Towards an European Law on Cooperative, Connected and Automated Mobility (CCAM)

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Abstract

The paper analyzes the legal framework on cooperative, connected and automated vehicles on the roads of the European Union. In particular, the Intelligent Transport Systems (ITS) services of Directive 2010/40/UE and its reform proposal for the adoption of a future Delegated Regulation on Cooperative Intelligent Transport Systems (C-ITS). European policy deals entirely with the cooperation, connection and automation of vehicles. This is seen as the most appropriate to achieve its objectives. In parallel, the automotive industry and the national authorities of the Member States are certifying automated vehicles that already reach level 3 of the Classification System of the Society of Automotive Engineers.

Keywords

Directive 2010/40/EU, Cooperative Intelligent Transport Systems (C-ITS), Vehicles, Road Transport, Technology, 5G.

1. Introduction

The mobile phone is the device that citizens take with them on road journeys. It allows them to ascertain the best route and the traffic conditions and also provides warnings of incidents or accidents. Gradually, in addition to mobile phones, "connected car" technology is being developed and implemented[3]. Cars and other road vehicles are being fitted as standard with elements that facilitate their connectivity, and are equipped, either as standard or optionally, with numerous sensors that turn them into another type of mobile device. These include On Board Diagnostics (OBD), which is used for fault detection but offers a basic level of connectivity. Another sensor is the eCall or automatic emergency call system, used in the event of an accident or with a direct call from the driver. There are also geolocation systems installed in vehicles, which allow their position and speed to be known at all times.

At the same time, while road vehicle connectivity systems are being implemented, the European Union is developing a policy called Cooperative, Connected and Automated Mobility, known by its acronym CCAM[4]. Its content includes the adoption of Community standards, the preparation of reports and communications by European institutions, mainly the European Commission, the creation of platforms to bring together experts and public and private entities to analyse the phenomenon, as well as important economic contributions through the financing of European research projects. The EU Member States, the automotive and technology industries, as well as numerous experts and researchers are also contributing towards making the CCAM a policy of great current interest and impact.

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[3] F. Mayán Momblán, El Vehículo Conectado: Su influencia en la gestión de la Movilidad, Rutas: Revista de la Asociación Técnica de Carreteras 182 (2020), p. 31.
[4] At https://bit.ly/3Wf9k34, accessed on 6 February 2023.

The European Commission considers the most promising hybrid connectivity package for the future to be the combination of ETSI's ITS-5G and mobile phone networks. Indeed, unconnected mobility is in decline, as car manufacturers, such as BMW, already connect their vehicles to 4G networks. Mobility can benefit from a "connected" environment[5].

The Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 5G for Europe: An Action Plan, of 14 September 2016[6], notes that although 5G is not yet fully standardised, its main technological features and components are already being developed and tested. It has been pointed out that there are some barriers to 5G deployment, which are mainly attributed to the fact that consumers are already satisfied, the need for cooperation between multiple stakeholders, such as technology operators and policy makers, and the high costs of infrastructure investment[7] .

The European Commission believes that human error is by far the biggest cause of accidents in the transport sector, and that digital technologies can help to reduce the accident rate. Furthermore, citing other EU strategies, the European Commission adds that cooperative, connected and automated vehicles can reduce energy consumption and emissions from transport. Moreover, this technology can improve the competitiveness of European industry and foster new business models and employment in the European Union. As well as this, it should lead to significant improvements in road safety, traffic efficiency and driving comfort, helping drivers to make the right decisions and to better adapt to conditions on the road[8].

From a technological point of view, the European Union's CCAM strategy has one central element: what are known as Cooperative Intelligent Transport Systems (C-ITS). Vehicles are to be equipped with on-board technology that enables them to receive detailed information on road traffic and safety conditions throughout Europe[9]. The idea is that the vehicle is not only a "receiver", but also a "sender" of information, and to consider each vehicle as a device (like a mobile phone) which will also interact with other vehicles. To use the current terminology of cooperation, this phenomenon is known as vehicle-to-vehicle (V2V) and vehicle-to-road-infrastructure (V2I)[10]. Vehicles can also communicate with pedestrians (V2P) or with external cloud service providers (V2C). Ultimately, the aim is for the vehicle to have an unlimited exchange of information (V2X)[11].

