

DIFFERENT APPROACHES TO THE NEW REGULATORY CHALLENGES FOR CONNECTED AND AUTOMATED VEHICLES (CAV)

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ABSTRACT

Automated Driving (AD) is foreseen to be one of the major social and technological challenges in the coming years. Many manufacturers are developing new models with cutting-edge functionalities, which are not included in the scope of the current regulatory framework. Apart from demonstrating their know-how and expertise on AD, their willingness to sell their AD models in the European market is accelerating the rule-making system. However, what is the roadmap for the European regulatory framework? Policy makers and regulatory bodies are pushing their boundaries at all levels (national and international) in order to introduce modifications in existing regulations. These regulations will enable the introduction of these new functionalities into the market. Without decreasing the standards of safety and security, the implementation of a clear and harmonized regulatory framework and approval process is extremely necessary.

The last amendments of the UN Regulation n°79 related to steering equipment or the creation of new standards such as the ISO 21448 regarding Safety and Intended Functionality (SOTIF) are examples of recent efforts from the regulatory bodies to achieve this goal. The aim of this paper is to show the state of the art of the regulatory framework regarding automated driving. In order to provide a thorough understanding of the forthcoming amendments and new standards, the different challenges that the European Commission (EC) / United Nations Economic Commission for Europe (UNECE) are facing will be analysed, as well as the different approaches to be considered by the international regulatory bodies.

Finally, as a result of this research, the conclusions will be presented as considerations and proposals for all players involved in this change of paradigm: users, manufacturers, approval authorities and technical services.

INTRODUCTION

The deployment of new advanced technologies and new needs in our society is resulting in a change of paradigm when talking about transport modes. This change of paradigm is resulting in new vehicle concepts, new business cases and new propulsion technologies. Nowadays, all manufacturers are developing models with more advanced functionalities, moving forward to more highly automated vehicles. New actors are also involved in these new vehicle concepts in order to provide highly automated or even autonomous vehicle prototypes.

However, the current European Regulatory Framework does not permit the deployment of highly automated and autonomous cars because its regulations are not totally adapted to the new technologies and functionalities that are being introduced in their new prototypes. Differently from other regions in the world, in Europe vehicles must fulfill a list of particular regulations depending on their category before being commercialized. Through type-approving a particular vehicle, its safety and reliability are ensured.

In particular, regulations are being created and modified following a specific procedure in the discussion groups of the United Nations European Commission for Europe (UNECE), in Geneva, and the European Commission (EC), in Brussels.

Discussion groups

Discussion groups are groups of representatives from the Member States and experts from organizations and stakeholders. They meet periodically and when a specific subject needs more focus, smaller or specific groups are created in order to deal with it during a specific period of time. Several groups have been discussing autonomous driving, agreements on vehicle characteristics and rules for road traffic. Some are regulatory groups which are

continuously improving their agreements, while others are discussion groups looking for the implementation of new technologies in the official rules.

Although both organizations, UNECE and EC, have a similar procedure of regulatory making, their structure and methodology strategies differ.

UNECE - Geneva: At the UNECE, the Transport Division holds the Inland Transport Committee which is in charge of road, rail and river transport. The Inland Transport Committee is organized in subsidiary bodies known as Working Parties (WP). Each WP deals with a specific subject; e.g. WP.1 is the Global Forum for Road Traffic and WP.29 is the World Forum for Harmonization of Vehicle Regulations. This last one is working on the adaptation and/or creation of regulations in order to enable the introduction of innovative technologies in the vehicle. The main goal is to make vehicles safer and more environmentally sound. Figure 1 below shows the structure of the UNECE.

