Institutional and Regulatory Challenges of Autonomous & Connected Transport

WG1: Thematic Report

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Chapter 1
Introduction

1.1 Global context and the COVID-19 impact

The COVID-19 outbreak has exposed many vulnerabilities of our societies. Indeed, it has shaken the worldwide economy, not only challenging our current lifestyle but also weakening future perspectives. With great discomfort, once again we, as humans, have learned how difficult it is to adapt our complex societies to unexpected events and how poor is our grasp of the world. Inevitably, while we are still into it, the chronicle on past events is flawed by disinformation, empty rhetoric, commercial propaganda and cultural biases: consequently, the most reasoned previsions tend to transform themselves in failed predictions, so only time will allow to reach an objective perspective and perhaps to build a new narrative of these days. Maybe, in the future, looking backwards it will be argued that 2020 has been a historical turning point between a past period – what was called the "short century" by Eric Hobsbawm – and a new Age, which today we do not have enough elements to start drawing. All we can claim, by now, is that the future will be anyhow different (OECD 2020). In a way, "BC" and "AC" could mean also "Before COVID" and "After COVID".

Within this context, transport is one of the sectors which has been deeply affected by the pandemic, due to massive lockdown and frontiers foreclosures which have imposed for example, home-working, flight cancellation and delays in supply-chain refurbishing. Actually, the impact of COVID-19 on this field has been somehow selective, since there has been an increase – if not a surge – on certain specific services, such as food-/shopping-delivery, while public transport, as other essential services – schools and public offices – have been reduced or suspended. Despite the positive outlook offered through the COVID-19 vaccination rollout, there are significant inequalities between countries due to restricted vaccine supply. The impact of this is also seen on transport services supply and demand, which unavoidably leads to a "new normal". It seems that the healing will take a long time and it will be a difficult endeavour, as well as the recovery of the world economy as seen through the challenges in international supply chains (Lozzi et al. 2020).

It might be said that the impact of the pandemic on Autonomous and Connected Transport (ACT) is still difficult to be assessed. The fact that the spreading of the virus was facilitated by the physical contact among people has discouraged individual travelling, thus hitting heavily some of the already weaker part of category of passengers, such as vulnerable people and informal workers (ILO 2020) but, conversely, has shown the advantages of a wider adoption of automated driving in logistics (Milakis, Thomopoulos, and van Wee 2020), despite the lack of full maturity of technology for a massive deployment. The fact about transport is that being a very complex ecosystem, it is likely exposed to imbalances which, in a globalised scenario, can cause unpredictable consequences of unknown magnitude.

1.2 WG1 objectives

Working Group 1 (WG1) aimed at addressing ACT Institutional and Regulatory challenges according to the Memorandum of Understanding of the COST Action WISE-ACT, performing "*an extensive review and evaluation of the existing institutional, regulatory and legal frameworks driving the deployment of ACT services*". Furthermore, WG1 was appointed to "*identify major barriers as well as to identify efficient policy recommendations to accelerate the deployment of ACT services minimising any risks*". In doing this, three tasks were assigned, namely to:

T1: Identify the macro-economic and fiscal implications of ACT and propose appropriate policy measures

T2: Review the required legal framework including its underlying ethics and accommodating liability concerns

T3: Explore safety scenarios of widespread ACT deployment and inform the development of relevant standards

1.3 Scope of this report background

At the time when WISE-ACT was launched, there were a lot of research projects focusing on Intelligent Transport Systems financed by the European Union, so this is a brief overview:

- AINARA – Automation and Intelligence Solutions for Automated Road Transport Systems;
- CARTRE – Coordination of Automated Road Transport Deployment for Europe;
- CATS – City Alternative Transport System;
- CityMobil2 – Cities Demonstrating Automated Road Passenger Transport;
- MarketUp – Transport Research Market Uptake;
- MAVEN – Managing Automated Vehicles Enhances Network;

- OPTICITIES – Optimise Citizen Mobility and Freight Management in Urban Environments;
- OPTIMISM – Optimising Passenger Transport Information to Materialize Insights for Sustainable Mobility;
- PRYSTINE – Programmable Systems for Intelligence in Automobiles;
- 5G-ROUTES – 5th Generation connected and automated mobility cross-border EU trials.