Thanks to C-ITS technology, drivers and traffic managers will be able to share and use previously unavailable information and coordinate their actions[12]. The European Commission expects that this cooperation, in the sense of interaction between vehicles and with the road infrastructure, will be made possible thanks to the digital connectivity of the vehicle[13]. Finally, sending and receiving messages from each vehicle and infrastructure and exchanging data between the various participants in the transport system will enable the various stakeholders in the European transport system to be connected in real time[14].

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[5] F. Nakamura, Role of connected mobility concept for twenty-first-century cities-Trial approach for conceptualization of connected mobility through case studies, IATSS Research 38 (2014) pp. 52-57. doi: https://doi.org/10.1016/j.iatssr.2014.07.003.

[6] COM/2016/0588 final.

[7] J. Kehoe, D. Hanberry, N. Flannery, Digital Consumer Trends 2021: 5G the Benefits and Barriers to Adoption. URL: https://bit.ly/3Xgk6qv.

[8] COM(2016) 766 final, introduction

[9] COM(2016) 766 final, par. 3.4.

[10] C. F. Chiasserini, P. Giaccone, G. Malnati, M. Macagno, G.Sviridov, Blockchain-based Mobility Verification of Connected Cars, in: IEEE 17th Annual Consumer Communications & Networking Conference (CCNC), 2020, par. III. doi: 10.1109/CCNC46108.2020.9045104

[11] F. Mayán Momblán, El Vehículo Conectado: Su influencia en la gestión de la Movilidad, Rutas: Revista de la Asociación Técnica de Carreteras 182 (2020), p. 37.

[12] E. Talavera Muñoz, Estrategias para la conducción autónoma cooperativa, PhD thesis, Universidad Politécnica de Madrid, 2018, p. 12.

[13] M. Gerla, E.-K.Lee, G. Pau, U. Lee, Internet of vehicles: From intelligent grid to autonomous cars and vehicular clouds, in: IEEE World Forum on Internet of Things (WF-IoT), 2014, pp. 241-246. doi: 10.1109/WF-IoT.2014.6803166.

[14] COM(2016) 766 final, introduction.

Special mention should be made of EU funding of projects for cooperative, connected and automated vehicles. Between 2014 and 2016 alone, through the Horizon 2020 Programme and the Connecting Europe Facility, the European Union co-funded more than €130 million for cooperative, connected and automated vehicles[15]. European investment has continued with other projects under the Horizon 2020 Programme[16], where numerous projects linked to this area can be found, all related to research and technological innovation.

Among the projects funded by the European Union, there is a particular interest in 5th-Generation, or 5G, technology as a facilitator of connected and automated mobility in cross-border corridors[17]. These are pilot projects to verify in situ how intelligent transport services (ITS) work in real conditions, following the principles of harmonisation, standardisation and interoperability between the various countries[18]. For example, as part of the Horizon 2020 Programme, the European Union has funded several projects to test 5G technology in connected and automated mobility corridors. These tests cover more than 1000 kilometres, including four cross-border corridors: Metz-Merzig-Luxembourg, Munich-Bologna via the Brenner Pass, Porto-Vito and Evora-Merida, both between Spain and Portugal, as shown in the picture below:

[15] COM(2016) 766 final, par. 2.
[16] COM(2016) 766 final, par. 2
[17] D. Rizopoulos, M. Laskari, G. Kouloumbis, I. Fergadiotou, P. Durkin, K. Kõrbe Kaare , M. Mahtab Alam, 5G as an Enabler of Connected-and-Automated Mobility in European Cross-Border Corridors-A Market Assessment, Sustainability 14 (2022), par. 2.1 doi: 10.3390/su142114411.
[18] L. Rey Ramos, G. Leiro García, G. Ruggiero Pelay, C-Roads Galicia y Movilidad conectada, El futuro corredor inteligente de Europa, Carreteras. Revista Técnica de la Asociación Española de la Carretera 234 (2021), pp. 67-68.

