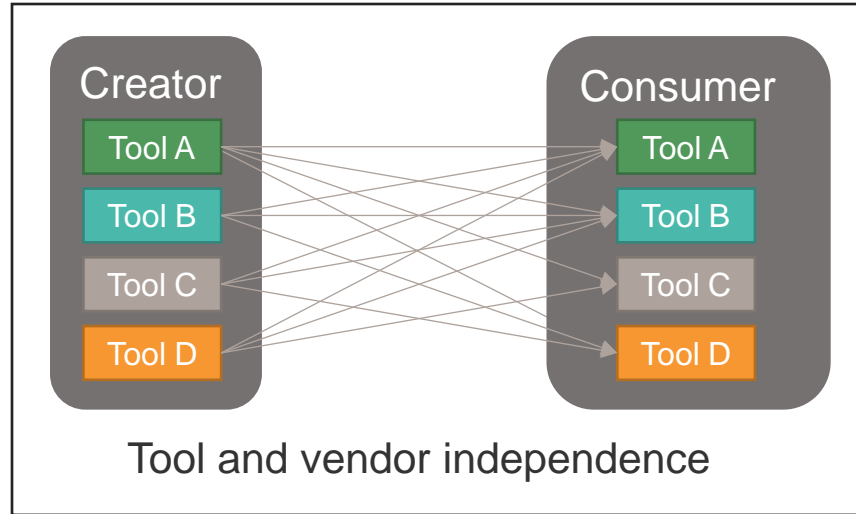
Strong established standard
(large and consistent adoption rate)

Weak standard
(small and inconsistent adoption rate)



The value of standards

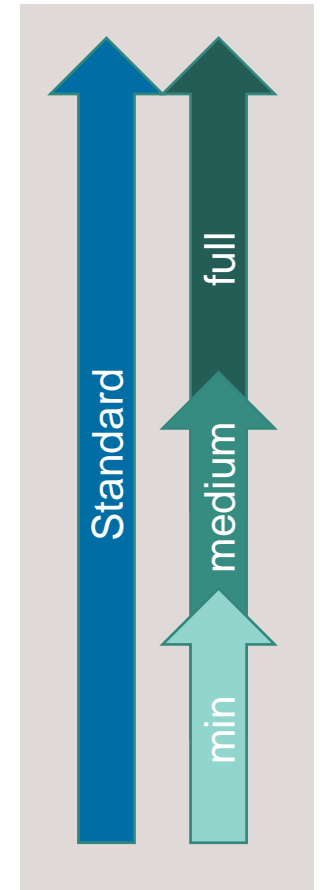
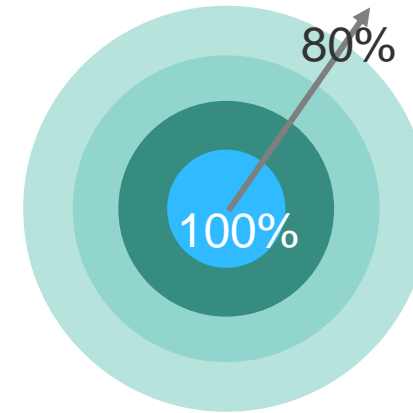
There's a lot to gain



Proposed solution

Steps to be taken

- Agree on quantification criteria (static / dynamic, hard / soft)
- Provide checkers for static parts
- Provide **reference implementations** for dynamic parts
- Build assessment tooling
- Rate data assets with the tooling
- Rate tools' compliance based on reference datasets and reference implementations
- **Provide discrete and achievable compliance levels**



Our reference so far

Quantifying quality in non-simulation domains

ASAM ODS Cross Test

on: Nov 02 - 03, 2022

at: BMW Training Academy, Unterschleissheim (near Munich), Germany

Register by Oct 19, 2022

ASAM hosted an ASAM ODS cross test to test the compatibility among ASAM-ODS based software components (i.e. servers and clients) from different vendors. All ASAM members were invited to take part.

At a cross test, the participating companies cooperate to verify and improve their software in real life scenarios. Participants help each other to understand the tiny differences in the formats of data of different programs and to solve the difficulties they might encounter in interpreting these data. Additionally, unclarities, ambiguities and contradictions in the Standard are revealed and can be resolved in a next step.



