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White Paper

Filling Legislative Gaps in Automated Vehicles

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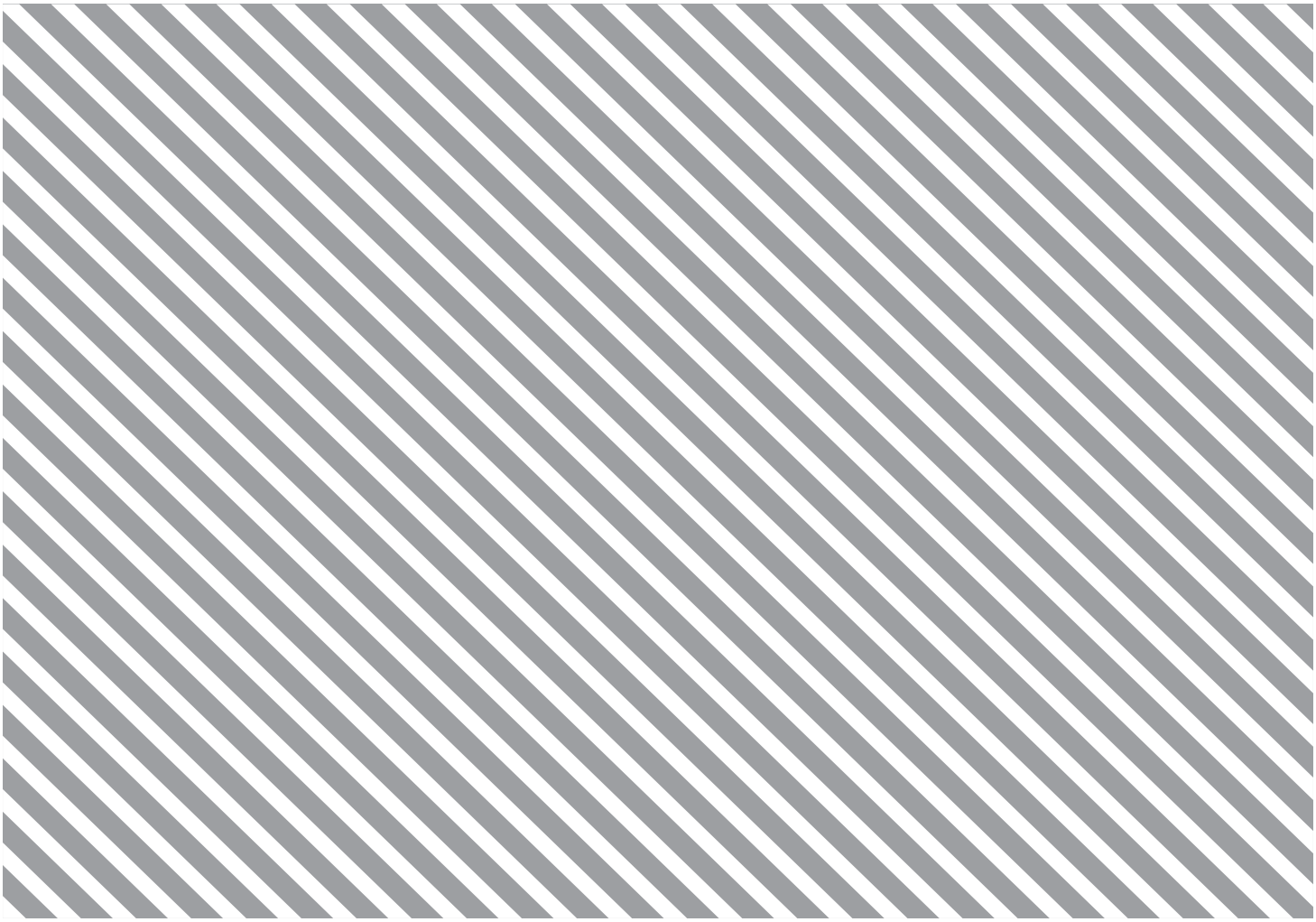

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Executive summary

An automated vehicle (AV) is one of the most critical components in the Fourth Industrial Revolution. Advances in the development of automated driving systems (ADS), which can replace a human driver in the future, are expected to bring about a safer and more efficient society where diverse social issues can be addressed. The National Highway Traffic Safety Administration (NHTSA) has pointed out four benefits communities can expect from the advancement of this technology:[1]

- **Safety**: The fact that 94% of crashes are attributed to human error[2] implies the potential to save lives and reduce serious injuries in that specific features of ADS are expected to remove human error. Given that more than 37,133 people died in motor vehicle-related crashes in the United States in 2017,[3] the lifesaving benefits of AVs are predominant.

- **Economic and societal benefits**: The widespread adoption of AVs could result in additional economic and societal benefits. According to the NHTSA study, motor vehicle crashes in 2010 cost $242 billion in economic activity, including $57.6 billion in lost workplace productivity, and $594 billion due to loss of life and deteriorated quality of life due to injuries.[4] Decreasing the number of motor vehicle crashes could reduce these costs.

- **Efficiency and convenience**: AVs may be more conducive to smoother traffic flow and relieve road congestion, thus freeing up time dedicated to driving. NHTSA estimates that Americans wasted 6.9 billion hours and 3.1 billion gallons of fuel in traffic delays in 2014.[5] With AVs, the time and expenses previously spent commuting could be put to better use.

- **Mobility**: AVs' driver-assistance features and potential to run without a driver behind the wheel could help most of the vulnerable people in communities to have new mobility options, hence improving the quality of their lives and possibly opening up new job opportunities. Taking into account the fact that 49 million Americans are over 65[6] and 61 million have some form of disability,[7] the expected benefits of AVs are paramount.