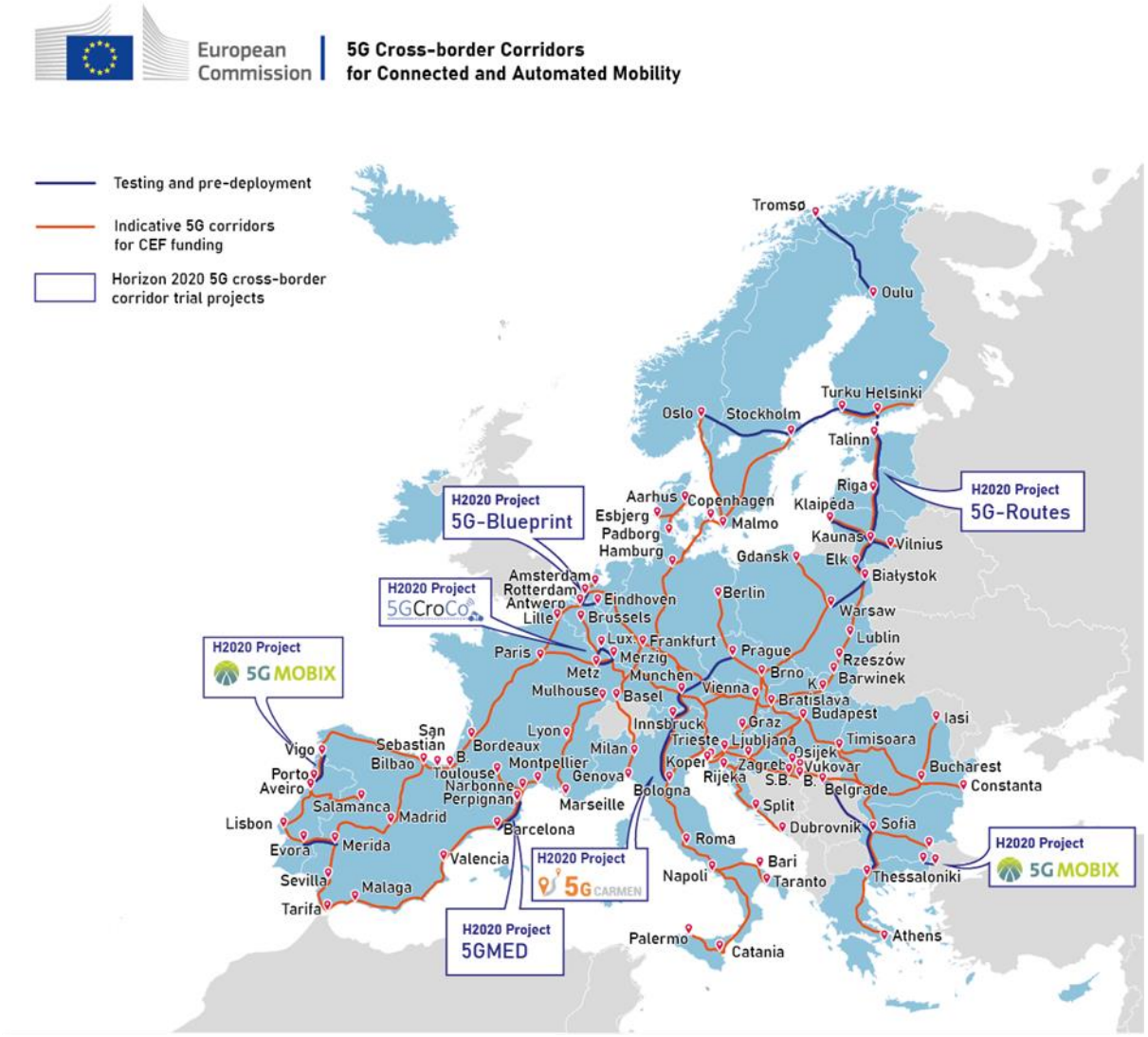

Figure 1: 5G Cross-Border Corridors for Connected and Automated Mobility in Europe

