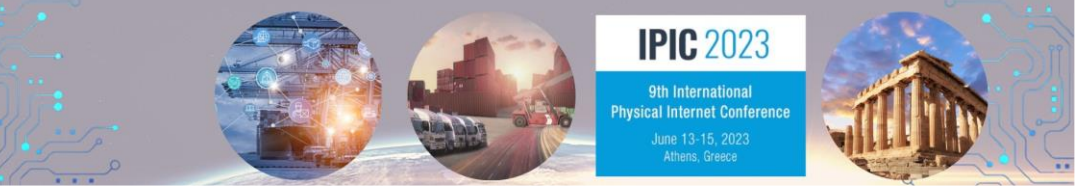

Autonomous vehicles under all weather conditions: steering towards a harmonised legislative framework enabling real-life deployment

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Abstract: *This paper presents and discusses the current status of testing and operation regulations for automated vehicles (AVs) at EU level. Current legal conditions for on-road testing and operation of autonomous vehicles vary strongly from country to country. This paper will focus on examples of European countries that have taken an advanced stance in the formulation of policies and rules (Austria, Norway, France) and developed national policies which already enable on-road testing and operation. This paper will identify and put forward a set of best practices that will support the review of existing and future legislation as the basis of a harmonized EU legal framework designed to give clear signals to the industry, regulators and the general public. Particular attention will be placed on ensuring that safety performance requirements are met across all Operational Design Domains (ODD). Taking adverse weather conditions into consideration will allow to reflect a more adequate real-life environment for AV operations. Updated regulations must ensure the safety of automated vehicle operations while providing some degree of flexibility, rather than imposing specific restrictions to enable future development and deployment of AVs. The technical work carried out under the EU-funded Horizon-2020 programme and more specifically the AWARD project provides the laying ground for the development of frameworks enabling the safe testing and deployment of autonomous vehicles for logistics operations onto public roads.*

Keywords: *autonomous vehicles, road transport, policy, ADS, testing, real-life deployment, logistics, adverse weather conditions*

Conference Topic(s): *autonomous systems and logistics operations (robotic process automation, autonomous transport/drones/AGVs/swarms), ports, airports and hubs; technologies for interconnected logistics (Artificial Intelligence, IoT, machine learning, digital twins); vehicles and transshipment technologies.*

Physical Internet Roadmap*: ☒ System of Logistics Networks, ☒ Governance.*

1 Introduction

Although the development of automated vehicle (AV) technologies has been rapidly progressing over the last years, large-scale deployment of driverless vehicles onto public roads requires a review and update of existing regulations. Authorities have already started adapting their rules to enable the manufacturing, commercialisation and deployment of

driverless AVs on European roads. At EU level, legislative bodies have already implemented a framework to harmonise the conditions for the type-approval of automated passenger and goods transport vehicles, thereby setting clear indications for the industry, regulators and general public. European legislative bodies have set uniform safety standards across borders for type-approval of Automated Driving Systems (ADS), albeit the operating conditions for on-road testing and deployment of AVs vary at member-state level.

This paper will examine policies in selected countries across the EU, enabling both on-road testing and deployment of AVs, while focusing on the best practices. Legal framework at EU-level, and more specifically the Automated Driving System (ADS) act (EU 2022/1426), national legislation for France, Norway and Austria will be presented. The goal of this study is to pursue a framework that harmonises and ensures safety performance requirements across all different traffic scenarios and conditions, to accurately reflect real-life deployment conditions which include adverse weather conditions. Updated regulation should ensure the safety of automated vehicle performance while at the same time providing a degree of flexibility that fosters the development of AVs in a safe way.

2 Analysis of selected EU and national regulatory frameworks

2.1 European framework on vehicle type-approval conditions: The ADS act

To ensure the safety of AV technology while facilitating their commercial deployment, the European Union has developed a new regulative framework that ensures uniform safety standards for AV testing and type-approval of the ADS. Entered into force in September 2022, the implementing EU Regulation No. 2022/1426 lays down procedures and technical specifications for the type approval of motor vehicles equipped with ADS. Contrary to the previous regulations, this act specialises in AVs and no longer requires the mandatory use of safety drivers for fully automated vehicles. In addition, the Regulation provides clear guidance for all stakeholders involved in the development and deployment of driverless vehicles, by informing manufacturers on the performance requirements and technical specifications that vehicles must meet, as well as specifying the modalities and competent authorities needed to obtain a compliance certificate. It should also be mentioned, that the regulation is quite open regarding the Operational Design Domain (ODD) that the manufacturer specifies. Additionally, it establishes aggregate safety metrics that will be used to benchmark performance, and ultimately used as a measurement for allowing AV real-world deployment.