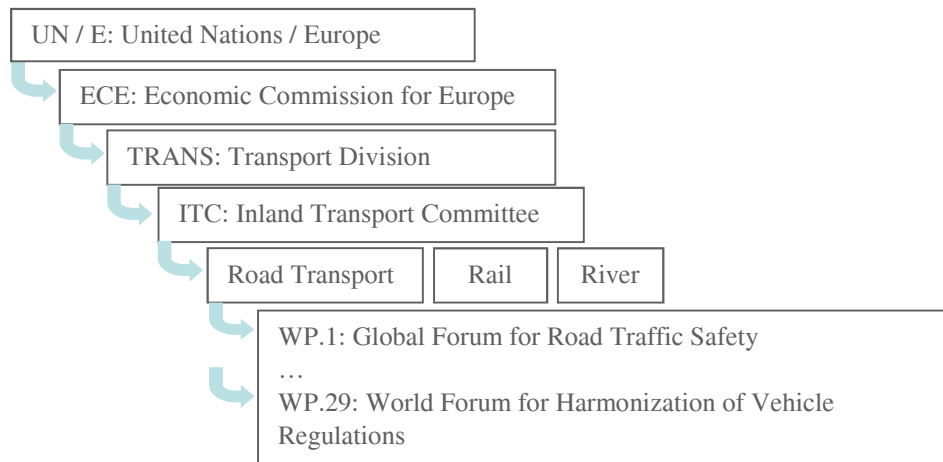


Figure 1. UNECE structure

European Commission – Brussels: In April 2016, 28 EU transport ministers signed the Declaration of Amsterdam, where all parties agreed the next necessary steps for the development of self-driving technologies. In the Amsterdam Declaration it is acknowledged that connected and automated vehicle technologies offer great potential to improve road safety, traffic flows and the overall efficiency and environmental performance of the transport system [1].

In this Declaration, actions needed to be done by the EU are outlined and described. These actions are grouped into four main pillars and are identified as follows:

- Development of a shared European strategy on connected and automated driving while strengthening the links between existing platforms such as the Cooperative Intelligent Transport Systems Platform (C-ITS), Gear 2030 and the Round Table on Connected and Automated Driving
- Continuation of the C-ITS platform for the deployment of interoperable C-ITS in the EU
- Review of the EU regulatory framework to support the development and use of automated and connected driving
- Development of a coordinated approach towards research and innovation activities in the field of connected and automated driving. As an example, at the Digital Day in Rome on March 2017, European countries signed a Letter of Intent to further intensify their cooperation on cross-border testing of automated road transport. Such cross-border tests will notably build on pilot projects funded under Horizon 2020

Cooperative Intelligent Transport Systems (C-ITS) Platform, created in early 2014, is a group that involves national authorities, C-ITS stakeholders and the Commission. Its objective was to develop a shared vision on the interoperable deployment of cooperative ITS in the EU. C-ITS allows road users and traffic managers to share information, “communicating” between them, and use it to coordinate their actions. In addition to what drivers can immediately see around them, and what vehicle sensors can detect, all parts of the transport system are thus able to share information.

The outcome of the C-ITS feeds the discussions held in the GEAR 2030 High level group on highly-automated vehicles. This high-level group was launched on January 2016 by the European Commission to ensure a coordinated approach and to address the challenges faced by the European automotive industry.

Its purpose is to build political support in order to help the automotive industry to quickly adapt to challenges from globalization, changing mobility patterns, digitalization, and environmental expectations, gathering industry and NGOs (CEOs level) and policy makers (Ministers and relevant Commissioners). Their work focuses on the adaptation of the value chain to new global challenges, automated and connected vehicles, and international harmonization and global competitiveness.

One of the most important actions taken by the GEAR 2030 group is the revision of the current legislation to enable autonomous driving. One of the conclusions of its final report submitted at the end of 2017 [2] was the revision by the Member States of their national traffic rules systems and the reporting in order to support converging approaches across the EU. Also, in this report, it was concluded that all Member States should confirm in the UNECE that the 1949 Geneva Convention and the 1968 Vienna Convention on Road Traffic were compatible with the safe use of automated vehicles with a driver expected by 2020 (level 3 and 4).

