Homologation with cyber-physical environments

How to scale the homologation process through certified testbeds

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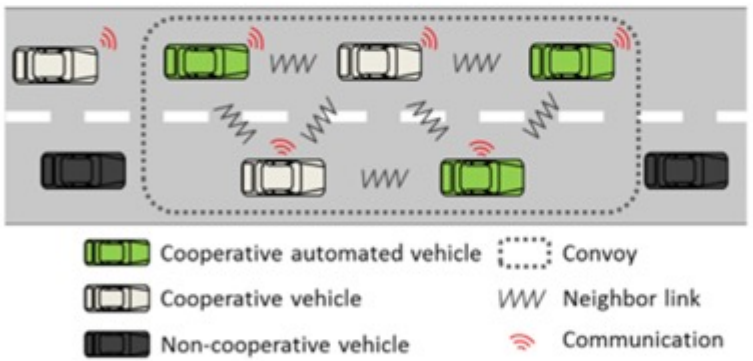
Vienna (remote)

ASAM Association for Standardization of Automation and Measuring Systems

The inspiration of IAMTS when it was founded in 2019

What are the *regulatory* and *technological* challenges in advanced mobility to enable automated driving and how can IAMTS contribute with a milestone oriented roadmap approach related to **testing and standardization** to meet these challenges?

How to efficiently verify & validate SAE L3/L4/L5 vehicles for type approval and commercial deployment?