In recent years, manufacturers have been deploying technologies that form the basis of AVs in their commercially available vehicles. For instance, research by the Ministry of Land, Infrastructure, Transportation and Tourism of Japan (MLIT) has revealed that 66.2% of new passenger vehicles sold in Japan in 2016 already include automatic braking systems that could mitigate harm or even help avoid collisions.[8] Tesla's Autopilot automatically adjusts the speed of a vehicle to maintain distance between it and the vehicle in front of it. The feature also guides the vehicle to lanes where the traffic is moving more smoothly.[9]

In addition, many AV companies have been conducting AV testing on public roads aimed at the development of more advanced ADS that currently are not in practical use. For example, the American Automobile Association (AAA) has announced that "Free Self-Driving Shuttle" has successfully transported more than 32,000 passengers since its launch.[10] Waymo, Alphabet's self-driving technology subsidiary, also announced in 2018 that it would launch a self-driving ride-sharing service "Waymo-One",[11] and that it has already achieved a total distance of 10 million miles in its AV testing programme on public roads.[12] Moreover, miles driven in AV testing in California significantly increased from about 500,000 miles in 2017 to more than 2,000,000 miles in 2018.[13]

Meanwhile, serious accidents caused by AVs have posed significant questions to society. Uber's automated driving test car killed a 49-year-old woman who tried to cross the road in Tempe, Arizona, in March 2018,[14] and, in the same month, a driver using Tesla's Autopilot crashed with a median strip on a highway in Mountain View, California, which caused the driver's death.[15] Just a month after these cases, AAA's survey in May 2018 revealed a decrease in the social acceptance of AVs, where 73% of 1,014 respondents expressed unease about riding in AVs, which was a 10% increase from the previous year.[16] On the practical side, growing scepticism about AV safety eventually pressured several AV companies into temporarily halting AV testing on public roads[17] and possibly affected the Senate's opposing the AV START Act. The bill aims to establish regulations for the development of ADS in the US and has yet to pass the Senate.[18]

Thus, it is critical to promote social acceptance by addressing not only technical aspects such as enhancing AV safety but also non-technical aspects such as educating consumers on the function and limitation of ADS, securing a solid legal basis for AVs in line with the technological progress and clarifying responsibility and liability. To promote meaningful dialogue, this White Paper provides an overview of recent legislative trends and explores possible challenges the community pursuing AVs' deployment will have to address, particularly by focusing on the non-technological aspects.

International endeavours in road traffic law

Overview

The ultimate goal in the race to develop ADS may be to achieve Level 5, a fully AV. Level 5 would dramatically change the role of the human in vehicle transport. In the course of reaching Level 5, ADS could take over more driving tasks from human drivers, replacing them accordingly. For this reason, it can be presumed that each state should amend existing provisions regarding drivers' obligations and responsibilities, permitting and licensing to legalize AV operations.[19]

Understanding provisions of the international conventions regarding automobiles and international endeavours to adapt ADS is critical for all the stakeholders for two reasons. First, most countries that are keen to develop ADS are the ratified parties of international treaties which are considered to be higher norm than national law.[20] Accordingly, domestic legislation in each country may be required to conform to the respective part of the international agreements. Second, it is necessary to have unified principles in municipal law of each jurisdiction due to automobiles being internationally traded products. Exacerbating the need for harmonization is the progress of globalization which has intensified the free flow of people and goods.[21]

Structure

The international conventions that have set out the universal principles for operating a car on public roads are the Geneva Convention on Road Traffic, which has been ratified by 98 parties,[22] and the Vienna Convention on Road Traffic, which has been ratified by 78 parties.[23] International endeavours for the adaptation of these treaties to new technologies, including ADS, have been led by the Inland Transport Committee (ITC) of the United Nations Economic Commission for Europe (UNECE).[24] Under this committee, the Global Forum for Road Traffic Safety (WP1) has been deliberating how to adapt the conventions to allow the use of AVs,[25] while the World Forum for the Harmonization of Vehicle Regulation (WP29) has been developing technical safety standards for AVs.[26] Although it is critical to pay careful attention to the progress of both working groups, this White Paper is mentioning only WP1 so it can focus on the non-technical aspect of AV regulations.

Efforts toward harmonization

Both the Geneva Convention and the Vienna Convention stipulate that a driver must be present to operate a car and that the driver shall at all times control the vehicle.[27] For these provisions, it was considered that the adaptation of both treaties should require their amendment to allow the systems that could affect the control of the vehicle.[28] Consequently, WP1 adopted the proposed revision of the Vienna Convention in March 2014 to permit specific AVs when they meet the conditions where the system that can affect the control of the car conforms to the international standards or a driver can forcibly take control of the car or switch off the system,[29] which became effective in March 2016.[30] On the other hand, although WP1 adopted in March 2015 the same revision as part of the Vienna Convention to change the Geneva Convention,[31] the proposal has resulted in the rejection by contracting parties due to procedural and administrative difficulties.[32]

To break through this stagnant situation, WP1 had been deliberating on how to ensure consistencies between the two treaties. In March 2017, the Informal Working Group of Experts on Automated Driving (IWG-AD) submitted an informal document stating that WP1 could recognize the amendment to the Vienna Convention as a clarification of the existing article of the Geneva Convention,[33] thus enabling signatories to assume that both treaties are consistent. Concurrently, WP1 reached an agreement that it would start to create a "non-binding advisory instrument" dedicated to highly and fully AVs to "form the basis of an ancillary legal instrument in the medium term."[34]