More recently, at the end of 2018, the Commission (in particular DG JRC and DG GROW) held the 1st Technical Workshop on new approaches for AD vehicle certification. The objective was to join Industry, Technical Services and Approval Authorities, so as to define a common strategy for the Safety Assessment of Automated Vehicles. The definition of this strategy will be continued in its 2nd workshop on March 2019.

UPCOMING CHALLENGES FOR REGULATORY BODIES

Historically, the UNECE Agreement on 1958, concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, and the EU Directive 70/156/EEC on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers (later derogated by the Directive 2007/46 first and Regulation (EU) 2018/858 later), set the regulatory framework and the basis for the type-approval process as it is known nowadays.

For a Technical Service, and for a homologation engineer in particular, the task of type-approving a vehicle or component has always been a clear and unambiguous activity. Nevertheless, manufacturers are including more and more advanced systems in their vehicles, sometimes out of the scope of the regulations. This leads to an increasing responsibility for the person signing a homologation because the decision to sign or not sign is not as evident as always.

From a Technical Service’s point of view, a group of “Main Challenges” have been identified. These challenges are being faced by policy makers and regulatory bodies, and current discussions held in WP.29 turn around the topics presented in the sections described below.

Challenge 1 – The time scale of legislation procedure and restructuring

The groups of experts such as the GRRF have been actively working on the creation of new proposals for regulations according to the recommendations received from the ITS/AD informal group of the WP.29.

These two groups have always been working in coordination, but the introduction of new players with disruptive technologies has increased the gap between their evolutions in time. While regulatory bodies have always evolved at a constant pace, traditional manufacturers and new player technologies are increasing their complexity exponentially.

This acceleration has led to the creation of dedicated task forces and specific working groups in the UNECE WP29 structure (see Figure 2). The GRVA “Groupe Rapporteur pour Véhicules Autonomes” (*Groups of Experts on Automated Driving*) was created in June 2018, mainly focused on encompassing activities for automated, autonomous and connected vehicles. Even though there was an Informal Working Group on Intelligent Transport Systems-Automated Driving (IWG ITS/AD), the resources were not enough to respond to the current market needs. For this reason, the organization took this decision and convened its 1st meeting on September 2018. These changes, promoted by the international regulatory bodies, were clear evidence of the willingness to adapt their structure to a more appropriate one according to the current automotive sector.

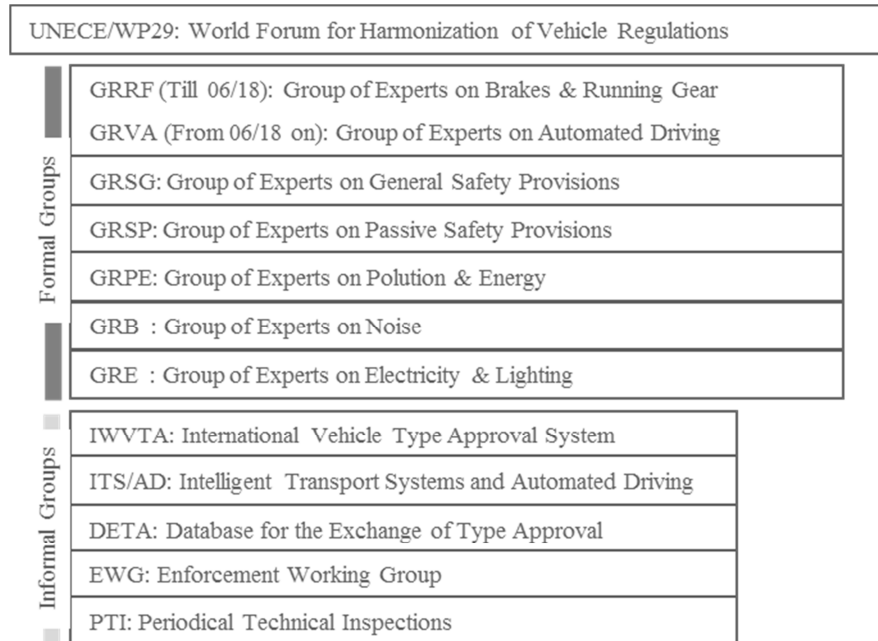


Figure 2 WP.29 Structure

For example, in order to deal with the new functionalities of the steering equipment, an informal group belonging to the GRRF was created in 2015. This informal working group was named the Automatically Commanded Steering Function (ACSF) working group.