Additionally, the following are EU-funded projects focusing on automated mobility/automated driving:

ADASANDME	Adaptive ADAS to support incapacitated drivers Mitigate Effectively risks through tailor made HMI under automation: https://cordis.europa.eu/project/id/688900
ARCADE	Aligning Research & Innovation for Connected and Automated Driving in Europe: https://cordis.europa.eu/project/id/824251
AutoMate	Automation as accepted and trustful teamMate to enhance traffic safety and efficiency: https://cordis.europa.eu/project/id/690705
AVENUE	Autonomous Vehicles to Evolve to a New Urban Experience: https://cordis.europa.eu/project/id/769033
AWARD	All Weather Autonomous Real logistics operations and Demonstrations: https://cordis.europa.eu/project/id/101006817
BRAVE	BRidging gaps for the adoption of Automated Vehicles: https://cordis.europa.eu/project/id/723021
CARTRE	Coordination of Automated Road Transport Deployment for Europe: https://cordis.europa.eu/project/id/724086
CoEXist	'AV-Ready' transport models and road infrastructure for the coexistence of automated and conventional vehicles: https://cordis.europa.eu/project/id/723201
DriveToTheFuture	Needs, wants and behaviour of 'Drivers' and automated vehicle users today and into the future: https://cordis.europa.eu/project/id/815001
HADRIAN	Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs: https://cordis.europa.eu/project/id/875597
HEADSTART	HARMONISED EUROPEAN SOLUTIONS FOR TESTING AUTOMATED ROAD TRANSPORT: https://cordis.europa.eu/project/id/824309
INFRAMIX	Road Infrastructure ready for mixed vehicle traffic flows: https://cordis.europa.eu/project/id/723016
interACT	Designing cooperative interaction of automated vehicles with other road users in mixed traffic environments: https://cordis.europa.eu/project/id/723395
ICT4CART	ICT Infrastructure for Connected and Automated Road Transport: https://cordis.europa.eu/project/id/768953
L3Pilot	Piloting Automated Driving on European Roads: https://cordis.europa.eu/project/id/723051
Levitate	Societal Level Impacts of Connected and Automated Vehicles: https://cordis.europa.eu/project/id/824361
MAVEN	Managing Automated Vehicles Enhances Network: https://cordis.europa.eu/project/id/690727
MEDIATOR	MEdiating between Driver and Intelligent Automated Transport systems on Our Roads: https://cordis.europa.eu/project/id/814735
SCOUT	Safe and COnnectedaUtomation in road Transport: https://cordis.europa.eu/project/id/713843
SHOW	SHared automation Operating models for Worldwide adoption: https://cordis.europa.eu/project/id/875530
SUaaVE	SUpporting acceptance of automated VEhicle: https://cordis.europa.eu/project/id/814999
TransAID	Transition Areas for Infrastructure-Assisted Driving: https://cordis.europa.eu/project/id/723390
TrustVehicle	Improved trustworthiness and weather-independence of conditional automated vehicles in mixed traffic scenarios: https://cordis.europa.eu/project/id/723324
We-Transform	Workforce europe – transformation agenda for transport automation: https://cordis.europa.eu/project/id/101006900

By 2021, initiatives of the European Commission aim at fostering ecology and digitalization, both of which are expected to offer transport innovations. Consequently, non-thermal engines, shared mobility and connected and automated driving can be considered a set of technologies that, combined, have the real potential to change our societies in the next years.

1.4 Method and structure

Since transport is considered a highly complex and fast-growing sector, it requires to be approached under different perspectives. For this reason, we deem convenient to adopt an interdisciplinary perspective founded on a range of disciplines e.g. law, sociology, economics, technology. This report reviews relevant evidence and practice across Europe, as well as relevant academic literature to offer an overview about key ACT institutional and regulatory challenges.

This report is structured around the three WG1 MoU tasks i.e. Tasks 1-3, followed by an overall summary as a conclusion.