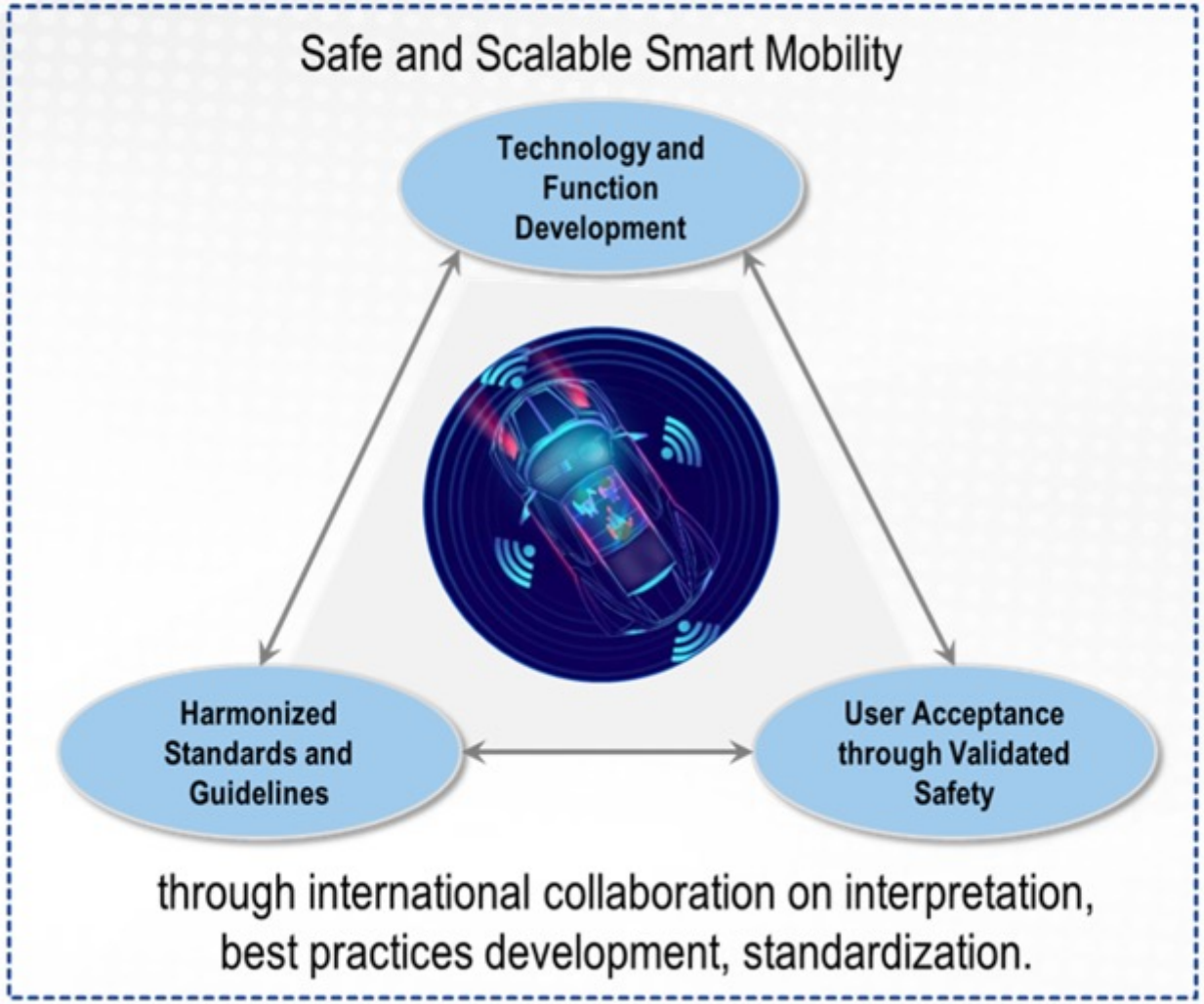


Source: IEEE

Source: SAE

IAMTS was officially announced
in April 2019 during the SAE WCX
in Detroit and incubated through SAE ITC

Focus of IAMTS – Scalable adoption of automated driving systems



International Alliance For Mobility Testing And Standardization

Since October 2022 IAMTS is officially headquartered in Vienna, Austria and operates as an international non-profit association

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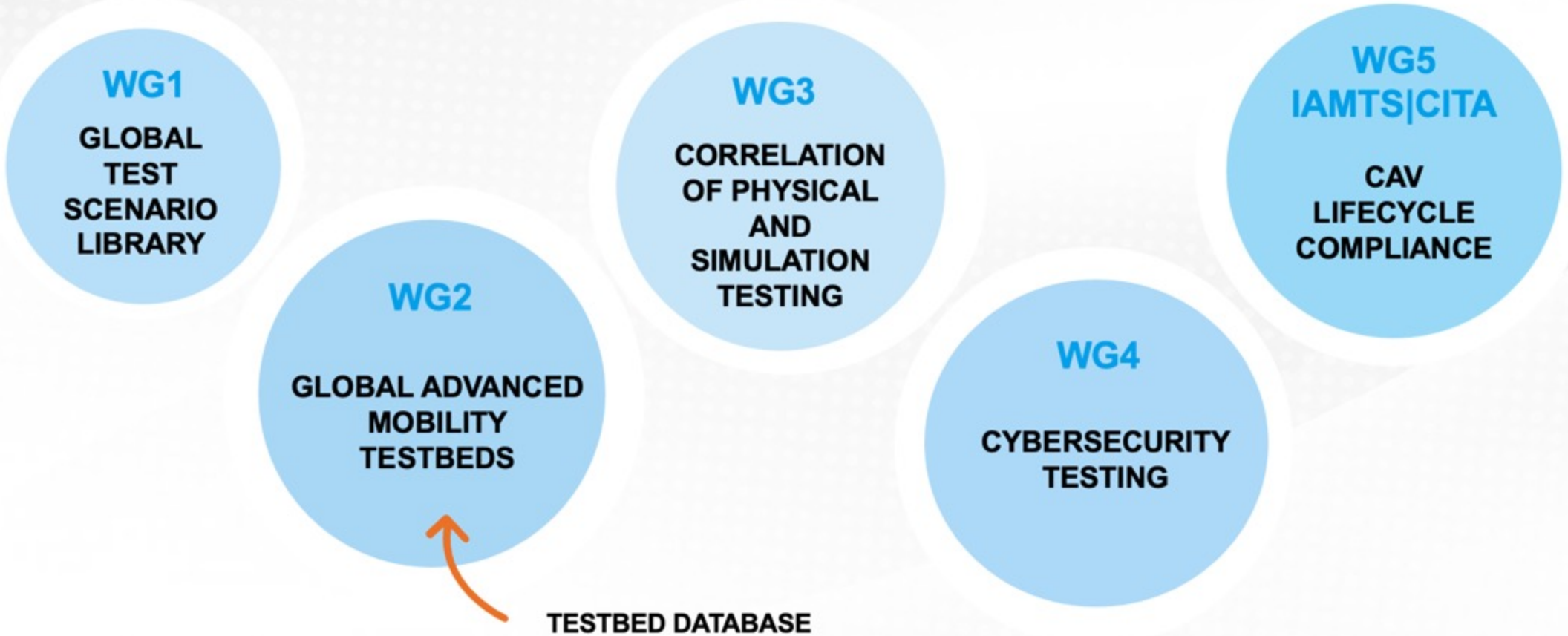
IAMTS Working Groups