<https://www.asam.net/conferences-events/detail/asam-ods-cross-test-2022>

Our reference so far

Quantifying quality in non-simulation domains

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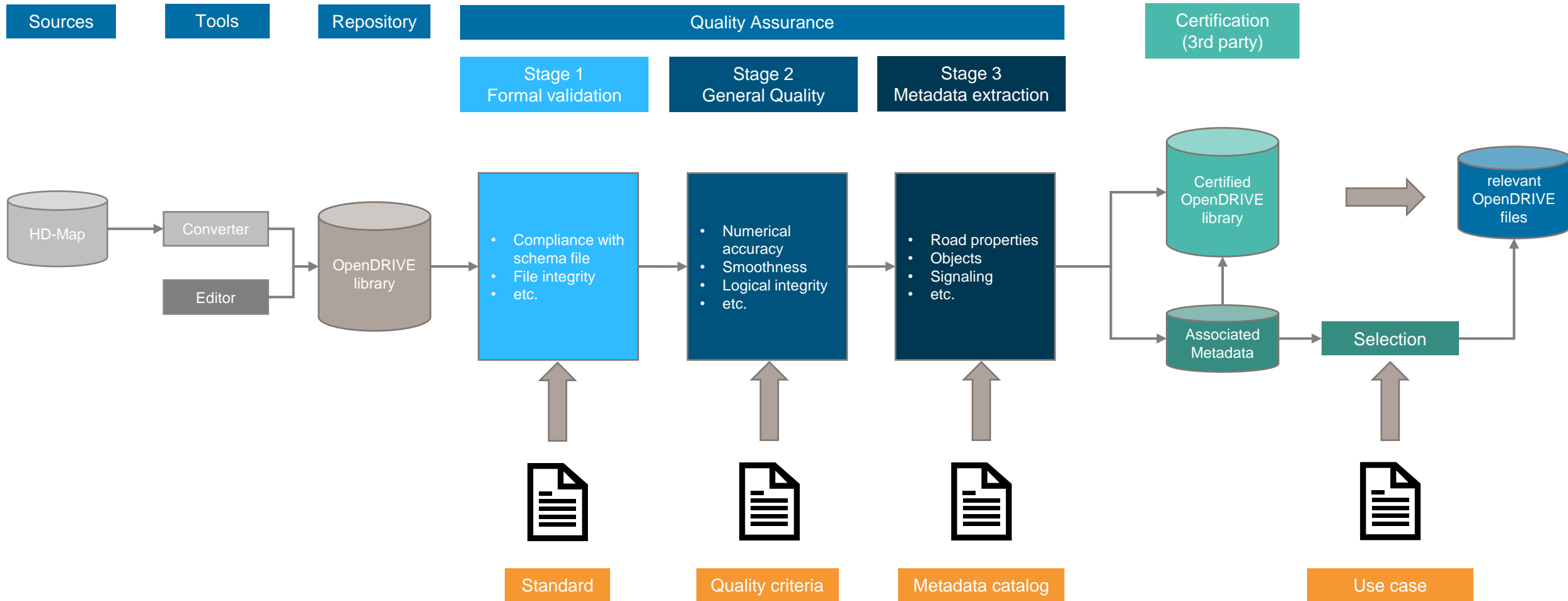
We can do better: Generalized approach