Figure 1: Geneva Convention and Vienna Convention

	Geneva Convention on Road Traffic, 1949	Vienna Convention on Road Traffic, 1968
# of ratified parties	98	78
Provision	Article 8.1 Every Vehicle or combination of vehicles proceeding as a unit shall have a driver.	Article 8.1 Every moving vehicle or combination of vehicles shall have a driver.
	Article 8.5 Drivers shall at all times be able to control their vehicles or guide their animals. When approaching other road users, they shall take such precautions as may be required for the safety of the latter.	Article 8.5 Every driver shall at all times be able to control his vehicle or to guide his animals.
	Article 10 The driver of a vehicle shall at all times have its speed under control and shall drive in a reasonable and prudent manner. He shall slow down or stop whenever circumstances so require, and particularly when visibility is not good.	Article 13.1 Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all manoeuvres required of him. … He shall slow down and if necessary stop whenever circumstances so require, and particularly when visibility is not good.
Proposed amendment	Article 8.6, paragraph 1 Vehicle systems which influence the way vehicles are driven shall be deemed to be in conformity with paragraph 5 of this Article and with Article 10, when they are in conformity with the conditions of construction, fitting and utilization according to international legal instruments concerning wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles.	Article 8.5 bis, paragraph 1 Vehicle systems which influence the way vehicles are driven shall be deemed to be in conformity with paragraph 5 of this Article and with paragraph 1 of Article 13, when they are in conformity with the conditions of construction, fitting and utilization according to international legal instruments concerning wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles.
	Article 8.6, paragraph 2 Vehicle systems which influence the way vehicles are driven and are not in conformity with the aforementioned conditions of construction, fitting and utilization, shall be deemed to be in conformity with paragraph 5 of this Article and with Article 10, when such systems can be overridden or switched off by the driver.	Article 8.5 bis, paragraph 2 Vehicle systems which influence the way vehicles are driven and are not in conformity with the aforementioned conditions of construction, fitting and utilization, shall be deemed to be in conformity with paragraph 5 of this Article and with paragraph 1 of this Article 13, when such systems can be overridden or switched off by the driver.
Adoption	March 2015	March 2014
Enforcement	Rejected	March 2016

Source: United Nations Treaty Collection, *CHAPTER XI TRANSPORT AND COMMUNICATIONS B. Road Traffic, 1. Convention on Road Traffic Geneva, 19 September 1949*; *CHAPTER XI TRANSPORT AND COMMUNICATIONS B. Road Traffic, 19. Convention on Road Traffic Vienna, 8 November 1968*

Specific agreements

Besides the procedures, consideration to the adaptation of both treaties to particular ADS has also progressed at WP1. The mainly discussed areas can fall into three categories according to the nature of the respective ADS.

– **Highly AVs: the concept of activities other than driving**
WP1 has discussed whether a driver can or cannot engage in other activities than driving when the vehicle systems drive the vehicle since the current provision stipulates that a driver shall at all times control a vehicle appropriately.[35] Consequently, WP1 agreed on two principles for a driver to be able to carry out other activities than driving as long as:

"**Principle 1**: These activities do not prevent the driver from responding to demands from the vehicle systems for taking over the driving task; and
Principle 2: These activities are consistent with the prescribed use of the vehicle systems and their defined functions."[36]

These principles could supplement auxiliary interpretation to the existing provision to accommodate ADS where a driver may be able to distract his attention from driving and perform such activities as emailing and video-streaming, therefore mitigating the driver's burden to driving.[37] On the other hand, WP1 denied the need to build a list of other activities than driving and underscored the importance of further evidence-based research to provide more clarity in these principles.[38]

– **Remote operations**
WP1 agreed in March 2016 that no amendment to the Geneva Convention and the Vienna Convention is necessary for public testing of driverless cars when there exists a person who can take control of the vehicle whether this person may or may not be inside a car.[39] Although this agreement still requires a "driver", whether inside or outside a car, it has contributed to facilitating the development of driverless vehicles around the globe. Currently, WP1 is deliberating whether this provision should apply to general uses other than public testing.[40]

– **Fully AVs**
WP1 affirmed in September 2017 that the Geneva Convention and the Vienna Convention "apply to all driving situations except in situations where the vehicle is moved by vehicle systems without any role of the driver"[41] and agreed to create a "non-binding advisory instrument" dedicated to highly and fully AVs.[42] Therefore, WP1 adopted in September 2018 a non-binding document titled, "Global Forum for Road Traffic Safety (WP.1) Resolution on the deployment of highly and fully automated vehicles in road traffic."[43] This guidance provides for contracting parties of the two treaties a set of recommendations aiming to support the safe deployment of highly and fully AVs and encourages signatories to incorporate these recommendations into their domestic policy frameworks for road traffic in cooperation with civil society and industry.[44]

Challenges

Taking the rejection of the proposal to revise the Geneva Convention into account, WP1 has made progress in the attempt to adapt and harmonize both conventions to ADS by flexibly interpreting their current provisions. However, it has two issues. First, the question has remained unanswered whether both treaties have applied to driverless vehicles. In September 2018, France submitted an initial proposal to revise Article 8 in the Vienna Convention with the consideration that vehicles with Level 4 and Level 5 would not conform to the country's obligations under the Vienna Convention.[45] While some delegates supported France,[46] the UK stated that additive amendments were not necessary since it considered that both conventions have already granted the use of Level 4 and Level 5.[47] In this regard, it should be noted that differences in the views of each state may lead to delaying the formation of international consensus, stagnating national legislature in contracting parties. Second, allowing flexible interpretations may incentivize states to compromise harmonization and end up with the fragmentation of international regulatory frameworks. At WP1, Germany expresses concern about this regard and underscores the importance of aiming for harmonization.[48] This argument emphasizes the possibility that a patchwork of state laws may impede a widespread roll-out of the technology and restrict the potential to benefit civil society and industry.

Adaptation of domestic laws in road traffic

Overview

Taking into account that international conventions can bind domestic laws in respective parts,[49] contracting parties may hesitate to legalize AV operations based on their sole discretion, which causes delays in the domestic legislation. Additionally, although the needs of civil society and industry in each state should be respected, it is undesirable that the reasons and circumstances of each country could hinder the international efforts toward harmonization, which thus causes fragmentation.