Chapter 2
Ethical and legal framework

It could be said that an AV can fall into the definition of a "robot", as provided by the standard ISO 8373:2012, being featured by "*actuated mechanism programmable in two or more axes (4.3) with a degree of autonomy (2.2), moving within its environment, to perform intended tasks' (2.6)*", where autonomy is defined as the "*ability to perform intended tasks based on current state and sensing, without human intervention*". Regarding AVs, it is debated to which degree or extent the technologies deployed into a vehicle could qualify it as merely "automated" or fully "autonomous". In this regard, the worldwide distinction among six levels of driving automation provided by SAE International has helped clarifying the classification of different technologies but has also raised further discussions. Apart from that, it might be agreed that an AV can be considered both a "service robot", being able to perform "*useful tasks for humans or equipment excluding industrial automation applications* (2.10)" and a "mobile robot", being able to "*travel under its own control (2.13)*".

Apart from the technical definition, in a broader perspective AVs can be considered also "social robots" (Fortunati, Cavallo, and Sarrica 2020), since such artifacts are able to generate a new ecosystem in which can be placed three different forms of interaction:

(1) among humans

(2) between humans and machines

(3) among machines

In such environments the boundaries between organic living beings and artificial devices become blurred, thus a new vision of reality can be draw, where "agents" neither are said to be passively "operated" nor to "decide" likewise humans but, as "inforgs", behave with a certain level of unpredictability raising liability for the consequences of their actions (Floridi 2015). Consequently, even in the field of AVS a thorough revision of traditional perspectives concerning ethics and law is required. The fields of ethics and safety have to remain separate, although both require to be assessed through a careful – and sometimes almost impossible – balance between conflicting principles or requirements. In this report we mainly focus on fully autonomous road vehicles, in order to be consistent with the broader WISE-ACT objectives.

2.1 Introduction: the fast-changing scenario in the European Union

Before tackling ethical and legal issues concerning AVs it needs to be clarified that the legal and ethical framework is expected to change significantly in the near future following an intense political agenda dictated by the newly installed European Commission. Indeed, despite the difficulties brought by the pandemic, the EU Parliament has published several proposals aimed at pushing towards innovation in 2020-21, which have consistent implications regarding the technologies involved in AVs.

- Framework of ethical aspects of artificial intelligence, robotics and related technologies, which includes a certification system based on a classification of risks posed by information technologies;
- Civil liability regime for artificial intelligence, where a system of strict liability is established for high-risk technologies;
- European data governance (Data Governance Act), where data sharing across EU is strengthened in order to allow a wider re-use of information by institutions and companies
- Single Market for Digital Services (Digital Service Act), where the legal framework for electronic commerce, which has been in force for almost twenty years, has been overhauled in order to regulate the liability of internet service providers for user-generated content;
- European Parliament Resolution of 20 January 2021 on artificial intelligence, where are addressed issues concerning international law such as the use of autonomous weapons.

2.2 Automated vehicles and ethical issues

The ethical issues raised by AVs have revolved around the "trolley problem" due to the large and speculative media coverage between 2010 and 2020, as highlighted in the Box "communication and AVs". Nevertheless, governmental and intergovernmental guidelines on ethics of connected and automated vehicles successfully underline the diversity of the ethical considerations relevant in the design and deployment of AVs. In this respect, the report of the German Federal Government is a pioneer in identifying issues such as accountability, safety and security, human-machine interface, driver training and public information, and self-learning algorithms as essential locus of interest for the ethics of AVs (Luetge 2017). As an intergovernmental organization, the European Commission's high level expert group also had a thematic approach, with a particular focus

on road safety, data and algorithms, and responsibility (Horizon 2020 Commission Expert Group to Advise on Specific Ethical Issues Raised by Driverless Mobility. Ethics of Connected and Automated Vehicles: Recommendations on Road Safety, Privacy, Fairness, Explainability and Responsibility, 2020).

