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OICA

Future Certification of Automated Driving Systems

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Submitted by the experts of OICA

Introduction

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- With the introduction of automated driving systems the number of software-based functions and thereby complexity will continue to increase.
- Compared to conventional vehicles, the potentially affected safety-areas and variances of scenarios will increase and cannot fully be assessed with a limited number of tests that are performed on a test track or test bench
- The aim of this presentation is to propose a new innovative certification scheme allowing to demonstrate the level of safety and reliability which allows for safe market introduction of automated/autonomous vehicles
- The concept and building blocks for a future certification of automated/autonomous driving systems that are discussed in this presentation could be applied both under a type approval or self-certification regime
- Application of a regulation under a self-certification regime requires precise descriptions of the procedures and tests to be applied by the manufacturer
- This presentation is based on ECE/TRANS/WP.29/GRVA/2019/13 and several documents that OICA submitted under the activities of WP.29 IWG ITS/AD (see back-up)

General Challenges/Premises for a suitable Approach to Regulate Automated Driving

- It is important to consider that WP.29 GRVA is aiming at regulating new technologies of which the majority is not available on the market yet

  → lack of experience should not be neglected and tackled with reasonable strategies (e.g. generic safety-approaches/requirements) in order to guarantee the highest possible level of safety.
- It will be difficult to regulate each and every topic in detail from the early beginning

  → need to prioritize the different topics

  → start with a first set of requirements and develop further as the experience and data on new technologies grow
- Technology for Automated/Autonomous Driving Systems will continue to evolve rapidly over the next years

  → need flexible structures that can be applied to the different kinds of L3-L5 systems instead of limiting the variation/innovation of different kinds of systems by design restrictive requirements

  → Regulating "function by function" would require frequent updates/ upgrades of regulations and would therefore not be practical. Furthermore, it could easily become highly design restrictive
- Need to find a pragmatic way for industry and authorities that on the one hand leaves "controlled" flexibility and on the other hand defines reasonable requirements/principles to allow evolution of the new technology within the agreed safety principles over the next years

  → structure should allow to add output of research initiatives and lessons learned at a later stage

“Classical” Certification Approach

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Example: Tires UN-R 30 and 54; UN-R 117

- Tire tests (“classical approach”):
  - Mechanical strength: Load/speed performance tests
  - Rolling sound emission values in relation to nominal section width and category of use
  - Adhesion on wet surfaces (wet and snow grip index)
  - Rolling resistance

→The “classical certification approach” typically defines a limited number of performance criteria and physical certification tests to set-up the necessary safety-level as a prerequisite for market entrance

→Such tests are performed on test tracks or on a test bench, requirements were refined over years

→Approach is well suited for systems with limited complexity, limited interactions with other systems and clearly defined system boundaries (typical for mechanical systems/components)

Existing Extension of the "Classical" Certification Approach

Example: Performance of a braking system (UN-R 13-H)

- Braking Tests ("classical approach"):
  - Min. deceleration: 6,43 m/s^2 and 2,44 m/s^2 for the fallback secondary braking system
  - Stopping distance in relation to initial speed: 60 m for 100 km/h
  - Parking brake to hold the laden vehicle stationary on a 20% up or down gradient

→ When ABS, ESP and Brake-Assist were regulated, it was realized that the "classical approach" was not able to address all safety-relevant areas of electric/electronic systems due to the high number of potential failures/scenarios:

- This led to the introduction of the process- and functional safety oriented audits: Annex 8 for safety of complex electronic vehicle control systems
- Introduction of simulation as acceptable simulation-approach for ESP

→ It should also be noted that at the time UN-R 13-H was updated regarding electronic control systems like ABS and ESP, such technologies were already deployed for some years and technically standardized (long-term-experience was available)

Further Extension of the “Classical” Certification Approach

Why the testing of the automated driving systems requires new elements:

- The number of software-based functions and thereby the system complexity will continue to increase with automated driving systems. Compared to the complex electronic control systems, the potentially affected safety-areas and variances of scenarios will further increase and cannot fully be assessed with a limited number of tests that are performed on a test track or test bench.
- The existing audit-approach used for electronic control systems both in safety systems (e.g. ABS, ESP) and driver assistance systems (L1, L2) should be further extended and upgraded to tackle L3-L5 systems.