One of the possible reasons why discrepancies in views toward conventional interpretations among states occur is that the path each country is pursuing to achieve full automation may differ state by state. While some of the stakeholders are seeking to improve driver-assistance systems installed in vehicles and gradually shift driving tasks from drivers to systems, some are endeavouring to operate driverless vehicles in a limited geographical area and progressively expand it to greater areas. The former strategy described as "something everywhere", and the latter described as "everything somewhere", may have respective priorities through full automation.[50]

Therefore, it is critical that the challenges of both strategies and the ways in which all stakeholders are to collaborate regardless of which approach they pursue are discussed. To promote dialogue, this White Paper tries to crystallize those challenges that stakeholders will face before long.

Definition of target

– **"Something everywhere" strategy**

This approach supposes that a driver is necessary, thus covering Level 3 and Level 4 (with a driver). Level 1 and Level 2 are out of the scope of this White Paper in that those systems are not capable of taking full control. Therefore, a driver must at all times engage in all driving tasks.

Level 3 systems still necessitate a driver for the following reasons. First, ADS can take full control of the vehicle only within the operational design domain (ODD). Thus, a driver must engage in all driving tasks as well as Level 1 and Level 2 if the vehicle is outside ODD. Second, even within ODD, ADS may request a driver to take over all driving tasks when the system encounters the scenarios that it cannot navigate.

Level 4 can be classified into two categories.[51] The first category, "Level 4 (with a driver)", assumes that ADS execute all driving tasks within ODD and that a driver takes full control of the vehicle outside ODD. For example, consider the case of a worker who owns a passenger car with Level 4 systems whose ODD defines full automation is effective only on freeways and uses this vehicle to commute from their home to the office. This case still requires a driver in that a driver must take full control of the vehicle on ordinary roads, from their home to the entrance of freeways, in urban areas, and from the exit of a freeway to the office.

The second category, "Level 4 (with no driver)", assumes that ADS execute all driving tasks within ODD and that the vehicle is used only within the ODD. For instance, consider the case that the City of San Francisco manages a self-driving bus service with Level 4 systems whose ODD defines full automation as valid only within the City of San Francisco, and this service is available only within the city. This case no longer requires a driver in that the bus is not expected to go outside the territories, thus allowing the assumption that all the people riding in the bus are passengers. Although ODD possibly includes not only geographical elements but also time and weather, it is beyond the scope of this White Paper.

– **"Everything somewhere" strategy**

This approach supposes that a driver is no longer necessary, thus covering Level 4 (with no driver) and Level 5.

The definition of Level 4 (with no driver) is as stated in the "something everywhere" strategy and Level 4 (with no driver) no longer requires a driver. Similarly, Level 5 does not either since it has no ODD definition and at all times engages in all driving tasks without any role for a driver.

What should also be noted in this context are "situations when a driver operates a vehicle from the outside of the vehicle",[52] described as "remote operation". Vehicles with remote operation capabilities seem to run without a driver but, in reality, a driver described as a "remote driver" engages in specific driving tasks from outside the vehicle. The classification of automation levels of remote operation explicitly depends on what driving task a remote driver must engage in; substantially, remote operation can be regarded as either of SAE levels.[53] WP1 agreed on allowing remote operation only in public testing,[54] and whether remote operation should be in general use is still under discussion.[55]

Discussion points

– **"Something everywhere" strategy**

– Clarification of "other activities than driving"

The two principles that WP1 agreed on hardly provide specific accounts for what activities a driver can engage in while the ADS take full control of the vehicle.[56] The clarification of other activities is critical because current domestic laws tend to prohibit a driver from carrying out activities that can distract their attention from driving such as holding a mobile phone.[57] For example, the informal document submitted to WP1 in May 2018 describes "potential examples" of other activities by classifying them into the three: "[u]se of the

vehicle infotainment system, ... , for other activities which are not related to the driving task,"; "[u]se of hand-held consumer electronic devices ... that are physically or electronically linked to the vehicle infotainment system,"; and "use of hand-held consumer electronic devices ... that are not linked to the car infotainment system and reading."[58]

However, it is still not clear what other activities deliver safe conditions in which a driver can sustain attention and have enough time to react to the request from the systems to take over full control of the vehicle. In this regard, it should also be noted that Level 3 and Level 4 (with a driver) may involve different situations, frequency and urgency in the takeover. The informal document at WP1 stresses the necessity of conducting further studies, researches and experiments regarding technical elements including human-machine-interface "to identify what activities can be done safely."[59]

– Clarification of driver's obligations

Current domestic laws impose on a driver who violates traffic rules such penalties as imprisonment, fines, suspension or revocation of their driver's licence and so forth. Given that vehicles with Level 3 and Level 4 (with a driver) allow a driver to engage in other activities than driving, the question remains whether a driver can entirely be exempted from the penalties when ADS take full control of the vehicle and violate traffic rules. If domestic laws impose these penalties on a driver due to violations that ADS commit, the driver would at all times be forced to monitor whether ADS comply with traffic rules for avoiding punishments, which mostly restricts other activities allowed to drivers. Conversely, if domestic laws excuse drivers' penalties by a violation committed by ADS, the question of who should be penalized would arise. At this point, it is still uncertain that ADS could at all times comply with traffic regulations, execute driving tasks, request takeovers and achieve minimal risk conditions. Hence, the possibility of a traffic violation by ADS should be taken into consideration.[60] In the same way, it is also necessary to consider how to ensure, in advance, the capability of ADS to take full control of vehicles with sufficient skill and knowledge to secure road safety since no such framework exists, while current domestic laws qualify a driver to do so through the acquisition of a driver license.[61]

– **"Everything somewhere" strategy**

– Clarification of "remote driver's" obligations

The remote operation that enables a driver to engage in driving tasks from outside vehicles is expected to play an influential role in filling technological and legislative gaps between driver-based operations and driverless operations on public roads. As long as a driver exists, no matter whether they are inside or outside the vehicle, stakeholders can assume that a remote driver shall engage in the same driving tasks as a driver behind the wheel.[62] However, this assumption may bring about another question of how regulators could identify remote drivers' obligations since almost all the remote operations may seem to be a driverless operation and what driving tasks a remote driver engages in may not be visible. For example, assuming that a driverless vehicle with a remote driver is running within the ODD, the remote driver would have to bear the same responsibility as Level 2 if they are at all times required to monitor the driving environment and execute an appropriate response.[63] In the same way, the remote driver would have to bear the responsibility of Level 3 if they are expected to take over full control of the vehicle when ADS request takeovers or the vehicle goes outside the ODD.[64] Conversely, current provisions of international conventions may not be able to regard a remote driver as a driver if the operation doesn't assign any driving tasks to the remote driver.[65] Thus, the unique nature of remote operations may blur the frame of obligations that either a driver or a system shall stand.