Several guidelines surrounding the ethics of autonomous systems, robotics, and artificial intelligence adopt a rights-based or principle-based approach(High-Level Expert Group on AI 2019b; European Group on Ethics in Science and New Technologies to the European Commission et al. 2018; Oyog 2020). More precisely, they acknowledge human rights and fundamental freedoms protected by the UN and EU charters and complement them with the ethics principles adopted in biomedicine during the 1970s and several principles emerging particular to new technologies. ACT generally constitutes a use case in these documents. A review by Jobin and colleagues (Jobin, Ienca, and Vayena 2019)"DOI":"10.1038/s42256-019-0088-2","ISSN":"2522-5839","issue":"9","journalAbbreviation":"Nat Mach Int ell","language":"en","page":"389-399","source":"DOI. org (Crossref identified 84 documents containing ethical principles for autonomous systems, robotics, and AI. While the wording changes slightly, the principles remain similar in these documents. Their analysis grouped the recommendations under 11 principles. Several of these principles, namely, **non-maleficence, beneficence, dignity, autonomy, justice, responsibility, and solidarity** were adopted also by the EC's expert report on ethics of AV('Horizon 2020 Commission Expert Group to Advise on Specific Ethical Issues Raised by Driverless Mobility. Ethics of Connected and Automated Vehicles: Recommendations on Road Safety, Privacy, Fairness, Explainability and Responsibility.' 2020).

The ethical principles for an ethical and trustworthy AV are identified to a great degree and remain coherent with the other emerging technologies. The design and deployment domains that require ethical consideration are also more or less identified to begin with and could be complemented with the progress in technology development. The next step for the stakeholders in AV community is to bring the abstract principles to operational level for the understanding and use of technology developers and regulatory authorities. Building this bridge is particularly important because ethics guidelines are not legally binding documents, although the issues that they raise are of utmost importance for the wellbeing of society, the non-compliance of which may have dire consequences for road users' rights and freedoms.

Communication and AVs

Effective communication builds trust and trustworthiness among the public. Media have played a critical role in the way in which AVs have been perceived by diverse groups and how they have shaped their concerns. Framing of the term itself, (fully intelligent, fully automated, fully autonomous, fully driverless, and driverless vehicles etc.) has proven to evoke affective positions that thereby influence behaviour, design, and policy making (Liu et al. 2021). Moreover, the highly used "trolley problem" framing continues to dominate the media imagination, filtering the speculative futures in decision-making, agency, and social control through this lens (Forlano 2019). That said, persuasive marketing driven by city councils interested in pushing smart city agendas, sustainability organizations interlocking climate change and AV adoption, and technology and auto industries emphasizing the "sexy" futurism and the "coolness factor" through celebrity endorsements on social media platforms have contributed to broadening the communication narratives on AVs.

Communication and AVs

Defining AI, a term first coined in 1956 by John McCarthy at a summer seminar at Dartmouth is not easy at all. And the truth is that it could not be otherwise, since the very concept of "human intelligence" is neither peaceful nor univocal. Indeed, when we speak of human intelligence, it is often unclear whether we are referring to cognitive, emotional, social intelligence.

In either case, AI would be a scientific field of computer science focused on the creation of programs and devices capable of displaying "intelligent" behavior. A discipline aimed at creating systems prepared to learn and reason as a human being. In short, a concept whereby machines think like human beings.

On the concept of artificial intelligence, see "A definition of Artificial Intelligence: main capabilities and scientific disciplines". A good proof of the interest that AI has aroused in the EU institutions is the large number of recent initiatives that have seen the light of day with the aim of proposing a joint and solid European vision on the issue. Thus, it is worth mentioning the communications "Artificial Intelligence for Europe", the "Coordinated Plan on Artificial Intelligence" (2018) , "Building Trust in Human-Centered Artificial Intelligence" (2019), the "White Paper on Artificial Intelligence" (2020) or other documents in which AI acquires its share of prominence such as "The European Green Deal" (2019) or "A European Data Strategy" (2020).