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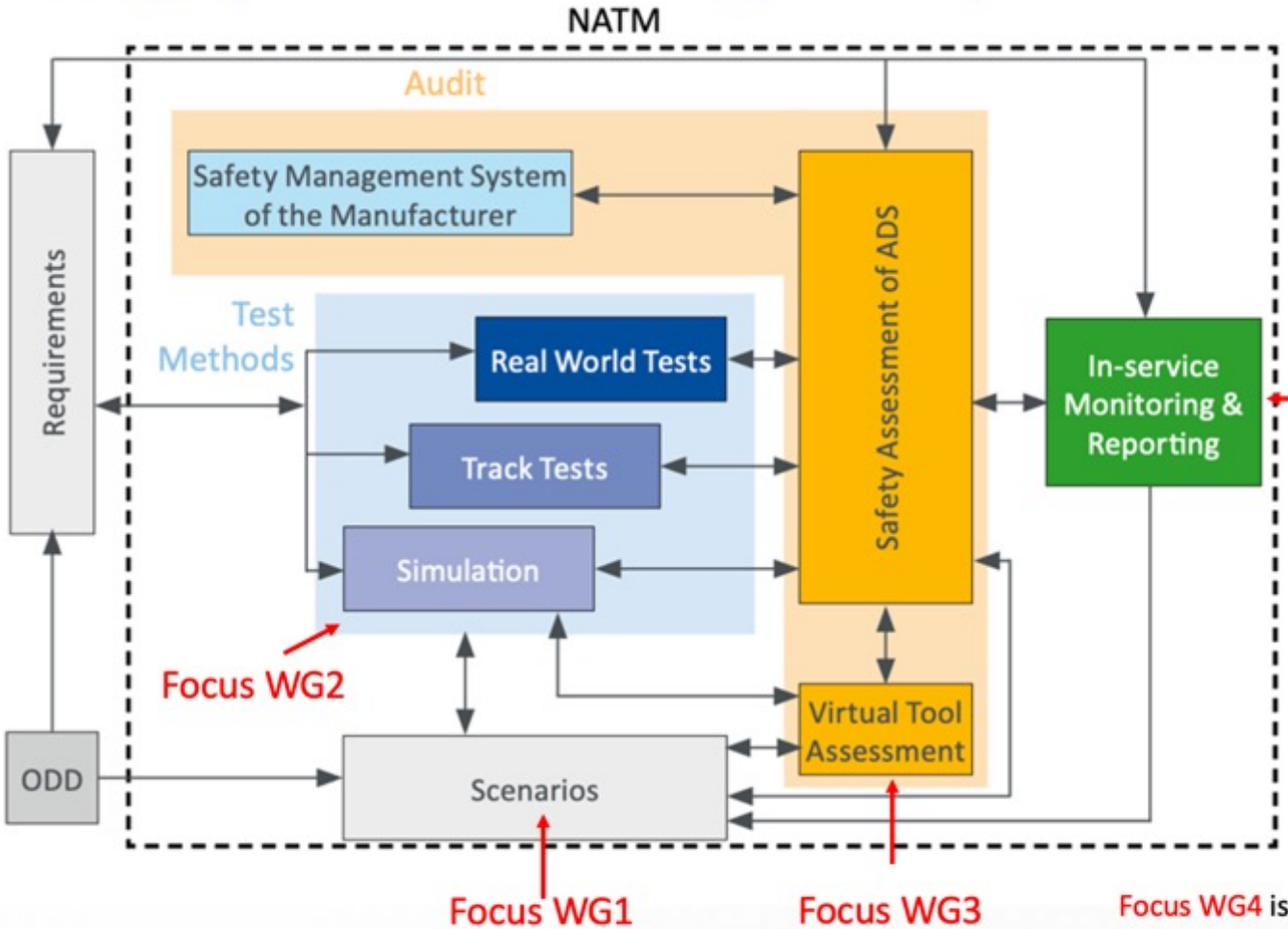
UNECE provides a comprehensive framework approach how to test automated driving systems which is supported by IAMTS