As an additional consideration, whether traffic laws should require a remote driver to be qualified by the same driving licence as a regular driver and to bear the same penalties, as well as how many vehicles a single remote driver can "drive," should also be addressed.

– Clarification of system's obligations

Theoretically, the system, at all times, engages in all driving tasks and no longer requires a human driver or even a remote driver at Level 4 (with no driver) and Level 5. Given that these levels of automation regard all the people inside the vehicle to be passengers, the question of who is responsible for the outcome of the driving by ADS should be answered. Additionally, as stated earlier, consideration of how to ensure the capability of ADS in advance instead of a driver licence is also necessary.

– **Additional implications**

As far as the driverless operation such as Level 4 (with no driver) or Level 5 is concerned, it may be difficult at this point to figure out appropriate solutions regarding the above-stated arguments. However, it is suggested that stakeholders co-design the direction towards the practical application of high or full automation over the interactive dialogue. For example, it may be possible that a state utilizes the governance framework for the authorization of public testing of ADS to new mobility services using driverless technologies since it is likely that, at the initial stage, corporations may operate this type of service within limited geographical areas rather than individuals owning driverless vehicles.[66] In this case, the ultimate entity to take full responsibility for full automation could be the corporation that operates the mobility service.

Notwithstanding the examples above, the transition from testing to the practical application of high or full automation may raise more complex and diverse arguments than this White Paper covers. Thus, promoting dialogue among stakeholders and learning from different initiatives in various contexts would be of great value in terms of legalizing AV operations.

Adaptation of liability framework in road traffic

Overview

Automobile liability frameworks vary state by state. The automobile liability frameworks of each country depend on their contexts in road traffic under, generally speaking, the civil law and related special laws. Although WP1 has been discussing driving tasks that could lead to a consideration of driver liability and system liability in AV contexts, some states participating in WP1 stress the importance of not working on liability issues in WP1.[67]

In spite of circumvention in the international discussion, careful consideration towards the frameworks of not only liability but also the relief of victims of automobile accidents is essential to nurture consumer acceptance of AVs.[68] Some of the automobile crashes caused by AVs indicate that even AVs may cause serious motor crashes, complicate the process of identifying the cause of the accident and thus pose significant risks to civil society. For instance, a 2015 Tesla Model S with a driver using Tesla Autopilot collided with a trailer at an uncontrolled intersection in Florida in May 2016, resulting in the driver's death.[69] NHTSA closed the preliminary investigation in January 2017 to conclude that it found no defects in the vehicle.[70]

This fatal accident suggests two critical issues. First, even an accident caused by a Level 2 AV required more than half a year for NHTSA to close the preliminary investigation, which indicates that more complexity of advanced ADS may lengthen the term to clarify the root cause of traffic accidents. Second, the victim of the automobile accident may not be compensated for the loss in the meantime, suffering unexpected financial difficulties and mental distress, therefore deteriorating consumer acceptance of AVs.

Notwithstanding the importance of the issue, aiming for the establishment of common automobile liability frameworks applicable to the majority of states would not be a pragmatic direction. Instead, it is suggested that stakeholders explore the possibility of adjusting current frameworks to the emergence of ADS by referring to other countries' governance frameworks and recent initiatives. To provide those opportunities broadly, this White Paper provides an overview of the automobile liability frameworks, the compulsory insurance systems and the future challenges of the focused countries.

Definition

To simplify the argument, this White Paper hypothetically defines that automobile liability applied to each level of AVs as falling into either of two categories. What is to be noted in considering the possible outcomes that AVs may bring in is mainly the latter, "system liability".

– **Driver liability**

At Level 1 and Level 2, a driver shall be liable to compensate for a loss caused to any other persons due to the supportive nature of these levels of AVs. At Level 3 and Level 4 (with a driver), a driver shall be liable to compensate for a loss caused to any other persons while the driver drives the vehicle.

– **System liability**

At Level 3 and Level 4 (with a driver), ADS shall be liable to compensate for a loss caused to any other persons while ADS drive the vehicle or driving tasks are taken over from the ADS to the driver. At Level 4 (with no driver) and Level 5, ADS shall be liable to compensate for a loss caused to any other persons. Since ADS are neither a natural person nor a judicial person that can legally compensate for a loss, this White Paper assumes that a manufacturer of a vehicle equipped with ADS shall be liable for system liability.

Negligence liability framework

– **Basic idea**

– Driver liability

The negligence liability framework usually evaluates driver liability under a negligence standard. A negligence standard primarily depends on a defendant's breaching a duty of reasonable care and the burden of proof is put on a plaintiff. In pursuit of driver liability under this framework, it is most likely that a victim of an automobile accident becomes a plaintiff and a driver of a vehicle becomes a defendant. For a victim to obtain compensation for a loss from a driver, the victim must prove that the driver breached the duty in operating their vehicle and caused the harm to the victim.