Why elements of the “classical” approach are still necessary:

- Testing of existing conventional safety-regulations should continue with the “classical approach” also for vehicles that are equipped with automated driving systems.
- Furthermore, classical certification elements (track testing) are an essential part of the multi-pillar approach (see from slide 14). Additions are needed to appropriately cover the software related aspects – they will <u>augment</u> and <u>not replace</u> the classical certification approach.

“Multi-Pillar” Certification Approach

Concept for certification

Real-World-Test Drive

- Overall impression of system behavior on public roads
- Assessment of system‘s ability to cope with real world traffic situations with a **standardized checklist**
- **„Driving license test“** for automated driving system
- Guidance through given set of situations which shall be passed

Physical Certification Tests

- Matching of audit/assessment results with real world behavior
- Assessment of system behavior in fixed set of challenging cases, which either aren‘t testable on public roads or cannot be guaranteed to occur during the real world test drive.
- Reproducibility of situations is given

Audit and Assessment

Simulation

- Audit of development process (methods, standards)
- Assessment of safety concept (functional safety, safety of use) and measures taken
- Check of integration of general safety requirements and traffic rules
- Use of simulation results (high mileage approval, capability to cope with critical situations, which aren‘t testable on proving grounds or in public)
- Assessment of development data/field testing, OEM-self-declarations

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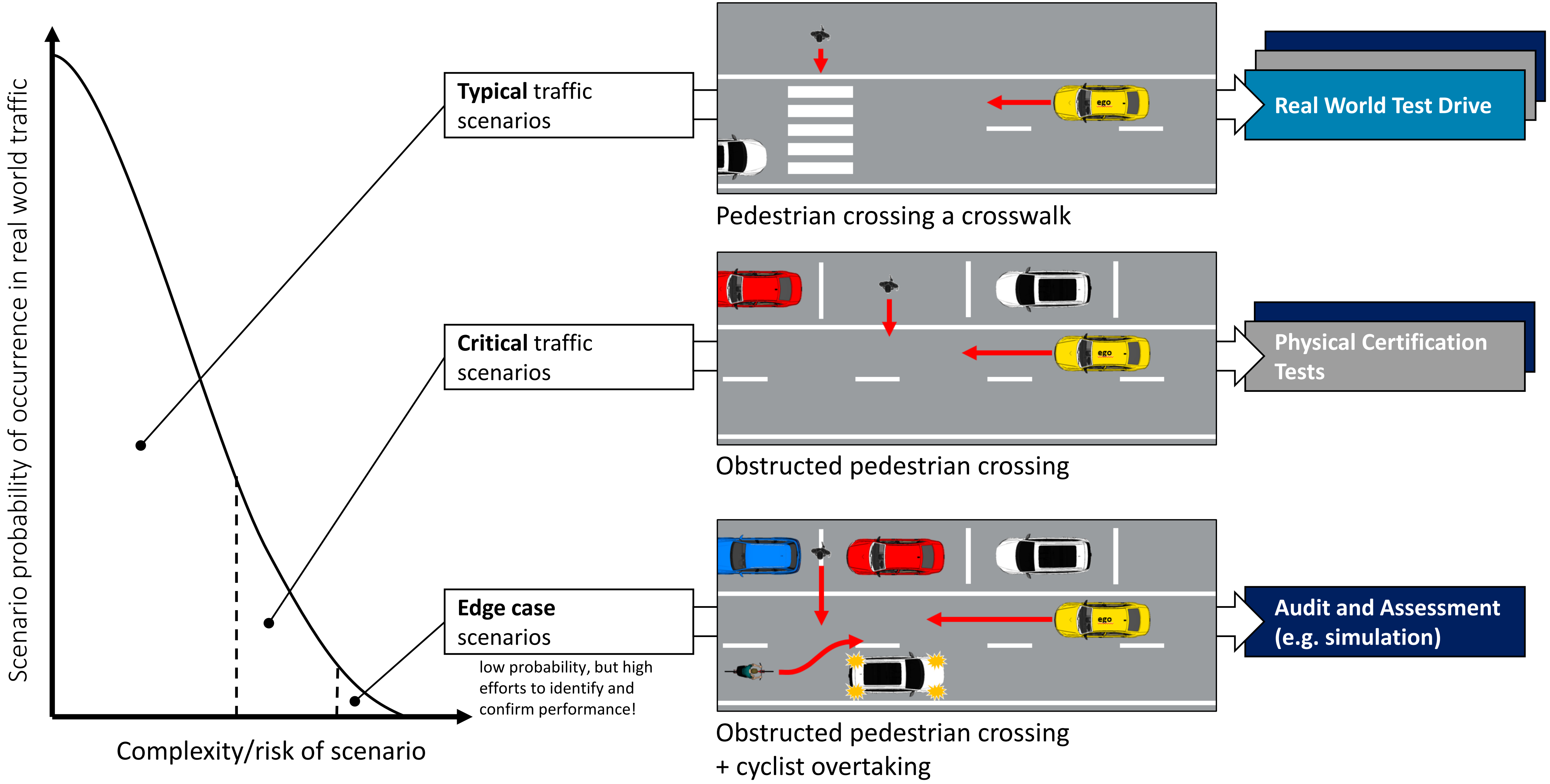
- Certification depends on all pillars – partial assessment doesn‘t have significance
- Scope of work should reduce with every step (audit/assessment: largest scope – real world test drive: final confirmation)
- Safety for test witnesses and other road users – no endangering tests on public roads
- Concept can be augmented by additional “pillars” in terms of requirements/methods/tools as needed (lessons learned)