One framework for multiple standards

ASAM Quality Checker

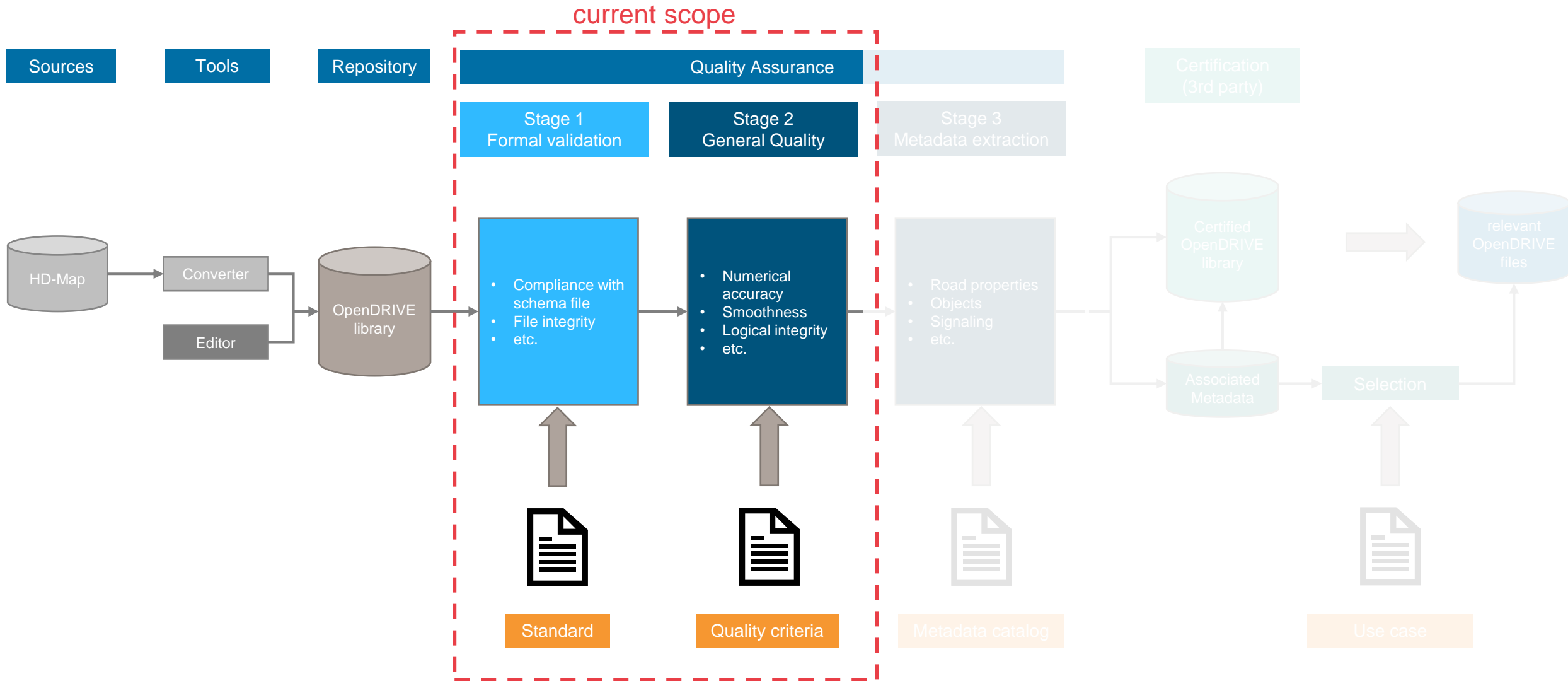
Example: Data flow for ASAM OpenDRIVE artefacts