– System liability

Although a plaintiff can attempt system liability under a negligence standard, it is more practical for the plaintiff to do so under product liability laws. In pursuit of system liability under product liability laws, it is most likely that a victim of an automobile accident becomes a plaintiff and a manufacturer of a vehicle equipped with ADS becomes a defendant. Many countries adopt product liability laws to strengthen manufacturers' responsibility because the negligence liability framework requires a plaintiff to prove manufacturers' negligence by themselves, which is considered too demanding due to several reasons, such as the information gap between consumers and manufacturers. The product liability may be consumer-friendly in that a plaintiff doesn't need to prove manufacturers' negligence but only to prove the existence of product defects and the relationship between the flaws and the loss. Conversely, it may also be consumer-unfriendly in that the establishment of product defects in the vehicle with ADS that must use sophisticated technologies may be extremely challenging.

– **Focused countries and their insurance systems**

– US

All states in the US have automobile financial responsibility laws, which require people involved in a car accident to furnish proof of financial responsibility.[71] Under state auto insurance laws, most states oblige motor vehicle owners to purchase a minimum amount of automobile liability insurance for both bodily injuries and property damages to secure financial responsibility required by the laws.[72] Currently, 28 states adopt the negligence liability framework for the evaluation of automobile liability, while other states adopt "no-fault", "choice no-fault", or "add-on".[73]

– UK

The UK evaluates automobile liability under the negligence liability framework[74] and obligates motor vehicle owners to buy a minimum amount of automobile liability insurance for both bodily injuries and property damages under the Road Traffic Act.[75] As further action towards the adaptation of AVs, the UK government established in July 2018 the Automated and Electric Vehicle Act, which strengthens the function of automobile insurance and the obligation of insurance companies. Namely, the act obligates insurers that underwrite automobile liability insurance for AVs, as a primary measure for the relief of victims, to pay compensation for a loss caused to victims whether the liable party is specified or not, unless the condition doesn't meet the prescribed exceptions such as accidents resulting from unauthorized software alterations or failure to update software.[76]

Presumption of negligence liability framework

– **Basic idea**

– Driver liability

The presumption of negligence liability framework assumes that an act was negligent unless a person who made the action can prove by themselves that they were neither intentional nor negligent. Contrary to the negligence liability framework, the burden of proof is put on a defendant. In pursuing driver liability under this framework, it is most likely that a victim of an automobile accident becomes a plaintiff and a driver of a vehicle becomes a defendant. However, the victim no longer needs to prove the driver's negligence since they can obtain compensation for a loss from a driver unless the driver can successfully establish that they didn't fail to exercise a duty of reasonable care in operating the vehicle. In practice, proving this is so challenging that the defendant's attempt to avoid liability tends to fail.[77] Furthermore, some states that adopt the presumption of negligence liability framework impose on a defendant much stricter conditions for the proof.[78] Accordingly, the presumption of the negligence liability framework practically constitutes the no-fault liability.[79]

– System liability

Theoretically, attempts towards system liability under this framework may follow the same path as the one under the negligence liability framework since the definition of system liability of this White Paper doesn't assume the presence of liable drivers. For this reason, although the presumption of negligence liability framework transfers the burden of proof from a plaintiff to a defendant, it is most likely, as an explanatory idea, that a victim of an automobile accident becomes a plaintiff and a manufacturer of a vehicle equipped with ADS becomes a defendant. For a victim to obtain compensation for a loss, the victim needs to prove that defects existed in AVs and thus caused harm. Notwithstanding this explanatory idea, some states adopting this framework, such as Japan and Germany, tend to prescribe by laws broader concepts of liable persons than drivers, and thus the other persons than drivers can be a plaintiff in pursuit of system liability under product liability laws so that a victim can be relieved from the burden of proof.[80]

Furthermore, these countries also tend to impose on them much stricter conditions not allowing their exemption from liability by the existence of product defects.[81] Therefore, even in pursuit of system liability, the presumption of negligence liability framework tends to assume these particularly defined persons as a primarily liable party, enabling the prompt relief of victims even in the case that other parties shall ultimately be liable exist.

– **Focused countries and their insurance systems**

– Japan

Japan adopts the presumption of negligence liability framework and obligates motor vehicle owners to purchase compulsory automobile liability insurance covering bodily injuries by the Automobile Liability Security Act.[82] The provisions of the act transfer the burden of proof from the "victim" to the "person operating an automobile for his/her benefit",[83] which this White Paper calls "operator" for convenience. Since the concept of "operator" includes not only a driver but also an owner of a vehicle, the car owner could be liable to compensate for a loss caused to any other persons even if the owner did not drive the car.[84] For "operator" to avoid liability, the act requires "operator" to prove all three of the following conditions:

Condition 1: "Neither he/she nor the driver failed to exercise due diligence in operating the automobile."

Condition 2: "There was an intention or negligence on the part of the victim or a third party other than the driver."

Condition 3: "There was no structural defect or functional disorder in the automobile."[85]

Condition 3 requires "operator" to prove that no structural defects or functional disorder in the vehicle exist. If the vehicle has any defects or malfunctions, this means "operator" cannot be exempted from primary liability and obliged to compensate for a loss to sufferers. However, the act doesn't restrict "operator" attempting to identify

ultimately liable parties such as a manufacturer of a vehicle with ADS. For this reason, it is most likely that "operator" will claim compensation to car manufacturers after "operator" fulfils their duty to compensate for a loss to sufferers.

As part of the efforts towards the adaptation of automation, the Research Panel on Liability related to Automated Driving in MLIT concludes that the amendment of the Automobile Liability Security Act is not necessary for the practical application of Level 3 and Level 4 (with a driver).[86] However, a question remains whether the act should apply to Level 4 (with no driver) and Level 5. The Research Panel also stresses the necessity to reconsider this issue in line with the technological advancement of ADS.[87]

– Germany

Germany adopts the presumption of negligence liability framework by its road traffic law, "*Straßenverkehrsgesetz* (StVG)",[88] and it requires motor vehicle owners to buy a minimum amount of automobile liability insurance for bodily injuries and property damages through its compulsory insurance laws. The provisions of StVG transfer the burden of proof from the "victim" to "*halter*" (keeper), an owner of a vehicle, and a driver if the case meets conditions expressed in monetary thresholds (up to €5 million for bodily injuries and up to €1 million for property damage).[89] If the monetary amount goes over the thresholds, the negligence liability framework applies.[90] Under this framework, a driver could avoid liability if they succeeded in proving they didn't breach a duty of reasonable care in operating a vehicle, while "keeper" could only do so if an automobile accident occurred by force majeure.[91] Therefore, StVG imposes a stringent burden of proof on "keeper", thus constituting in fact a no-fault liability.