Example of the different pillars' functions



Concept for certification – the pillars and their individual purpose

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Audit/Assessment

Simulation

- Understand the system to be certified
- Assess that the applied processes and design/test methods for the overall system development (HW and SW) are effective, complete and consistent
- Assess system's strategies/rest performance to address (multiple) fault-conditions and disturbances due to deteriorating external influences; vehicle behavior in variations of critical scenarios
- Simulation: Test parameter variations (e.g. distances, speeds) of scenarios and edge-cases that are difficult to test entirely on a test track

Physical Certification Tests

- Assess critical scenarios that are technically difficult for the system to cope with, have a high injury severity (in case the system would not cope with such a scenario) and are representative for real traffic
- Compare with critical test cases derived from simulation and validate simulation tools

Real World Test Drive

- Assess the overall system capabilities and behavior in non-simulated traffic on public roads and show that the system has not been optimized on specific test scenarios
- Assess system safety requirements like e.g. HMI and ODD
- Assess that the system achieves a performance comparable to an experienced driver

Concept for certification of automated driving systems Level 3-5

Why the new approach can generate an equivalent/higher safety-level compared to the "classical" approach:

- The multi-pillar approach recognizes established process and functional safety oriented audits for certification of complex electronic vehicle control systems as a foundation.
- Consequently, this new approach requires manufacturers to give evidence that their system has been designed and tested in a way that complies with established safety principles, different traffic rules, and ensures safe performance both under fault-conditions and arbitrary external influences.
- Furthermore, the new approach evaluates specific complex situations on a test track.
- To complement the assessment, the new approach includes a real-world-drive test in real world traffic (non-simulated).