NATM:
New Assessment Test Method for Automated Driving

Source: UNECE

Focus WG4 is cybersecurity being addressed in UN R 155

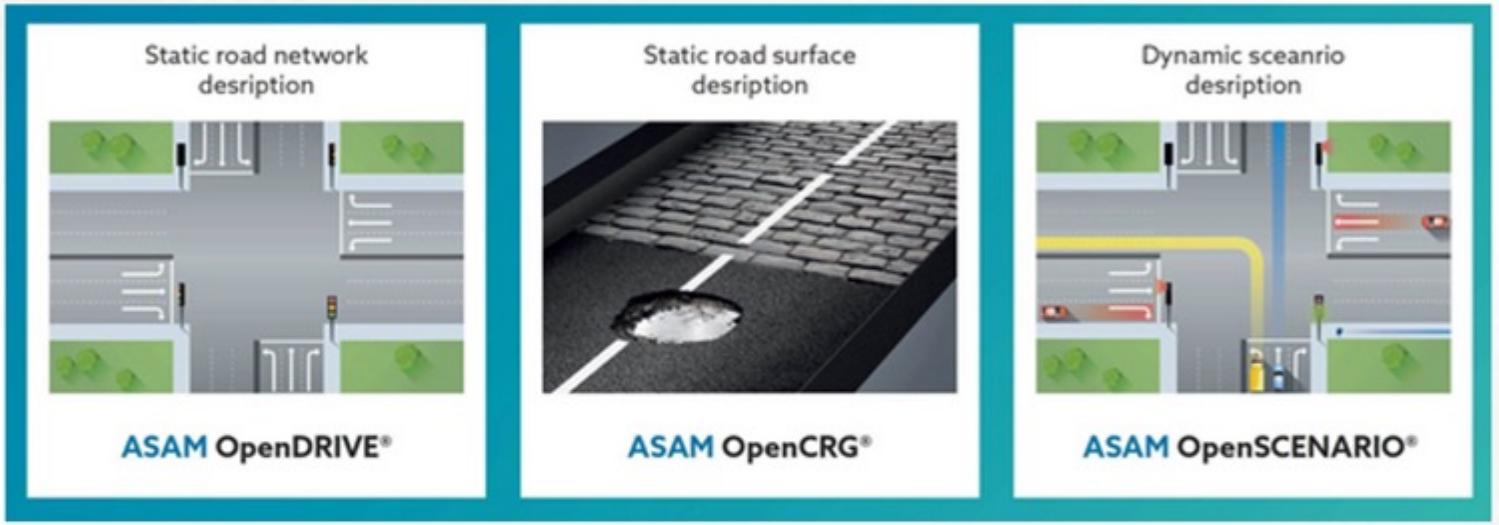
Mapping route deployment of automated driving systems to certified cyberphysical testbed environments in a scalable manner

L2+/L3 highway deployment

L4 robotaxi deployment in urban environments

L4 automated valet parking

Examples of standardization efforts based on industry consensus to support the type approval of L3 and L4 enabled automated driving systems