This Regulation, also known as ADS Act, currently specifies:

- the information required by the ADS manufacturer to support their request for EU type-approval;
- the performance requirements and technical specifications applicable to ADSs, under a variety of scenarios and operating conditions (OOD) that the vehicle finds itself in;
- the review process to be used by the relevant approval authorities in their assessment of ADS compliance with the applicable technical specifications;
- the review of documentation, tests to be conducted and guidance for approval authorities, when reviewing applications.

The deployment of fully automated vehicles at the European level is currently limited to individually approved routes. The scope of the EU Regulation No. 2022/1426 is in fact limited to specific "use-cases" of fully automated vehicles or dual mode vehicles operating on a predefined route, which may include urban, suburban, motorway or predefined parking facilities environments. The traffic of fully automated vehicles is currently only allowed in

hub-to-hub routes and pre-defined areas (InterRegs, 2022). This regulatory framework will however be crucial to shape the future of AVs across the EU, by gradually opening up the door to permit the European type approval of fully automated vehicles in the years to come. The ADS regulation is in fact part of a broader maturation in Europe's AV regulatory and commercial environment, which provides a harmonised approach while granting an adequate flexibility to enable the development and deployment of AVs (European Commission, 2018).

While the ADS act specifies the framework for the type approval of vehicles at the EU level, national authorities are granted a level of flexibility to guarantee alternative national requirements and permit exceptions for AVs test operations and deployment. Different countries have introduced regulatory measures to support the testing of autonomous vehicles on their roads: While some countries grant authorization on a case-by-case basis, others focus on modifying national laws to facilitate vehicle testing across their territory (Traton, 2022).

2.2 National framework for AV testing and operation: the case of France

The French regulatory framework currently distinguishes between two main schemes to allow automated driving on public roads: the testing framework and the permanent regime.
If those two regimes are different in terms of use-cases (public transport, automotive, logistics), they are only differentiated by their level of automation. This results in three major categories: partially automated (the system is not able to ensure safe maneuvers), highly automated (the system ensures safe maneuvers within its ODD) and totally automated (the system ensures safe maneuvers within its ODD and is subject to remote control).

Within the testing framework, the circulation of a vehicle without permanent action of the driver requires an authorization, even for experimental purposes. Such experiments may concern one or more of the following cases: technical testing and development, performance evaluations in the situation for which the vehicle is intended to be driven and public demonstration. The vehicles involved in the experiment without partial intervention of the driver need to be registered under a specific registration certificate called WW DPTC.

A specific set of conditions may be linked to ensuring the safety authorization during experimentation. The authorization specifies the sections on which the vehicle is allowed to drive in the delegated driving mode as well as the delegated driving functions that can be activated on these sections. Both passenger and goods transport services may be subject to authorization. Vehicles intended for public transportation either of passengers or goods will have to trial on routes which are predefined in the authorization. However, tests of vehicles with delegated driving, which are intended for the public transportation of passengers, will include a trial period without passengers onboard.

Delegated driving vehicles operating under an experimental authorization must be equipped with a recording device to identify the phases of delegated driving. The applicant must also guarantee that the financial and technical capacities are appropriate for the purpose of the experiment. The authorization specifies the starting date and the duration of the experimentation. If the maximum duration of the authorization is two years, it may be extended by renewal of the authorization, depending on the evaluation of the experiment.

Article 125 of the "Plan d'Action pour la Croissance et la Transformation des Entreprises" (PACTE) Act allows for the extension of experimentation, to use-cases where the driver may not be in the vehicle or responsible for all driving tasks. This provides France with a framework for experimentation that covers the highest levels of automation, with an adapted liability regime.
The application file describes the conditions under which the experiment will be carried out. It contains: a technical file of the vehicle(s), an experimentation file as well as a road

manager, the competent traffic police authority, where specific traffic police measures are required and the relevant transport organising authority, if it is a public transport service. Information on authorised experiments is recorded in a national register within the state services which are monitored in compliance with industrial and commercial confidentiality. The dissemination of this information is restricted to the State services that are involved in the steering and evaluation of the experiment.