2.3 ACT testing regulation for passenger vehicles in public roads

Until now, there is no internationally harmonized legal framework for automated driving functions. Nevertheless, laws and regulations that individual countries make, have to respect binding international contracts, like the Vienna Convention on Road Traffic from 1968 or the Harmonized Technical United Nations Regulations for Wheeled Vehicles (1958) by the UNECE (United Nations Economic Commission for Europe). European countries furthermore have to follow EU directives.

Due to advancements in technology, also regarding automated mobility, some of these regulations were updated between 2010 and 2020 to better meet the needs of the contemporary traffic and mobility landscape. The Vienna Convention for example was adapted in 2016 and is now explicitly including regulations regarding automated driving.

Austria and Germany are two countries that have included automated driving functions into their national regulations.

In **Austria**, the usage of automated functions like the parking assistant and motorway pilot with automated lane keeping system is allowed according to the AutomatFahrVO when the requirements are being met.

Changes in the Road Traffic Act in **Germany** in 2017 make the usage of automated systems (Level 3) under certain circumstances possible. Nevertheless, a driver is still required.

Regulations vary not only between countries but may also vary within a country, as it is the case for the **United States** for example, where each state can make their own laws regarding automated driving. In the state of California, autonomous vehicles without a safety driver are allowed on the streets if a permit has been issued and requirements are being fulfilled.

In the **United Kingdom**, the legal framework has been reviewed by the Law Commission of England and Wales and the Scottish Law Commission, in order to identify the needs for adaption of the law that are necessary for a safe deployment of automated vehicles on UK roads. The second report was published in 2022 jointly with the Scottish Law Commission.

In 2020, the UNECE has made an effort to develop a harmonized regulatory for Automated Lane Keeping

Systems (ALKS). 53 countries (amongst other the EU-Member States, Japan and South Korea) agreed to the so called "*UN Regulation on uniform provisions concerning the approval of vehicles with regards to Automated Lane Keeping System*", which came into force internationally in January 2021, allowing signatory states to consider the approval and deployment of vehicles equipped with such systems. The regulation states that the system can only be activated on roads where pedestrians and bike riders are not allowed and when the vehicle is not going faster than 60km/h. The regulation is the first binding international regulation that includes Level-3 functions.

2.4 Legal framework for testing new functionalities

Most EU-countries have introduced national procedures to allow tests of automated vehicles. Nevertheless, the requirements and possibilities vary from country to country. Usually, permits are granted on an individual basis and one or several national authorities might be involved. In most cases, applicants should expect, that they will have to convince the authorities of the necessity and safety of the planned tests on a personal level. Furthermore, the requirements, that applicants have to fulfil, might not always be transparent. In some countries, requirements are defined more specifically than in others.

A detailed analysis of the different national frameworks unveiled, that some countries use a very individual approach (e.g. Denmark, where many entities are involved and each application involves a political process). Other countries already use more standardized approaches (e.g. Sweden, where the authority performs Site Acceptance Tests). Austria makes use of a quite unique approach by defining different test cases within the legal framework. The CAD Knowledge Base provides continuously updated information on regulations in EU and non-EU countries.

Regulatory Sandboxes

In recent years "regulatory sandboxes" have emerged worldwide as a new and promising method to facilitate disruptive technologies. In this sense, the legislator provides a certain limited field with a temporary and special discipline, retaining the power to adjust it depending on the feedback received. In essence, legislation is used as an experimental tool in order to exploit the potentials of technological innovations. Remarkably, such kind of legal phenomena can be found in the field of fintech with crypto currencies as well as in artificial intelligence applications.

The creation of ACT trial sites (see the WISE-ACT WG4 Thematic Report) or living labs allowing autonomous and automated vehicles to circulate on ordinary roads is encouraged by the EU. Particularly, the European Commission has pledged to support the adoption of this approach in the development of technological infrastructures in the transport[4]. Since this sector is included in the list of "high-risk sectors" in the recent proposal for a Framework of ethical aspects of artificial intelligence, robotics and related technologies of 20 October 2020, it is likely that "regulatory sandboxes" will play a crucial role in the future.

Living Lab examples worlwide

These are a few examples of living labs in the world:

Transpolis in Lyon (France), a 0.8 km2, €18 million has already been invested.