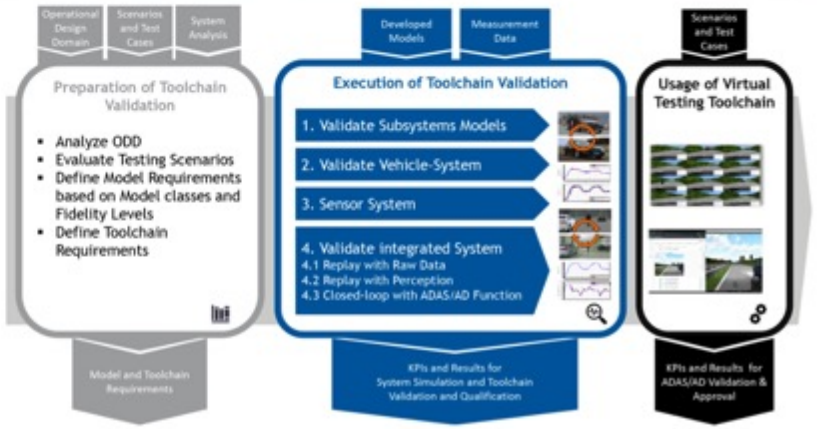
Road network

Road Surface

Driving scenarios

Environmental models

IAMTS
Reference Model



Validated
simulation toolchain

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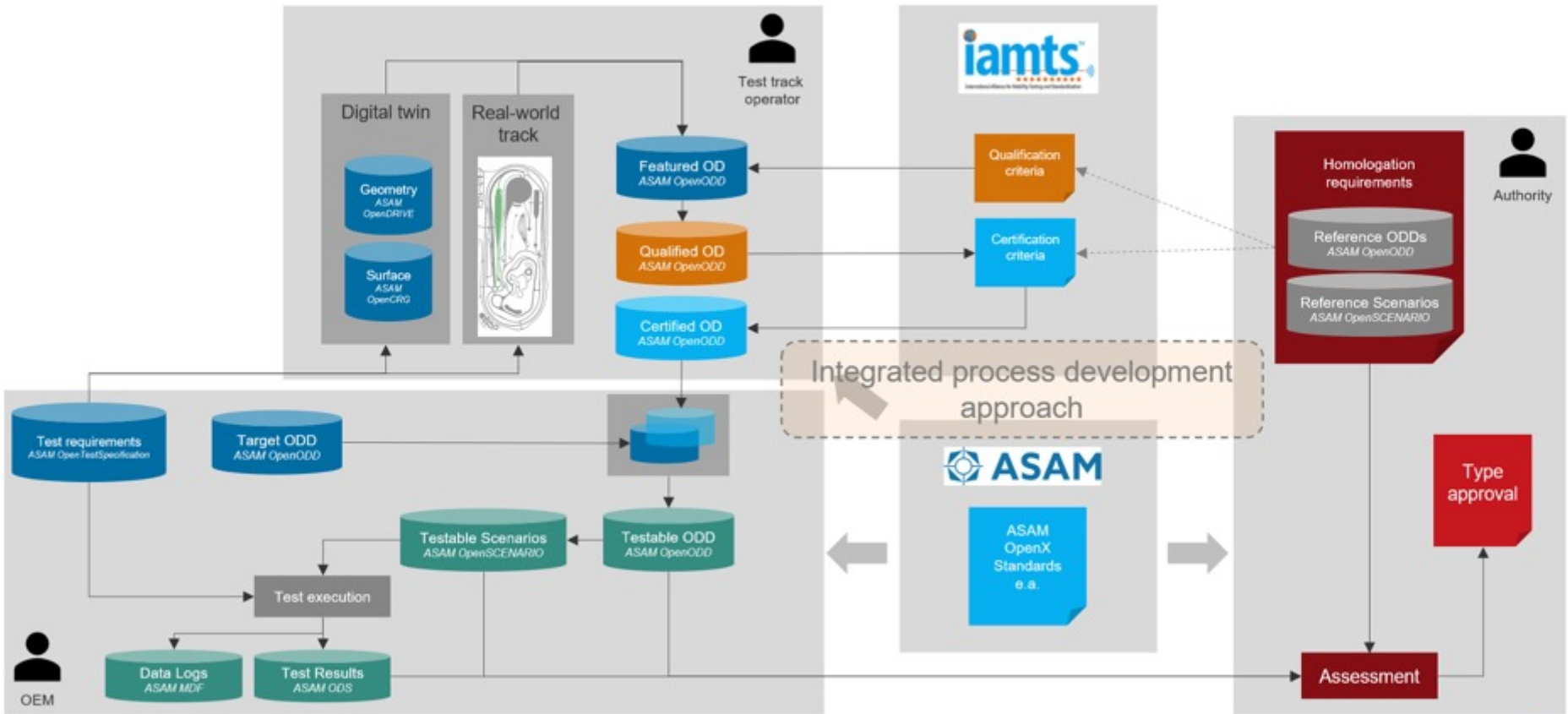
Collaboration between ASAM and IAMTS – focus on standards

How it works – the details



Concept by Marius Dupuis, CEO ASAM e.V.