Our plan as of Jan 12, 2023



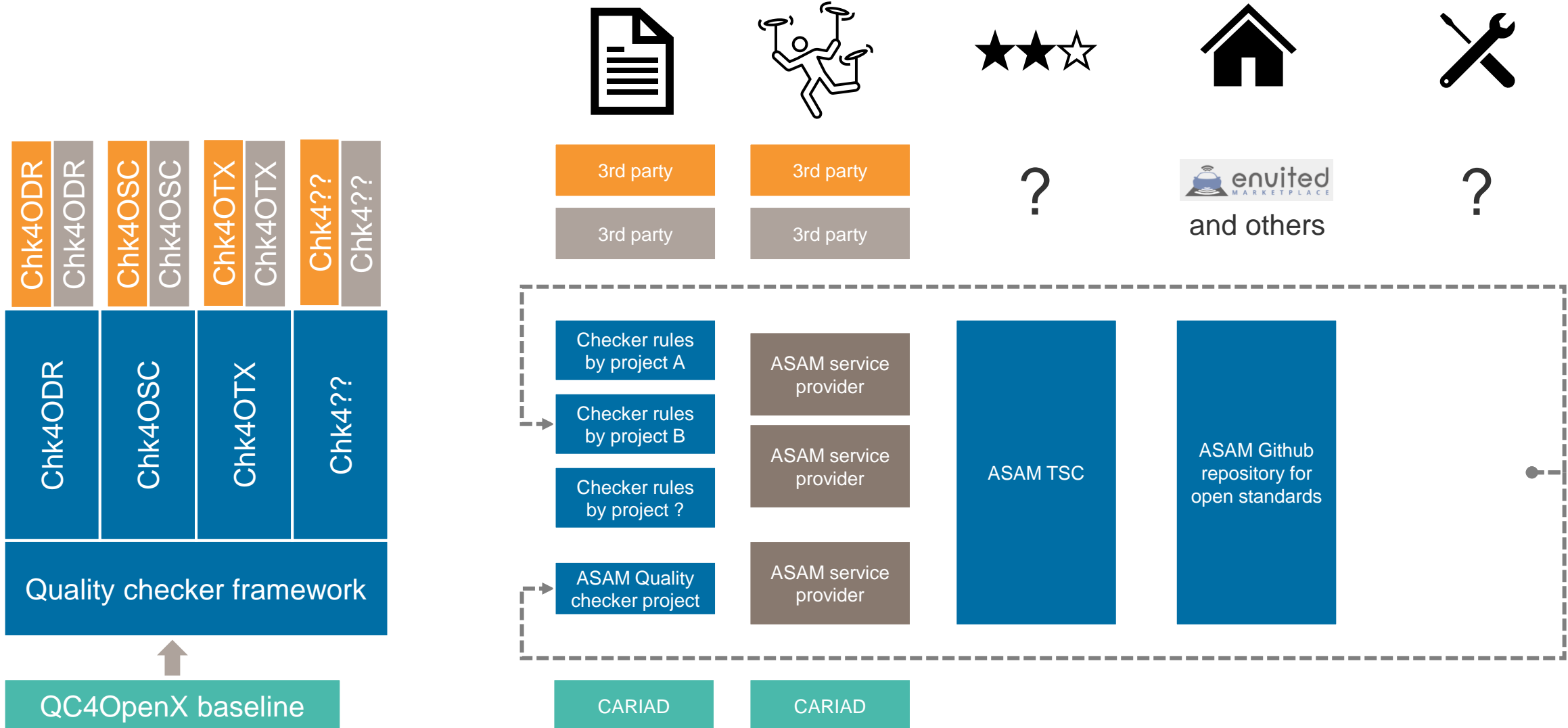
Example: Data flow for ASAM OpenDRIVE artefacts

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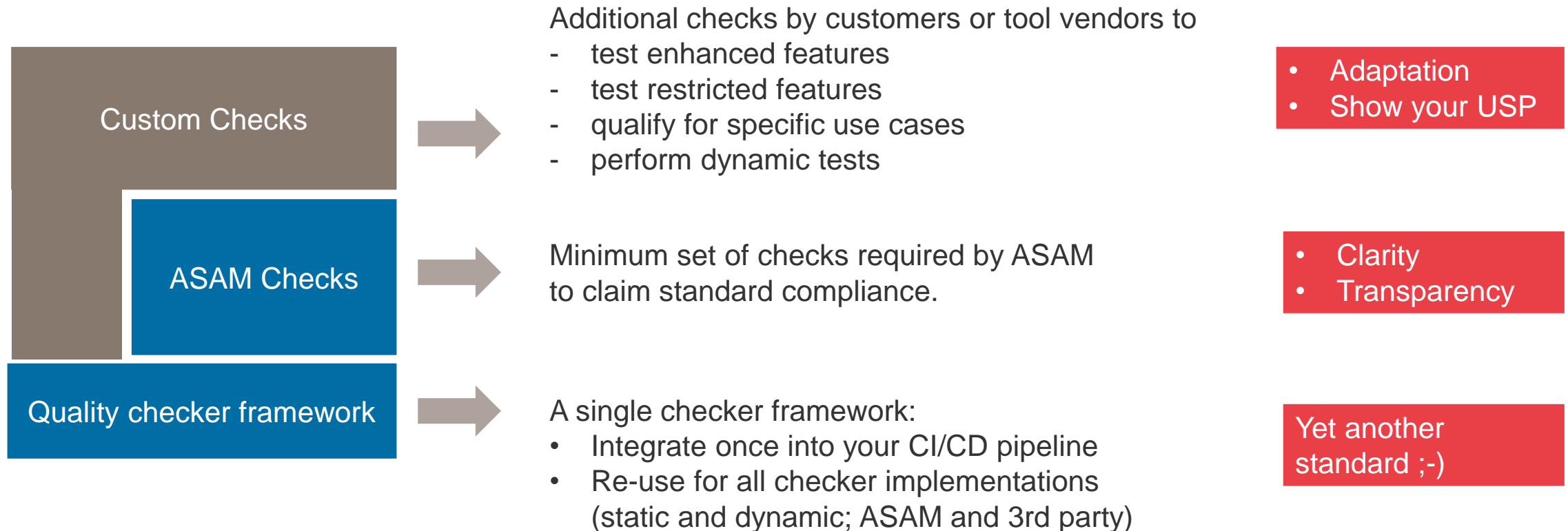
Our project: ASAM Quality Checker