Since its creation, the UN Regulation No. 79, dedicated to steering equipment, has been amended several times. In October 2017, the 2nd series of amendments came into force. This series brought new regulation concepts such as the division of automatically commanded steering functions into categories (A, B1, B2, C, D and E), depending on their level automatization and/or the introduction of the Corrective Steering Function (CSF). As the 2nd series only regulated the functions of category A and B1, the policy makers started working on new amendments. For this reason, a new series of amendments came out in 2018. The 3rd series of amendments will entry into force in new type approvals on 1st September 2019, bringing into place legislation functions of category C, a specific CEL in Annex 6 and the introduction of the Emergency Steering Function (ESF). Figure 3 below shows the main introductions of each series of amendments.

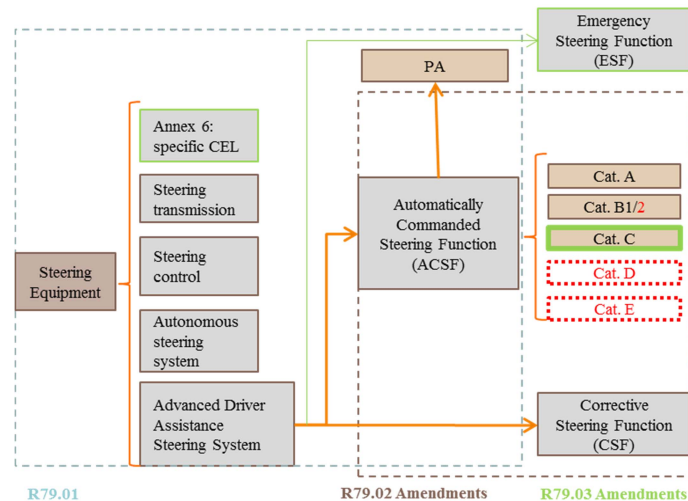


Figure 3 Series of amendments of UN Regulation 79

In last ACSF meeting, held in January 2019 in Hangzhou [3], a proposal for Technical Requirements for an Automated Lane Keeping System was submitted. This new regulation should address the technical requirements for SAE Level 3 vehicles. According to the National Highway Traffic Safety Administration (NHTSA), SAE level 3 represents Conditional Automation, which means that the driver is a necessity, but is not required to monitor the environment. The driver must always be ready to take control of the vehicle with notice [4].

Challenge 2 – Time scale of the type-approval process

The current type-approval process consists of several predefined and standardized steps where the length of these steps is well known. Depending on the manufacturer and the workload of the technical services, this duration might change but, in the long term, it can be considered a steady process. This means that if the manufacturer is planning a new model release, the homologation process is a phase of about 6 months and they can schedule it in their plan.

This traditional process is divided into five primary phases or steps: technical documentation receipt, definition of the worst case to be tested, prototype receipt, tests performance and report drafting to get the certificate from the ministry.

However, with the upcoming change of paradigm, more stages will be incorporated to the type-approval process including new phases and aspects such as ISO 26262 for functional safety of electrical or electronic systems, Cyber-Security and Over the Air updates monitoring, simulations, among others. The introduction of more phases will increase the whole duration of the process.

This process will be reduced once the process is optimized (ISO 26262 for instance, could be shared between models) so some stages could be shared for the same manufacturer.

Determining how long the whole process is going to take is still unknown. That is why, it is important for manufacturers to consider this time factor when planning to launch their product on the market.