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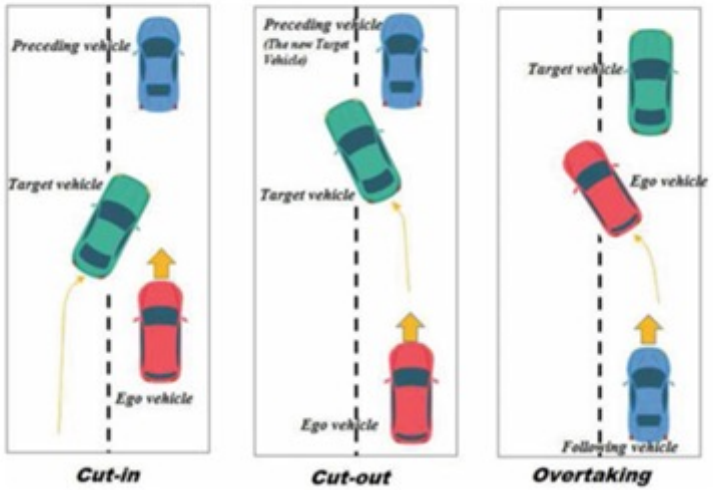
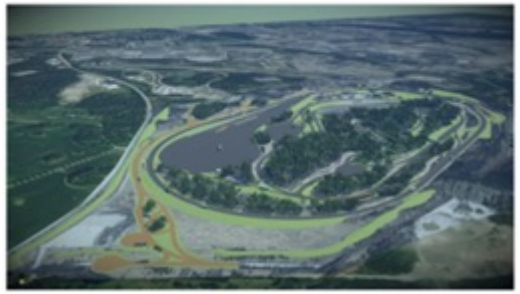
The regulator needs to validate a relevant set of scenarios within the ODD utilizing certified cyber-physical testbeds to assess the safety of the ADS

Regulator and OEM select from a catalogue of standardized scenarios (the challenge is to agree on critical scenarios)



OEM provides scenarios in standardized digital format

Regulator and OEM select closed and open testbeds from a database of certified cyber-physical testbeds*



Road operator and testbed operator provide OD in standardized digital format

Regulator and OEM map scenarios to specific ODD elements of selected certified testbeds

As much scenario validation as possible needs to be done virtually.

*combination of virtual and physical testbed

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What are the lead regulatory approaches whether automated driving is safe ?

UN Regulation No. 157 regulates automated lane changes for ADS (Automated Driving Systems) for passenger cars and light duty vehicles for up to 130 km/h on motorways

With the entry into force of the Regulation (EU) 2022/1426 laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated vehicles, the KBA has been enabled to issue EU type approvals for motor vehicles with a fully automated driving function (level 4) in small series production.

Source: KBA

***Important note:** if a vehicle is approved in one EU member state it can be sold in all member states*

Whilst the scope of this Regulation is expected to be expanded in future, it is currently limited to the following "use cases":

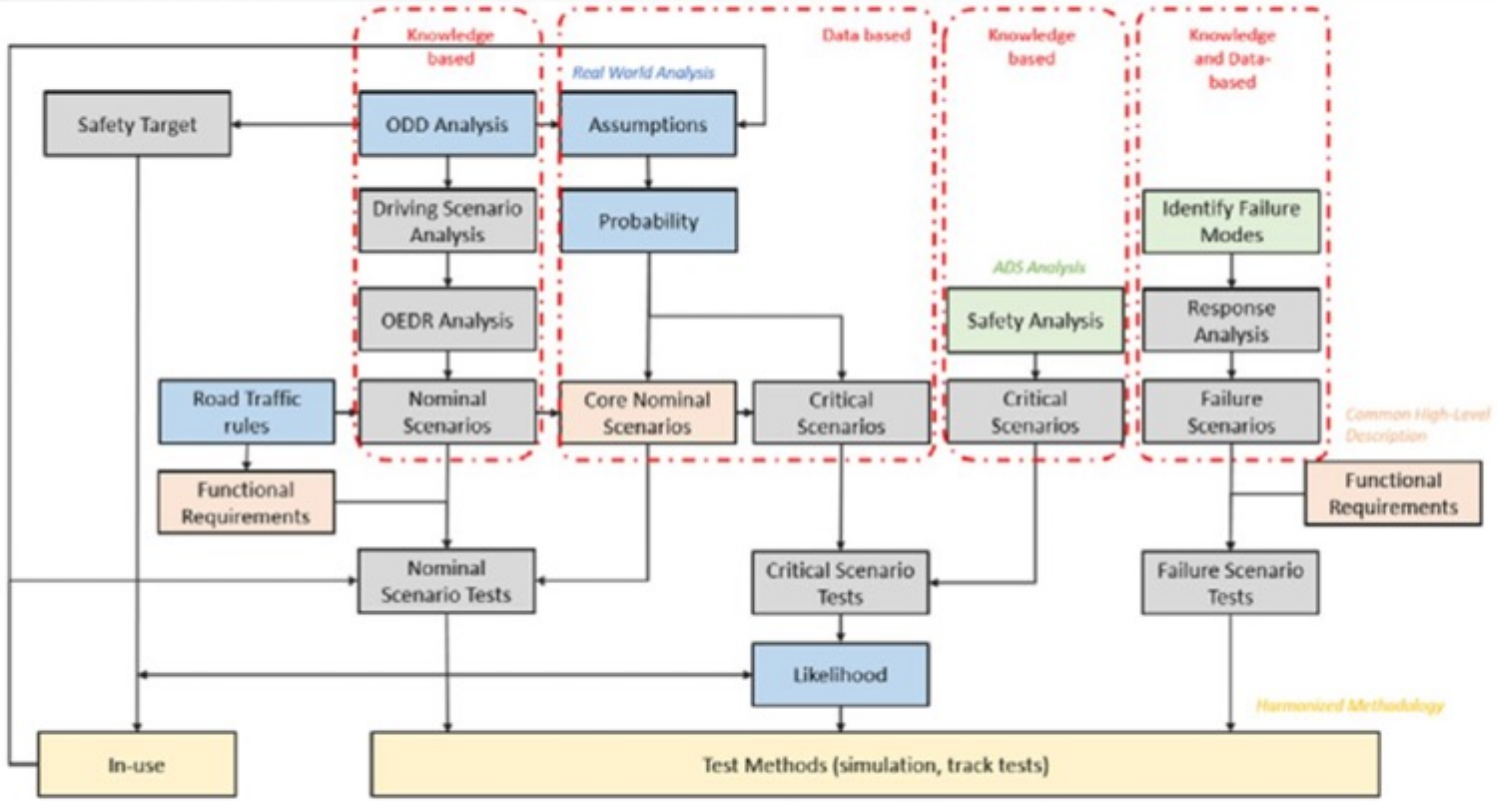
- Fully automated vehicles operating in a predefined area in an urban or suburban environment.
- Fully automated vehicles or dual mode vehicles operating on a predefined route, with fixed start and end points, which may include urban, suburban or motorway environments.
- Dual mode vehicles with a fully automated driving mode for parking applications within predefined parking facilities.