Quality checker framework for OpenX and more



ASAM Quality Checker

Application and benefits



Benefits

Why is ASAM doing it?



Trust: Quality checks are defined by the same people who define the standards.



Clarity: ASAM provides an authorized interpretation of standards.



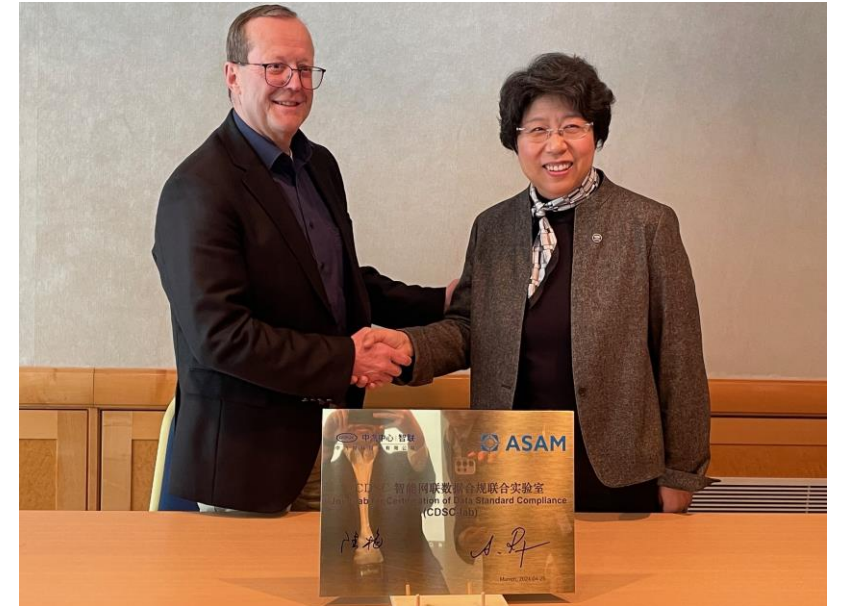
Maintenance: ASAM's checks are adapted with each standard revision project.



Value: ASAM membership fees are invested in a single, consistent tool suite.

Quality assurance is a global thing

Collaboration with CATARC



Panel discussion

Essentials of our workshop

Panel discussion

Moving forward...

Q:

Before we talk about the way to move forward: what is your impression of the past one-and-a-half days during this workshop? Was it the right format? Did the right people convene? Who else should we have invited?

Q:

What do you think are the points we agreed on and where do we have the strongest disagreement?

Q:

We wanted to bridge the gaps between industry and academia, in particular because ASAM's membership is strong in both fields? Where do you see these gaps? Are they preventing or helping us in joint activities?

Q:

We discussed a lot about quality criteria, KPIs and the same. Where do you think, this information will be most valuable? In a vendor – customer relationship? In a regulator – solution provider relationship? In the communication to the public about credibility of simulation and the systems tested with virtual methods?

Q:

How transparent can providers of simulation solutions be if it comes to their individual performance along the KPIs we discussed? What data would you be willing to make available if your competitor also did? What data would an end-user like to see from their (potential) vendors?

Q:

Where should we go from here? Are we already at a stage where we can start thinking about a standardization initiative? What would such a standard look like? Or would it be better to go with a study group (e.g. ASAM TestSpecification)?

Q:

Self-reported KPIs – even if along a standard – might become an essential part in future customer-vendor relationships. But what about its trustworthiness? Do we have to think about certification of tools along the quality criteria we discussed here? Who would perform this certification?

Q:

Final question with short answers: what are your personal three key takeaways from this workshop?

Thank you for
your attention!

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