With the end of the Horizon 2020 Programme, the European Commission has launched new funding opportunities for cooperative, connected and automated mobility (CCAM) projects through the current Horizon Europe Research & Innovation Programme[19]. It can be seen how EU policy focuses on cooperative technologies in road transport; indeed, the acronym itself has changed from CAM to CCAM.

Finally, special mention should be made of the C-ITS Platform for the deployment of C-ITS in the European Union. It was launched in November 2014 as a Commission expert group, as an operational tool for dialogue, exchange of technical knowledge and cooperation between the Commission, public sector stakeholders from Member States, local and regional authorities and private sector stakeholders such as car manufacturers, equipment manufacturers, road and telecom operators and service providers[20].

At present, the C-ITS Platform seems to be acting mainly in the form Expert group on cooperative, connected, automated and autonomous mobility, a public-private partnership known as CCAM that brings together state and industry representatives[21]. According to its statutes, the purpose of the association is to promote and facilitate competitive research on cooperative, connected, automated and

[19] At https://bit.ly/3WbHe8X, accessed on 6 February 2023.
[20] COM(2016) 766 final, par. 2
[21] CCAM members can be consulted at https://bit.ly/3X8pooC, accessed on 6 February 2023.

autonomous mobility at EU level by bringing together different CCAM actors. The partnership focuses on the coordination of research and innovation activities at European and international level to accelerate the implementation of CCAM technologies and services (Art. 3.1). To this end, the partnership will collaborate with the European Union within the framework of the Horizon Europe Programmes (Art. 3.2)[22].

2. Regulatory framework for CCAM in the European Union

Among the EU legal instruments, a reference to cooperative systems and vehicle-infrastructure interfaces can be found in the European Commission's White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" of 28 March 2011. To achieve the goal of "zero fatalities" in road transport by 2050, the White Paper refers to cooperative systems as one of the road safety technologies which should be standardised and deployed throughout the European Union. Other technologies include driver assistance systems, intelligent speed limiters, seat-belt reminders, eCall systems and improved roadworthiness testing systems, including for vehicles with alternative propulsion systems. However, the White Paper lacks the regulatory and binding force of a Community Regulation or Directive.

Also without regulatory value, but with more detail on CCAM, the Commission Communication of 30 November 2016 entitled "A European Strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility"[23] is of great interest. It highlights that investments and regulatory frameworks need to converge across Europe[24], for which it is imperative that operators have a regulatory framework that provides legal certainty for the phenomenon of cooperative, connected and automated vehicle deployment within the European Union.

In the same vein, the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Europe on the move. Sustainable mobility for Europe: safe, connected and clean, of 17 May 2018[25], uses two crucial concepts: connectivity and vehicle automation. It adds that provided a sound regulatory framework is in place, automated vehicles and advanced connectivity systems will provide safer vehicles.

In view of the above, it is clear that the regulatory framework for cooperative, connected and automated mobility (CCAM) and the C-ITS technology that will make it possible is insufficient. Indeed, the European Union currently lacks a legal regulation that expresses what this policy aims to achieve and what measures will be taken to achieve it. This is also the case in some Member States, such as Spain. The European Commission is aware that other countries outside the EU, such as the United States, Australia, Japan, Korea and China, are making rapid progress in the deployment of cooperative intelligent transport vehicles and services[26].

The future regulatory framework for CCAM should be a Community one, which will require coordination within European institutions and between Member States. The aim is to ensure continuity of service, so that it is maintained when the vehicle moves between EU countries. Finally, it is necessary to avoid fragmentation of the internal market with different rules, which could harm public acceptance of these technologies[27].

Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport[28] (hereinafter Directive 2010/40/EU) is applicable, although it focuses on Intelligent Transport Systems (ITS).

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[22] At https://bit.ly/3QEjyZI, accessed on 6 February 2023.
[23] COM(2016) 766 final, introduction.
[24] COM(2016) 766 final, par. 3.7.
[25] COM(2018) 293 final, introduction.
[26] COM(2016) 766 final, introduction.
[27] COM(2016) 766 final, par. 1.
[28] *Official Journal of the European Union*, L 207/1 of 6 August 2010.

The future EU regulation will hinge on Directive 2010/40/EU and future Delegated Regulations complementing it and adopted by the Commission. The Proposal for a Directive of the European Parliament and of the Council amending Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport of 14 December 2021[29] is analysed for this purpose. Among the contents of the Proposal, Article 2 of Directive 2010/40/EU is amended to include cooperative, connected and automated mobility services (CCAM) as a new priority area for the development and use of specifications and standards (new Article 2.1.d.IV).

2.1. Legal framework for the implementation of Intelligent Transport Systems (ITS) in Directive 2010/40/EU and Delegated Regulations

The original text of Directive 2010/40/EU was subsequently amended by Decision (EU) 2017/2380 of the European Parliament and of the Council of 12 December 2017 amending Directive 2010/40/EU for the extension of the deadline of Art. 12 of the Directive for the adoption of delegated acts by the European Commission. The consolidated text is available on Eurlex[30].

As a Directive, it has been transposed into the legal systems of the Member States of the European Union[31]. In Spain, Directive 2010/40/EU has been transposed through Royal Decree 662/2012 of 13 April, which establishes the framework for the implementation of Intelligent Transport Systems (ITS) in the road transport sector and for interfaces with other modes of transport[32].

Furthermore, in accordance with Art. 7 of Directive 2010/40/EU, the European Commission may adopt delegated acts in accordance with Article 290 of the Treaty on the Functioning of the European Union in accordance with the provisions of Article 6. A separate delegated act shall be adopted for each of the priority actions (Art. 7.2).

In particular, following the list of priority actions listed in Art. 3 of Directive 2010/40/EU, this is Commission Regulation (EU) 2017/1926, which complements Directive 2010/40/EU as regards the provision of multimodal travel information services throughout the Union[33].

Commission Delegated Regulation (EU) 2015/962 of 18 December 2014 supplementing Directive 2010/40/EU with regard to the provision of EU-wide real-time traffic information services[34]. This Regulation will be repealed as of 1 January 2025, with the entry into force of the new Commission Delegated Regulation (EU) 2022/670 of 2 February 2022 supplementing Directive 2010/40/EU as regards the provision of EU-wide real-time traffic information services[35].

Commission Delegated Regulation (EU) No 886/2013 of 15 May 2013 with regard to data and procedures for the provision, where possible, of road safety-related minimum universal traffic information free of charge to users[36].

In relation to the priority action of Article 3(d) of Directive 2010/40/EU, several instruments have been adopted: Commission Delegated Regulation (EU) No 305/2013 of 26 November 2012 supplementing Directive 2010/40/EU with regard to the harmonised provision for an interoperable EU-wide eCall Text[37]; Commission Delegated Regulation (EU) 2017/79 of 12 September 2016 establishing detailed technical requirements and test procedures for the EC type-approval of motor vehicles with respect to their 112-based eCall in-vehicles systems, as well as 112-based eCall in-vehicle separate technical units and components[38], and; Regulation (EU) 2015/758 of the European Parliament and of

[29] COM/2021/813 final.
[30] At https://bit.ly/3IOJ7FB, accessed on 6 February 2023.
[31] At https://bit.ly/3Xq0wbE, accessed on 6 February 2023.
[32] Official State Gazette, no. 90, 14 April 2012.
[33] *Official Journal of the European Union*, L 271/1, 21 October 2017.
[34] *Official Journal of the European Union*, L 157/21 of 23 June 2015.
[35] *Official Journal of the European Union*, L 122/1 of 25 April 2022.
[36] *Official Journal of the European Union*, L 247/6 of 18 September 2013.
[37] *Official Journal of the European Union*, L 91/1 of 3 April 2013.
[38] *Official Journal of the European Union*, L12/44 of 17 January 2017.

the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service[39].