Once granted an application, a request for an experimentation file must be carried out, which must include:

- Presentation of the context of the experiment (actors involved and their respective roles, the management of the experiment, and the overall context of the experiment)
- Presentation of the experiment (start and end dates, including the blank run if applicable, location, objectives, daily time slots, safety studies carried out, experimental protocols used, and if applicable, the type of transport service experienced)
- Presentation of the modalities of the experiment (the number of vehicles used, the identification number (VIN) of the vehicles used, interactions with other road users, routes taken, the profile of the experimenters and where applicable, the interactions and coordination between the remote supervision and control systems and the existing traffic management and control systems, as well as the communication protocols between the remote driver and any persons on board the vehicle)
- A sub-file on roads containing in particular (a general location plan of the roads used, the list of road sections used characterization of road sections, equipment and signaling required for the experiment, and if necessary, detailed plans showing the integration into the existing system (cross-sections, organization of junctions, signaling, etc.).
- Regulations in force on the roads concerned in terms of traffic and parking regulations;
- A duly completed certificate of financial and technical capacity;
- Any other information that the applicant deems necessary to be made known.

The holder of the authorisation shall submit to the competent ministers a six-monthly follow-up, or quarterly in the case of an experiment involving a vehicle intended for public transport, of the authorised experiment within one month of the end of each six-month period, as well as a final report within one month of the end of the experiment.

Decree No. 2021-873 of June 29th 2021 “Implementing Ordinance No. 2021-443 of 14, April 2021 on the responsibility regime applicable in case of circulation of a vehicle equipped with an automated driving system and its conditions of use”, sets the conditions for the deployment of automated vehicles and automated road transport systems on French roads. It covers levels of automation up to fully automated systems, without a driver on board, provided that they are under the supervision of a person in charge of remote intervention and that they are deployed on predefined routes or zones. The decree sets definitions and general safety provisions for these systems, as well as requirements for the driver or the person in charge of remote intervention. In addition, the decree sets conditions under which fully automated systems (including vehicles, roadside or remote equipment and operational procedures) can be put into service, following a specific safety demonstration process. Orders specify procedures for approved qualified bodies and the content of their report on system safety, as well as conditions for the authorization of remote operators, particularly in terms of training.

A number of reference documents (methodological documents or guides) are intended to support stakeholders such as system designers, operators, service organisers, and approved bodies, in the implementation of safety demonstrations.

When the automated driving system is active, the driver is no longer required to be in a state in which they can conveniently and immediately carry out all maneuvers incumbent on them. However, the driver must remain fit in order to respond to requests at all times, comply with the instructions of law enforcement officers and give way to priority vehicles.

Table 1: Overview of provisions depending on the use-case in France

Overview of provisions depending on use-cases		
Use-case	***Case A: On-board driver***	***Case B: Remote intervention***
Partially automated vehicle	To be able to respond to any request for handover To be able to respond to law enforcement orders and facilitate the passage of priority vehicles	**Not allowed**
Highly automated vehicle	To be able to respond to any request to take over (NB: by design = out of scope) Be able to respond to law enforcement orders and facilitate the passage of priority vehicles	**Only within an automated road transport system (ARTS)** System validated by decision of the service organiser, after safety demonstration and opinion of an approved qualified body. Remote operator able to intervene according to the system's conditions of use
Fully automated vehicle	*Not applicable*	

2.3 National framework for AV testing and operation: the case of Norway

Test applications for self-driving vehicles in Norway are governed by the "Lov om utprøving av selvkjørende kjøretøy" (Test of Self-driving Vehicles Act, TSVA), which came into effect on the 1st of January 2018 and is expected to be revised in 2023. The aim of the TSVA is to encourage and formalise the testing of self-driving vehicles by setting a framework centered around traffic safety and privacy. Tests are to be performed in line with the maturity of the technology at hand and should be designed to establish the implications and risks of the use of self-driving vehicles with respect to external factors, namely mobility and traffic development, the environment and traffic safety. Any vehicle that comprises an electronic system capable of automatically controlling the vehicle and the driving thereof and which either operates without a responsible driver or operates with a responsible driver who is not in a traditional driver's seat is considered self-driving. This includes vehicles that allow the electronic driving system to hand over control to a driver.