Challenge 3 – The role of the driver

The role of the “driver” as known nowadays is under discussion. According to the Convention on Road Traffic of Vienna of 1968 [5], the concept “driver” is defined as *any person who drives a motor vehicle or other vehicle (including a cycle), or who guides cattle, singly or in herds, or flocks, or draught, pack or saddle animals on a road.*

Nowadays, it is compulsory to get a driving license to drive a motor vehicle, which is granted by the traffic authority of each country. In the case of Europe, the driving license enables you to drive through any Member State of the European Union.

However, the upcoming change in AD vehicles is the new role of the “driver” or, preferably, the lack of it. Instead of drivers, experts are using other expressions like users or operators. So, one could think that if no one is in control of the vehicle, there is no need to own a driving license to use it. But, somehow, it must be ensured that the vehicle fulfils the road traffic rules and understands the signals or daily life events on the road such as road works, heavy rain, the approach to a flock of sheep, etc.

Experts are considering new ways to ensure that the vehicle fulfils and understands the general traffic laws. This consideration or proposals are further detailed in the chapter *Considerations and proposals to certificate the vehicles of the future* (page 8).

Challenge 4 – The gap between technology and legislation

The current applicable Directive 2007/46/EC [6] includes an article that specifies the requirements for type-approval exemptions; *Article n° 20 Exemptions for new technologies or new concept*, where Member States may, on application by the manufacturer, grant an EC type-approval in respect of a type of system, component or separate technical unit that incorporates technologies or concepts which are incompatible with one or more regulatory acts listed in Part I of Annex IV of the mentioned Directive.

This means that if a manufacturer has a model which does not fulfil one of the regulations necessary to grant a type approval, they can use this Article 20 as an alternative.

Member States may issue a temporary approval valid only in its territory, providing the following information to the Commission and other states:

- The reasons why the technologies or concepts in question make the system incompatible with the requirements
- A description of the safety and environmental considerations concerned, and the measures taken
- A description of the tests, including their results, demonstrating that, by comparison with the requirements from which exemption is sought, at least an equivalent level of safety and environmental protection is ensured

Published on May 2018, the new Regulation (EU) 2018/858 [7], has adopted this article in Article 39 and it will enter into force on 2021.

However, the forthcoming vehicle technologies cannot be considered as exemptions themselves, regulations will have to evolve in order to overcome their actual limitations.

Challenge 5 – Societal acceptance of the “unknown” level of risk

The number of accidents in developed countries has been decreasing in recent years. According to the Eurostat, there were 50 road traffic victims in total per million inhabitants in the EU Members [8].

The defenders of AD vehicle deployment argue that the introduction of AD vehicles in the vehicle park will lead to a reduction of traffic fatalities. The even more optimistic claim is that it is the only plausible strategy to get to zero traffic fatalities.

Although the long-term benefits of AD are unquestionable and probably true, experience has shown that it is not plausible to prevent accidents during the implementation process. For this reason, even if the final objective is to get zero fatalities, the way to achieve this goal is not clear. It depends on the society and institutions to declare the number of fatalities that can be accepted and in which period. The level of exigency of society will impose the complexity or number of regulations regarding AD legislation.

If the authorities decide to accept a temporary increase in road fatalities before achieving the turning point; they will also have to establish a limit in terms of time and number of accidents/fatalities.

Challenge 6 – Change of paradigm in passive safety

One of the remarkable changes that will be introduced is the concept of “living mode”. This new method of transport will replace the existing “transport mode” by creating new experiences while being in a vehicle.

Using the phone, sleeping or even writing emails while going to work or on holiday will be a reality in the near future. But, even if road fatalities are supposed to tend to zero, the safety of vehicle users cannot be decreased. This means that manufacturers will have to include new passive safety systems. Airbags, seat belts, head supports, etc. will have to be redesigned and redefined.

In addition, it will be necessary to do new research into human injuries in case of accident. The main reason is that passengers will be able to “sit” in new positions adopting postures that could lead to more harmful injuries if an accident occurs.