Source: ATS Group

The EU will seek to develop and adopt requirements for whole vehicle type approval of fully automated vehicles produced in unlimited series by July 2024

Source: Lexicology

Some interesting details about EU 2022/1426 regulation



Some interesting details about EU 2022/1426 regulation

Test site

The test site shall comprise characteristics (example: friction value) that correspond to the specified ODD of the ADS. As necessary to apply the specific conditions of the ODD of the ADS, physical tests will be performed within the actual ODD (on-road) or at any test facility that replicates the ODD conditions and shall be determined by the manufacturer and the type approval authority. The ADS shall be tested on-road in accordance with the applicable law of the Member States and provided that tests can be carried out safely and without any risk to other road users.

Environmental conditions

Tests shall be carried out under different environmental conditions, within the limits of the defined ODD for the ADS. For environmental conditions not tested that may occur within the defined ODD, the manufacturer shall demonstrate as part of the assessment to the satisfaction of the type-approval authority that the vehicle is safely controlled.

To test the requirements for failure of functions, self-testing of the ADS and initiation and implementation of a minimal risk manoeuvre, errors may be artificially induced and the vehicle may be artificially brought into situations where it reaches the limits of the defined operating range (e.g., environmental conditions).

Some interesting details about EU 2022/1426 regulation

TESTS

The scenarios included in the following points have to be considered a minimum set of tests.
At the request of the type-approval authority, additional scenarios that are part of the ODD can be executed.

Lane keeping

Lane changing manoeuvre (LCM)

Response to different road geometries

(e.g. T-Junctions, cross sections, roundabouts)

Following a lead vehicle

Parking

Response to national traffic rules and road infrastructure

(e.g. speed limit signs, signal lights, pedestrian and cyclist crossing, road maintenance, motorway entry/exit, toll stations)

Collision avoidance:

Avoid a collision with a road user or objects blocking the lane

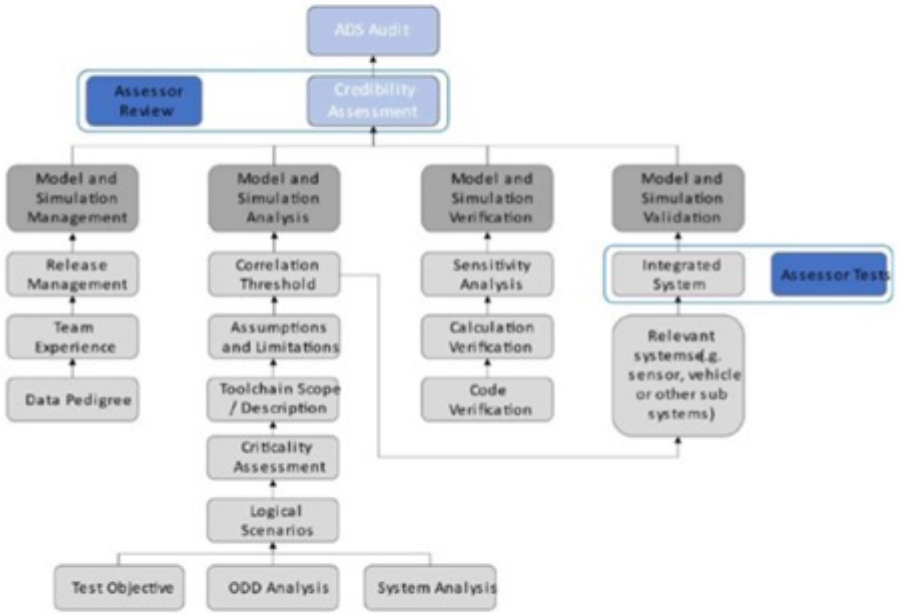
Avoid emergency braking before a passable object in the lane.

Stationary obstacle after lane change of the lead vehicle (cut-out)

Lane change of another vehicle into lane (cut-in)

Some interesting details about EU 2022/1426 regulation

PRINCIPLES FOR CREDIBILITY ASSESSMENT FOR USING VIRTUAL TOOLCHAIN IN ADS VALIDATION



The manufacturer shall define the logical scenarios used for virtual testing toolchain validation. They shall be able to cover to the maximum possible extent the ODD of virtual testing for ADS validation

Example VW ID.Buzz (L4) – hypothetical scenario

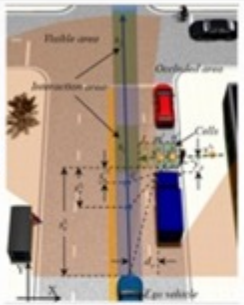
1

VW wants to operate a fleet of L4 vehicles in a major German city

2

VW defines a route network to be considered for the ADS fleet operation

3



VW derives scenario and ODD feature library from route network

4

VW maps scenarios and ODD features into a certified virtual testbed

5

VW runs test cases in validated virtual tool chain in virtual certified testbed

6

VW replicates certain test cases in a physical certified testbed

7

KBA

VW reports test results to KBA and seeks regulatory compliance approval towards EU 2020/1426 for deployment route in German city

Example VW ID.Buzz (L4) – hypothetical scenario

8

VW needs to proof that all manufactured L4 vehicles for the new deployment are working properly for the specified scenarios and the target ODD (vehicle in the loop testing), operator needs to proof that vehicle is safe to operate in target ODD (requires physical testing in target ODD)

9

VW/operator needs to proof on a regular basis that its deployment fleet operates safely (reporting, validation of deployment fleet through inspection)

For any system updates that are safety relevant regulatory approval is needed (software updates, hardware updates, ODD extensions)

What are the key commonalities in the regulatory approaches for ADS ?

There is a common understanding on the terminology about a level 3 and a level 4 ADS

There is also a common understanding that regulatory approval of ADS requires simulation, closed test track testing and open road testing

The driving behavior of the ADS is described through scenarios and validated in an ODD (operational design domain)

What are the key challenges to implement the regulatory approaches ?

We need a standardized way to describe scenarios and a standardized set of scenarios

We need to ensure that the simulation tools being used are validated to provide test results that can be trusted and have sufficient fidelity to approximate reality

We need to use cyber-physical testbeds that are suitable to validate the ADS across the full spectrum of relevant scenarios and within the ODD

What is the value that IAMTS provides to help implement the regulatory approaches ?

IAMTS has access to an expert community through its members and partners that covers product and process development know-how, regulatory know-how and infrastructure know-how to validate automated driving systems end-to-end.

IAMTS interacts closely with standards development organizations (SDO's) and regulating authorities to provide input based on best-practice in the industry to standardize scenarios and ODD features, cyber-physical testbed qualification and certification processes, simulation toolchain validation, cybersecurity testing and quality assurance along the lifecycle of automated driving systems.

IAMTS develops and maintains active relationships with operators of cyber-physical testbeds that can be utilized for safety and security assessments of automated driving systems.

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