In order to test self-driving vehicles in Norway, an application for a test permit must be filed with the Road Directorate (RD) of the Norwegian Public Roads Authority (NPRA). The applicant must be a natural or legal person, and the permit is issued for a fixed time period unless circumstances justify an extension. A permission to test a self-driving vehicle is given on the basis of a specific vehicle and its functionalities, a risk analysis of the proposed project, and one or more designated responsible drivers or operators. Should any of these parameters change, for example because the software of the vehicle is updated, the test environment changes, or a new operator is given permission to operate the self-driving vehicle, the RD

must be at least notified. If any safety-relevant aspects of the project are affected, an application for a new permit might be required. Permits may be suspended or revoked if the conditions for the permit are no longer met.
The application for tests under the TSVA must contain: the description of the vehicle and the automatic system, the risk analysis of the proposed project and the responsible driver or operator.

The vehicle to be included in the test should comply with the requirements of the relevant regulations (depending on whether it is a car, vehicle, motorcycle, tractor, etc.), unless an exemption has been agreed upon. In practice, many self-driving vehicles require such an exemption as they lack features considered essential to be compliant with the standard regulations, such as a steering wheel. The regulations also include standard provisions for vehicles operating in the public domain, such as adequate brakes and compliance with EU regulations on Electromagnetic Compatibility (EMC) emissions. Test vehicles should also be registered in accordance with the Road Traffic Act (Lov om vegtrafikk), although this requirement can be waived in certain instances, for example for very limited testing under strictly controlled circumstances. All vehicles must be insured, and proof of insurance must be provided with the application. The vehicle's automatic system, meaning the system that allows the vehicle to be self-driving, is subject to particular scrutiny. Documentation must be provided that details not only a functional description of the automatic system and its capability to safely drive the vehicle, but also with proof that these functions have been adequately tested by a third party. The security of the system, including provisions protecting the system from cyber-attacks must also be documented. This latter aspect is also relevant for General Data Protection Regulation (GDPR) considerations, which the automatic system must be shown to comply with.

The proposed project must be analysed with respect to safety and risks. Both the environment in which the vehicle is to operate in as well as its interactions with said environment must be carefully described, as well as risk and mitigating measures must be explained. The assessment of the project must be complete and illustrative enough for the RD to be able to evaluate whether the proposed project fulfils the TSVA safety requirements. Normally, this means that an applicant will provide a full safety analysis of every feature along a proposed track for the self-driving vehicle including pictures of the route, explanations of the interactions between the vehicle and other traffic participants, as well as a risk matrix evaluating potential risks by severity and frequency. The RD can ask for a risk analysis to be verified by a third party and risk-mitigating measures should be proposed where appropriate. If the RD issues a permit based on the application, these proposed measures must be put in place, documented, and an updated risk analysis must be sent to the RD for their records. If the RD decides to inspect a project, the environment must match the one proposed in the application (including risk-mitigating measures), otherwise the permit will be suspended or revoked.

Regarding the responsible driver or operator, a distinction must be made between the safety responsible for the project and the responsible drivers or operators. The safety responsible assumes legal safety for the pilot and must ensure that the pilot is executed under the circumstances for which the permit is given. A responsible driver is an operator of the self-driving vehicle whose responsibility is to monitor the vehicle (either while in the vehicle or remotely). All operators must be named and identified in the application, and must provide the documentation for the qualifications of the operator to assume responsibility for the vehicle. These qualifications usually include at least a driving license for the vehicle category

that the self-driving vehicle falls under (car, minibus, bus…) and a training certificate on the use of the automatic system.

The relationship between the responsible driver and the self-driving vehicle must be made clear in the documentation supporting the application. For example, routines should be described that remedy emergency situations, such as means for an operator to remove the vehicle from the flow of traffic in the event that the automated system becomes unresponsive. The operator's level of involvement during normal operations should be made clear, as well as the circumstances under which they are expected to take action.