In parallel, other systems such as lighting and signalling will need to be adapted. The International Automotive Lighting and Light Signalling Expert Group, named GTB, presented in the last GRE meeting the signalling requirements for automated and autonomous. Their objective is to take this opportunity to consider a global solution, instead of letting national authorities reach their own conclusions. For this reason, in last GRE they proposed to create a Special Interest Group to deal with this in conjunction with other stakeholders.

Challenge 7 – Dealing with disruptive transitions

A key factor to guarantee the success of the deployment of AD vehicles in the current traffic network is the management of the transition period. AD vehicles, standard cars, buses, trucks, pedestrians and other multiple vehicles and modes of transport will cohabit on the roads.

Although this transition will wake up public opinion and generate controversy, this is not the first transition seen in the cities. Not so many years ago, people experienced the transition from horses to cars. The late 19th and early 20th centuries were actually the age of streetcars. In the US, for example, the first cars appeared between 1920 and 1939 and their presence increased very fast leading to changes in the transport infrastructure and network.

However, is it possible to predict how many years take to replace the worldwide car fleet? In 2016, there were around 88 million passenger cars and light commercial vehicles sold worldwide, according to the study “National car data” presented by Macquarie Research in January 2017 [9]. According to the automotive trade journal Ward’s Auto, it is estimated that by 2035 a record of 2 billion cars will be beaten. Considering these two factors, it can be easily estimated that it would take, at least, 23 years to fully replace the car fleet, considering only passenger car and light commercial vehicles.

This means that, even if the trends are met and there is not any unexpected event, AD vehicles will have to live together with all other transport modes without causing a catastrophe.

Challenge 8 – User awareness of new technologies

Linked to the societal acceptance of AD vehicles, another challenge for AD manufacturers are societal awareness of the technology.

Even if new generations (known as Gen Z, iGen or Centennials) are very used to disruptive technologies, AD vehicles are supposed to be available to everyone. This means that it is necessary to make sure that all drivers, the new ones and the existing ones, understand well all functionalities.

In addition, it is not enough to ensure that the user knows what a particular functionality does. It is important to make sure that this person clearly knows the limits of the system and he/she is aware of his/her responsibilities. For instance, if someone is using a functionality of SAE 3, that can be activated or deactivated, it must be clear when the vehicle must be under the control of the driver and who is the ultimately responsible in each mode of use.

A misuse caused by misunderstandings or unawareness of the technologies used in the roads can easily lead to accidents and fatalities that must be avoided.

Challenge 9 – Cyber-security and planned obsolescence

It is widely held that certain gadgets, cars and other devices have deliberately short lifespans. This is known as planned obsolescence. In smartphones, for example, the software updates are usually only available for the latest versions, which force the user to buy a new model of smartphone. As a result, manufacturers can sell more units and increase their sales. This situation could be transposed to vehicles. Instead of having a car that can run for more than 30 years, new vehicles could include systems that become obsolete after a limited period or use.

On the other hand, cyber-security is an issue that highly concerns the international regulatory bodies. Today, cybersecurity is present in everyone's life. In the automotive sector, as ADAS depends on an array of electronics, sensors, etc., these systems could lead to safety risks to passengers and other pedestrians if a minimum high standard of security and safety is not guaranteed.

Since December 2016, a new Task Force on Cyber Security and Over The Air issues was created. At the end of 2018, the Test Phase for draft UN Regulation on Cyber Security and Software Updates was presented. The aim of this "test phase" is to provide some guidelines on how to assess the regulatory requirements and verify the effectiveness of the regulation while verifying at the same time that Approval Authorities and Technical Service are able to reach the same conclusions based on identical OEM documentation [10].

Challenge 10 – Adaptation of the vehicle life cycle

Considering the standard cycle of a vehicle in Europe, this is basically divided into the following phases: initial assessment, homologation and authorization, Conformity of Production (COP), in-use compliance and Product Technical Inspection (PTI). With the new Regulation (EU) 2018/858 [7] new priority focus has been pointed out: Market Surveillance (MS) and Continuous Technical Inspection (CTI).

Since September 2015, when the Diesel gate scandal came out, market surveillance has become essential to avoid more cases like this one.