As an effort towards automation, Germany amended StVG in June 2017 that allows Level 3 AVs to run on public roads for the first time in the world. The amendment of StVG preserves the current liability framework of "keeper" and drivers,[92] while it doubles the number of monetary thresholds particularly for AVs to broaden the scope of StVG's application.[93]

Figure 2: Frameworks of automobile liability and compulsory insurance

		US (California)	UK	Japan	Germany
Legal Basis		Common Law	Automated and Electric Vehicles Act (2018)	Automobile Liability Security Act (1955)	Straßen-verkehrsgesetz (amended in 2017)
Automobile Liability Framework		Negligence	Negligence	Presumption of Negligence (In fact no-fault liability)	Presumption of Negligence (In fact no-fault liability)
Primarily Liable Parties	Driver Liability	Drivers	Drivers	Operators (Drivers)	Keepers (Drivers)
	System Liability	Manufacturers	Insurers (Ultimately manufacturers)	Operators (Ultimately manufacturers)	Keepers (Ultimately manufacturers)
Burden of Proof		Victims	Victims	Operators (Drivers)	Keepers (Drivers)
Compulsory Liability Insurance	Personal Death of injury	Required (min. amount of 15K USD)	Required (min. Amount of "unlimited")	Required (min. Amount of 30M JPY)	Required (min. Amount of 7.5M EUR)
	Property Damage	Required (min. amount of 5K USD)	Required (min. amount of 1M GBP)	Not Required	Required (min. amount of 1.22M EUR)

Source: Sompo Japan Nipponkoa Research Institute, Inc., *Trends in overseas*, 27 September 2017

Discussion points

– **Negligence liability framework**

– Increase of social costs

In pursuit of system liability, the increased number of lawsuits under product liability laws may increase social costs as a whole, offsetting expected societal benefits that AVs may bring. A highly specialized characteristic of ADS may complicate and burden the proof of product liability in courts from the viewpoint of a plaintiff as well as a defendant. On the plaintiff side, the plaintiff as a general consumer may have difficulties to prove defects of the vehicle with ADS by themselves and thus need tremendous support from not only lawyers but also other specialists such as technical experts who are familiar with the technologies used in AVs, all of whom should be paid. On the defendant side, car manufacturers may face a considerable number of claims from their users since it can be presumed that the more advanced ADS are, the more claims their users will file under product liability framework.

– Relief of victims

Complexity and specialization in the dispute over system liability about ADS may result in not only increased social costs but also prolonged resolution. One of the concerns about prolonged resolution involves the deterioration of consumer acceptance of AVs in that the plaintiff who suffers a loss caused by ADS may not be able to receive any compensation in the meantime. Generally, liability insurance shall not function as relief of victims if the insured is not responsible. Considering possible situations under system liability in AV contexts where drivers don't exist, and where owners who purchase automobile liability insurance are not responsible at all, the only measure that a plaintiff can take may be to pursue system liability against car manufacturers. To avoid this scenario, which may cause confusion in civil society, what is suggested is that the states adopting the negligence liability framework evaluate those risks and take appropriate measures towards the forthcoming AV era. In this regard, the UK's initiative that strengthens insurers' responsibility to save victims indicates one of the possible directions for the countries adopting the negligence liability framework to deliberate.

– **Presumption of negligence liability**

– Cost allocation

The presumption of negligence liability framework could bring about the prompt relief of victims even in pursuit of system liability in AV context. As stated, "operator" shall be primarily liable to compensate for a loss caused to victims in the Japanese framework as well as "keeper" in the German framework even in case product defects are recognized in the vehicle. Assuming that both countries decide to apply current frameworks to all levels of AVs to form in fact no-fault liability, victims will quickly be able to obtain compensation from either "operator" or "keeper." For the stabilization of this framework, consumer acceptance regarding the cost allocation may be essential since such persons determined by laws as "operator" or "keeper" have to bear primal social costs as an insurance premium. Currently, it may be acceptable for a motor vehicle owner as "operator" to bear an increased insurance premium at the renewal of insurance policy since the majority of automobile accidents are attributed to human error; in other words, driver liability. However, this logic may not be applied to system liability in AV context in the same way because human factors may no longer cause automobile crashes, and thus an AV owner may not be comfortable to take charge of the proportion of costs that other responsible parties may have to bear.

– Additional implication

The simplified illustrative assumption as mentioned in this White Paper is useful to clarify surrounding issues, while it sometimes blurs the landscape of the most significant argument that stakeholders have to tackle.

One of the critical questions is, who should be liable for automobile crashes caused by ADS? What is considered to be most likely will be to build judicial precedent in line with the proliferation of ADS. However, the highly specialized feature of ADS must complicate the process of product liability litigation, thus deteriorating consumer acceptance of this promising technology. To address this chicken-and-egg problem, further initiatives should be conducted among stakeholders.

One possible idea is to hold a mock trial where stakeholders from different backgrounds come together to argue hypothetical cases regarding AV crashes. It may help to not only reveal who should be liable from the different perspectives but also clarify practical applications over the disputes such as what elements are needed in pursuit of root causes of AV-related accidents and how to ensure those elements among stakeholders such as data policies. Even if each jurisdiction views automation differently, having those initiatives around the globe and connecting them may help nurture broad social consensus regarding the issue of system liability among stakeholders in advance, thus contributing to addressing this knotty problem.