The Zalazone in Hungary near Budapest, 2.5 km2, 140 million € of investments over 10 years, will be the largest test site in the world, currently under construction[41].

The K-City in South Korea. $10 million was injected by the Ministry of Transport[42].

The Mcity in the United States in Michigan. 0.14 km2. At the end of 2017, $111 million had been invested on the basis of public and private funds.

The CETRAN (Center of Excellence for Testing and Research of Autonomous Vehicles) test circuit in Singapore. Created in August 2106, the 0.018 km2 zone offers a road and urban environment (office towers, rain machine, etc.) for testing VAs before their deployment on open roads, and coupling with a virtual simulator[44].

2.5 Examples for national frameworks in selected EU countries

The following countries are selected as examples to illustrate the differences in national frameworks within the European Union, based on H2020-SHOW D3.1:

2.5.1 France

In May 2018, the French strategic framework for the development of autonomous vehicles was published. The

framework gives examples for the future use of self-driving vehicles, identifies the key issues and sets ten priority governmental actions. The former minister Anne-Marie Idrac acts as Senior Head of this National Strategy for the Development of autonomous vehicles.

In France, every test authorization is granted on an individual basis and several different ministries are involved. Initially, the applicant has to provide documents which explain the objectives of the test, describe the vehicles and how safety will be ensured. Authorities will raise questions, that the applicant must consider. If all involved ministries agree, the Ministry of Ecological Transition will send the dossier to the local road authority to ask for an opinion, after what the Ministry will issue a permit for the specific route.

Contact Point	– Ministry of Ecological Transition – is the main contact to which the application for authorization is submitted – Ministry of domestic affairs – Ministry of Economics
Links for further information	Overview page of Ministry of Ecological Transition (in French): https://www.ecologie.gouv.fr/vehicules-autonomes Arrêtédu 17 avril 2018: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT0000368686691/ Application form (in French): https://www.demarches-simplifiees.fr/commencer/autorisation-experimentation-vdptc
Specific characteristics	– Authorization is granted on an individual basis (no technical restrictions beforehand) – Several Ministries involved – A questionnaire (about 90 questions) summarizing the main issues of the experiment – The authorization is granted for max. two years and only for this test

Activating automated driving systems is only allowed on specified routes. In addition to the specific characteristics mentioned in the table, it always has to be tracked, whether the vehicle is in automated driving or manual driving mode.

Since several authorities are involved in the application process, handling times may be longer. H2020-SHOW partners also mentioned that they would appreciate an optimized process for repeated applications with a common baseline. At the moment, it is necessary to submit a comprehensive application again. Also, they see room for improvement regarding the communication with the interministerial committee.

Recent legislation approved in France

In France, the *Law of orientation of mobilities* voted in December 2019 authorizes the government to take by ordinance within two years *"any measure within the scope of the law in order to adapt the legislation, in particular the Highway Code, to the case of the circulation on the public highway of land motor vehicles whose driving functions are partially or totally delegated to an automated driving system"*. Every test requires an authorization which is granted on an individual basis. Three ministries are involved (Ecology, Domestic affairs, Economy) as well as ANSSI, the French cyber-security police, the local road operator of the experimental site and the competent authority in traffic police.

2.5.2 Austria

Austrian efforts in the field of automated mobility are accompanied by the "Austrian Action Programme on Automated Mobility". The "Contact Point Automated Mobility" was established at AustriaTech as a first point of contact in legal and technological issues, for national test environments as well as national and international stakeholders who want to test according to the Austrian Automated Driving Regulation.

This first regulatory framework for automated driving – "AutomatFahrV" – was introduced in 2016 and was amended in March 2019. This amendment added a separate chapter for systems in series production, along the already existing chapter for test applications.

Regarding test applications, the current framework includes three different test cases: "Autonomous Minibus", "Motorway Pilot with Automatic Lane Changing" and "Autonomous Military Vehicle". If all requirements of "AutomatFahrV" are met by the applicant, the ministry issues a test certificate for testing on public roads. The process also includes a council of experts, that regularly meets to discuss incoming requests.

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