Finally, all permits are given on condition that any significant events during the project, particularly any incidents are shared with the RD and that information from the project is shared. The RD can (and often do) require the applicant to keep a data log with vehicle data that the RD could access if required (in case of incidents), and it is commonly stipulated that data from the end of the set-up period be submitted such that the RD can verify that operations with the self-driving vehicle are running as expected. Furthermore, there is a requirement for all tests that a report should be submitted at the latest 6 months after the end of the project, together with a version of the report that can be made public.

2.4 National framework for AV testing: the case of Austria

In 2016, a dedicated legal framework to enable tests on open roads has been established (AutomatFahrV). At that time, Austria has taken the approach of defining specific use-cases, which included automated minibuses, motorway pilots with automated lane changing and automated military vehicles. There has been a major amendment of the edict in April 2022, as five new use-cases were added. Previously, demands for new use-cases have been collected, including the new use case "Automated vehicle for the transport of goods" which enables the testing of the Hub-to-Hub use-case in the H2020 EU-funded Project AWARD.

This new use-case has been introduced to allow the testing of automated freight transport on public roads. It is primarily suitable for rather short distances, since the speed is limited to 30 km/h for tests with automated vehicles that have not been type-approved beforehand, and 50 km/h for automated vehicles in which the base vehicle has been type-approved before. Regardless, the actual approved operating speed must be based on the results of a detailed route analysis and risk assessment of the route.

This analysis and risk assessment of the route is one of the new requirements that have been introduced by the amendment in 2022. Applicants must analyze every segment of the route based on a provided checklist. If risks are unveiled, appropriate mitigation measures must be defined. Additionally, the training of the safety operator must include the specific characteristics of the route and use-case specific manoeuvres. Table 2 contains an overview of the information needed to be provided by the applicant to obtain a test permit. Testing on public roads is possible for vehicle manufacturers, research institutions, system developers and transport companies.

Table 2: Summary of requirements and necessary information to obtain a test permit in Austria (own representation, AustriaTech 2023)

Filled in application form:	Safety relevant information:
• Contact person • Description of the use-case • Purpose of the test/research questions • Name of operators	• Analysis and risk assessment of the planned route following a given template (including corresponding documentation of risk mitigation measures) • Confirmation of operator training:

• Licence plate number • Confirmation of third-party liability motor insurer • Duration of tests • Planned route or area • Evidence of having informed the state governor and the road administration • Approval from the driver/operator to perform data recording • Accident data recorder • Description of necessary infrastructure adaptations • Additional questions	○ Test driver certificate (or similar) – focussing on driver skills ○ Training/introduction covering the vehicle specifications, route specifications, use-case specific manoeuvres. etc. • Description of how the necessary manoeuvres have been tested beforehand on a proving ground and in simulation • Description of manual override of the system • Description of manual deactivation of the system • Description of a risk analysis for the whole test and if mitigation measures have been taken; including description of method used

The regulation does not foresee to impose additional restrictions regarding time of operation, weather conditions or similar conditions. The safety validation is based on a self-assessment by the applicant. The applicant needs to describe the results of the safety validation for the overall test case and more specifically for the intended route, which includes documenting the corresponding risk mitigation measures.

As specified in §1 Abs 6 of AutomatFahrV, test reports must be submitted at the end of the test period. These reports are publicly available on the website of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology. Critical situations and/or accidents that occurred during the test drives must be reported immediately.

Currently, testing permits can only be issued if they are covered by one of the pre-defined use-cases. If this is not the case, the ordinance has to be amended, which requires time. In most use-cases, testing is only allowed with a safety driver inside the vehicle. The safety driver must be able to intervene and override the system at any time. The legislation for testing of fully automated vehicles without safety driver in the vehicle (remote operation) is currently under development in Austria (BMK, 2022).

3 Conclusions

The legislative framework is usually following technological developments and the European Union is working on setting the rules for a safe and successful deployment of AVs at two levels: EU wide and at Member State level. A different distinction divides legislation into testing and real-world deployment. Testing of AVs is applicable to all the countries studied in this paper (mainly at use-case level accompanied by an application for testing to be submitted to the relevant authorities) while real-world deployment is still limited. Testing of AVs at use-case level on predefined routes is possible in the countries mentioned in this research paper under specific conditions.