Conclusion

It is critical to promote social acceptance of AVs not only for the maximization of societal benefits but also for the mitigation of risks brought about automated driving technologies. Given how quickly ADS are advancing, it is suggested that the relevant stakeholders proactively engage with one another in further research, studies and discussions to adapt current legal frameworks to automation from both technical and non-technical aspects. The preceding sections of this White Paper focus specifically on non-technical aspects and explore three main issues to legalize AV operations.

First, international endeavours to adapt the two international conventions – the Geneva Convention on Road Traffic and the Vienna Convention on Road Traffic – to automation should be carefully noted because international laws may bind domestic legislation of each state in respective parts. WP1 in UNECE has been making efforts for the adaptation of highly AVs: the concept of activities other than driving, remote operations and fully AVs. On the other hand, there is concern that stagnant discussion in WP1 could delay domestic legislation on highly and fully ADS or possibly incentivize states to compromise international harmonization and end up with the fragmentation of international regulatory frameworks.

Second, further research on obligations of the driving from the viewpoint of both the “something everywhere” strategy and the “everything somewhere” strategy needs to be conducted to encourage the harmonization of international endeavours and thus avoid a negative impact on domestic legislation. Future challenges of the “something everywhere” strategy involve clarifying drivers’ obligations during their engaging in other activities than driving, while the those of the “everything somewhere” strategy involve clarifying systems’ obligations. As an additional implication, remote drivers’ obligations also need to be deliberated to help fill technological and legislative gaps between driver-based operations and driverless operations on public roads.

Third, careful consideration of whether changes need to be made to the current frameworks of automobile liability and compulsory insurance is necessary to nurture consumer acceptance of AVs. The more advanced ADS are, the more claims regarding system liability will be made. Under negligence liability framework, victims of AV-related accidents may face not only burdensome and costly product liability lawsuits but also difficulties in proving product defects in AVs due to the technological complexity, thus possibly failing to obtain compensation for a loss. Under the presumption of negligence liability framework, relevant stakeholders need to consider how to sustain vehicle owners’ acceptance for their bearing social costs instead of other parties that shall be liable. Thus, it is of great importance to find ways of how to pursue system liability in advance, both promptly and effectively.

Appendices

Appendix A: SAE automation levels

Level	Name	Narrative definition	*DDT*		*DDT fallback*	*ODD*
			Sustained lateral and longitudinal vehicle motion control	*OEDR*		
Driver performs part or all of the DDT						
0	**No Driving Automation**	The performance by the driver of the entire *DDT*, even when enhanced by *active safety systems*.	*Driver*	*Driver*	*Driver*	n/a
1	**Driver Assistance**	The sustained and *ODD*-specific execution by a *driving automation system of either the lateral or the longitudinal vehicle motion control* subtask of the *DDT* (but not both simultaneously) with the expectation the the driver performs the remainder of the *DDT*	*Driver and System*	*Driver*	*Driver*	Limited
2	**Partial Driving Automation**	*The sustained* ans *ODD-specific* execution by a *driving automation system of both the lateral and longitudinal vehicle motion control* subtasks of the *DDT* with the expectation that the driver completes the *OEDR* subtasks and supervises the *driving automation system*.	***System***	*Driver*	*Driver*	Limited
ADS ("System") performance the entire DDT (while engaged)						
3	**Conditional Driving Automation**	The sustained and *ODD-specific* performance by an *ADS* of the entire *DDT* with the expectation that the *DDT fallback-ready* user is receptive to ADS-issued requests to intervene, as well as to *DDT performance-relevant system failures* in other *vehicle* systems, and will respond appropriately.	*System*	***System***	*Fallback-ready user (becomes the driver during fallback)*	Limited
4	**High Driving Automation**	The *sustained* and *ODD*-specific performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a user will respond to a *request to intervene*.	*System*	*System*	***System***	Limited
5	**Full Driving Automation**	The *sustained* and unconditional (i.e., not *ODD*-specific) performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a user will respond to a *request to intervene*.	*System*	*System*	*System*	***Unlimited***

Source: SAE International, J3016, June 2018

Appendix B: Key terms

Automation: Use of electronic or mechanical devices to operate one or more functions of a vehicle without direct human input; generally applies to all modes.

Automated Driving System (ADS): The hardware and software that are collectively capable of performing the entire dynamic driving task on a sustained basis, regardless of whether it is limited to a specific operational design domain. This term is used specifically to describe a Level 3, 4 or 5 driving automation system. (SAE J3016)

Automated vehicle (AV): Any vehicle equipped with driving automation technologies (as defined in SAE J3016). This term can refer to a vehicle fitted with any form of driving automation. (SAE Level 1-5)

Dynamic driving task (DDT): All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints. (SAE J3016)

DDT fallback: The response by the user or by an ADS to either perform the DDT or achieve a minimal risk condition after occurrence of a DDT performance-relevant system failure(s) or upon operational design domain (ODD) exit. (SAE J3016)

Minimal risk condition: A condition to which a user or an ADS may bring a vehicle after performing the DDT fallback to reduce the risk of a crash when a given trip cannot or should not be completed. (SAE J3016)

Object event detection and response (OEDR): The sub-tasks of the DDT that include monitoring the driving environment (detecting, recognizing and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e. as needed to complete the DDT and/or DDT fallback). (SAE J3016)

Operational design domain (ODD): The specific conditions under which a given driving automation system or feature thereof is designed to function, including, but not limited to, driving modes. This can incorporate a variety of limitations, such as those from geography, traffic, speed and roads. (SAE J3016)

Remote drive/remote operation: A driver who is not seated in a position to manually exercise in-vehicle braking, accelerating, steering and transmission gear selection input devices (if any) but is able to operate the vehicle. (SAE J3016)

Source: US Department of Transportation, *Preparing for the Future of Transportation, Automated Vehicles 3.0,* 2018, 3.

Acknowledgements

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