Deriving the scope of work

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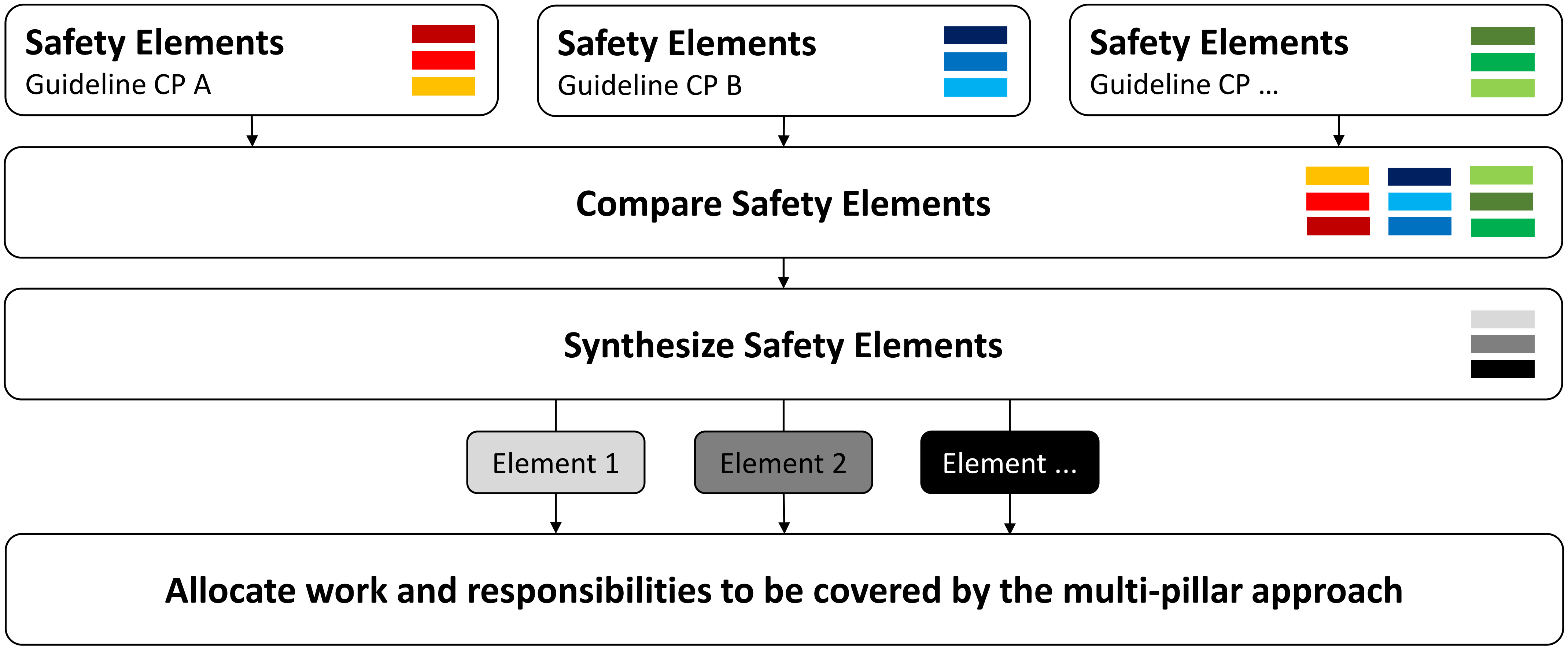

→ **Some general safety-frameworks on national level are already available. They are not design-restrictive and could be further explored for regulatory use at UNECE**

→ **Shared global understanding of safety elements endeavored by OICA/AAPC**

Back-Up

References

This presentation is based on

- ECE/TRANS/WP.29/GRVA/2019/13
- GRVA-02-09
- and on several documents that OICA submitted under the activities of WP.29 IWG ITS/AD and under the former TF AutoVeh including its subgroups 1 and 2:

- ITS_AD-12-11
- ITS_AD-13-05-Rev1
- ITS_AD-14-07

- TFAV-02-05
- TFAV-SG1-01-02
- TFAV-SG1-01-03
- TFAV-SG1-01-04
- TFAV-SG1-01-05
- TFAV-SG2-01-02

- TFAV-SG1-02-08
- TFAV-SG2-02-07

-SG1-03-10