EU legislation aims to set out the type-approval rules for AVs in regards to their automated driving system (ADS). The objective at EU-level is to create a harmonised pathway for fully automated vehicles to be deployed on public roads across European Member States. While the implemented harmonised approach for the type-approval of AVs across Europe through the ADS act is critical to set uniform safety standards, it is also crucial to provide adequate flexibility to the rapidly evolving AV technological and industrial landscape. The EU sets policy benchmarks, in which Member States have the leverage to formulate regulations

independently without threat of sanction therefore setting structures for cooperation and learning among national policymakers (Hansson, 2020).

This allows for the development and implementation of a wide range of policy strategies on a national level. While some grant authorization for testing on a case-by-case basis like in Austria, others already have a national regulation including a permanent regime, like in France. Comparing regulations is important not only for policymakers but also for engineers who need to understand the implications of regulations for design requirements (Lee & Hess, 2020). While each Member State implements specific strategies to set requirements for AV testing and deployment permits, some common requirements have been set across borders, notably in terms of safety and traffic requirements.

Developing an automated driving system (ADS) remains a highly-resource intensive endeavor, requiring extensive technical and specialised expertise (Hogan Lovells, 2021). The steps taken by national authorities to develop the legal basis for the approval of ISO/SAE Level 4 driving automation, and fully automated vehicles in the most advanced cases, enable to further build upon the existing regulatory concepts and prepare the market for the safe deployment of AVs.

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References

- Advanced legal framework in the EU: Driverless through Europe, Tranton (2022) https://traton.com/en/innovation-hub/legal-framework-in-the-eu-driverless-through-europe.htmlKurose J., K. Ross, A. Wesley (2009): Computer Networking: A Top Down Approach Featuring the Internet, 5th edition, Addison-Wesley, U.S.A., March 2009.
- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions On the road to automated mobility: An EU strategy for mobility of the future COM/2018/283 final https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0283
- Lisa Hansson (2020) Regulatory governance in emerging technologies: The case of autonomous vehicles in Sweden and Norway, https://www.sciencedirect.com/science/article/pii/S0739885920301657
- Regulations on the Type Approval of Fully Automated vehicles Published, InterRegs (2022), https://www.interregs.com/articles/spotlight/draft-eu-regulations-on-the-type-approval-of-fully-automated-vehicles-published-000241
- AustriaTech (2023) Information on your Test Application https://www.austriatech.at/en/testantraege-kontaktstelle/
- BMK (2022) Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology: Aktionsplan Digitale Transformation in der Mobilität (AP-DTM) in: https://www.bmk.gv.at/themen/mobilitaet/alternative_verkehrskonzepte/telematik_ivs/publikationen/aktionsplan-digitale-transformation.html
- Lee, D., & Hess, D. J. (2020) Regulations for on-road testing of connected and automated vehicles: Assessing the potential for global safety harmonization. Transportation Research Part A: Policy and Practice, 136, 85–98. https://doi.org/10.1016/j. Tra.2020.03.026.
- Lov. (1965) Lov om vegtrafikk (vegtrafikkloven) (LOV-1965-06-18-4) [Government bill] https://lovdata.no/dokument/NL/lov/1965-06-18-4.

- Lov. (2017) Lov om utprøving av selvkjørende kjøretøy (LOV-2017-12-15-112) [Government bill] https://lovdata.no/dokument/NL/lov/2017-12-15-112.
- Bundesrecht konsolidiert: Gesamte Rechtsvorschrift für Automatisiertes Fahren Verordnung, Fassung vom 06.04.2023 https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20009740
- European Commission (2022), Commission Implementing Regulation (EU) 2022/1426 of 5 August 2022 laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated vehicles, http://data.europa.eu/eli/reg_impl/2022/1426/oj
- Hogan Lovells (2021) White Paper calls for flexibility as the EU establishes its first-ever regulatory framework enabling the launch of Autonomous Vehicles. www.hoganlovells.com. (n.d.), https://www.hoganlovells.com/en/news/hogan-lovells-white-paper-calls-for-flexibility-as-the-eu-establishes-its-first-ever-regulatory-framework-enabling-the-launch-of-autonomous-vehicles
- Jack Caporal, Jasmine Lim, Sean Arrieta-Kenna, Will O'Neil (2021) Driving the Future of AV Regulations Barriers to Large-Scale Development. https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210528_Caporal_Driving_AV_Regulations.pdf?PFqAqfAeOi340lC_PmcKVt1XOx3kCE4b