Furthermore, the fact that software updates and communications between the vehicle and other agents (V2X, V2V, V2I) will probably be over the air, approval authorities and policy experts consider it is important to have a CTI to authorize manufacturers to modify the vehicle software after approval.

CONSIDERATIONS AND PROPOSALS TO APPROVE THE VEHICLES OF THE FUTURE

Nowadays, five approaches are being considered to face the future of the homologation process. These five proposals are:

1. Classic homologation: Where a limited number of relevant test cases are selected, respecting the criteria of representativeness, repeatability and statistical relevance. These tests are supposed to be performed in proving grounds at the Technical Services, and according to all the vehicle regulations.
2. Real-world test drive: In this case, two different approaches can be chosen; through mileage validation or through the "digital driving license" concept. On the one hand, the mileage validation process is based on the idea that the vehicle is considered approved if it drives "X" kilometres without accidents. On the other hand, the digital driving license is based on the concept that the vehicle should be approved if it is able to pass a certain circuit that is representative of the real world. While the first process' limitation is clearly its expensiveness in terms of time and costs, the drawback of the second option is the difficulty of choosing a relevant representative circuit for the vehicle.
3. Simulation: This method enables to virtually test a very extensive list of test cases in a short period of time. Although programming the scenarios can be very expensive in terms of time and costs, once they are created the exploitation of the scenarios will help reduce time and cost validation.

4. Audit – Process oriented: The audit can be at three different levels: organizational, quality and assessment. The first one, the organizational audit, ensures that the vehicle manufacturer developing team is organized according to functional safety standards. The second one, the quality audit, guarantees that the AD function that is being validated has been developed according to ISO 26262, which sets the functional safety standards minimizing the safety risks due to malfunction of the vehicle hardware/software functions. The third one, the assessment, guarantees that the functional safety has been correctly considered in the function development.
5. Manufacturer declaration: Last but not least is to trust the vehicle manufacturer by means of a “manufacturer declaration” or “self-certification”. This way to proceed is the one used in some countries such as the US to certify the vehicles sold in their country.

According to the International Organization of Motor Vehicle Manufacturer (OICA) [11], automated and autonomous vehicles will need to follow a “Multi-Pillar” certification approach. Due to the difference in the scenario probability of occurrence in real-world traffic, an assessment considering only one approach (for instance Real World Test Drive) would imply to test the “typical” traffic scenarios. Thus, more critical scenarios would not be tested. Each approach has pros and cons and, probably, there is not a correct unique solution, but a combination of all the previous.

CONCLUSIONS

Until 2018, the homologation process has been clear and unambiguous. Signature decision was a consequence of an objective procedure. But, from now on, with the deployment of AD vehicles, their technologies and the huge number of functionalities and scenarios to be tested make the traditional validation process unaffordable in cost and time.

For this reason, five approaches will have to be considered all together: classic homologation, real-world test drive, simulation, manufacturer declaration and audit. In combination or not, the decision of how AD vehicles will be approved will be crucial for the proper deployment of these vehicles.

In overall terms, AD vehicles will bring a change of paradigm with lots of new challenges that all players (rule-makers, approval authorities, Technical Services, manufacturers and users) will have to solve in cooperation. Rule-makers will have to establish clear and objective procedures and prescription to avoid grounds of flexible interpretation. Approval authorities will have to define clear and harmonized designation rules and homologation processes, including COP and audit requirements. Technical Services must be technically competent and strictly follow rules and procedures. Manufacturers will have to present their prototypes, solutions and information in a way compatible with homologation. And users, even if for the moment they are not playing an active role, will have to cooperate to guarantee that the technology is not misused.

It seems that first steps have already been done to coordinate all players and come out with results in the near future. The reorganization of the WP.29 creating the GRVA working group on AD and the release of the new Regulation (EU) 2018/858 on Type Approval are clear examples of the efforts that international bodies are making to promote the proper deployment of automated driving vehicles on the roads worldwide.

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