Commission Delegated Regulation (EU) No 885/2013 of 15 May 2013 with regard to the provision of information services for safe and secure parking places for trucks and commercial vehicles[40].
However, no Commission Delegated Regulation has been found to complement Directive 2010/40/EU with regard to the priority action of Art. 3(f) on the provision of reservation services for safe and secure parking places for trucks and commercial vehicles.

Among the reasons for the implementation of ITS, Directive 2010/40/EU points out that the increase in road traffic volume cannot be dealt with by the traditional method of expanding infrastructure, but through the use of Intelligent Transport Systems (ITS) (points 1 to 3 preamble).
The legal definition of ITS is that they are systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic and mobility management, as well as for interfaces with other transport modes (Art. 1).

ITS make it possible to capture data on road networks, traffic and journeys (Art. 2.1). These data are made available to all providers and users of applications and services (point 11 Preamble), and coordinated and consistent deployment of interoperable ITS is required throughout the European Union (preamble 23).

Under the European Data Strategy, national access points are an important component of the common European mobility data space and need to be built upon, especially in terms of data accessibility[41]. According to Art. 2(o) of Delegated Regulation (EU) 886/2013, an 'access point' is defined as a digital point of access where the road safety-related traffic data necessary for generating the minimum universal traffic information regarding road safety are collected, formatted and made available for exchange and reuse. In Spain, the Directorate-General for Traffic has implemented a National Access Point (NAP – http://nap.dgt.es) which provides high-quality real-time traffic information and collects the information provided by Spanish traffic management bodies in accordance with Delegated Regulation 886/2013[42].

2.2. Cooperative Intelligent Transport Systems (C-ITS) in the 2021 Proposal amending Directive 2010/40/EU

Directive 2010/40/EU, among the priority areas provided for under Art. 2, requires "linking the vehicle with the transport infrastructure" (Art. 2.1.IV). To make this a reality, it stipulates that measures must be taken to integrate the various ITS applications into an open in-vehicle platform. Furthermore, it states that progress should be made in the development and implementation of cooperative ITS, i.e. vehicle-to-vehicle, vehicle-to-infrastructure or infrastructure-to-infrastructure, based on facilitating the exchange of data or information. This would require the use of a standardised message format for the exchange of data or information between vehicle and infrastructure (Annex I).
However, among the priority actions of Article 3 that have led to the adaptation of Delegated Regulations, there is none explicitly related to the connection of vehicles to transport infrastructures.
On 13 March 2019, the European Commission adopted a Delegated Regulation on specifications for Cooperative Intelligent Transport Systems (C-ITS)[43], but it did not enter into force following an objection by the Council of the European Union[44].
At the present time, the above-mentioned Proposal for a Directive of the European Parliament and of the Council amending Directive 2010/40/EU on the framework for the deployment of Intelligent

[39] *Official Journal of the European Union*, L 123/77 of 19 May 2015.
[40] *Official Journal of the European Union*, L 247/1 of 18 September 2013.
[41] Proposal for a Directive amending Directive 2010/40/EU, COM/2021/813 final, preamble, point 7, at https://bit.ly/3XcKbaI, accessed 6 February 2023.
[42] At Dirección General de Tráfico, *Directive 2010/40/EU. Progress Report*, August 2017, p. 46, at https://bit.ly/3QGBO4L, accessed on 6 February 2023.
[43] At https://bit.ly/3iNgm1j, accessed on 6 February 2023.
[44] At https://bit.ly/3CTbQp4, accessed on 6 February 2023.

Transport Systems in the field of road transport and for interfaces with other modes of transport, of 14 December 2021, should be highlighted.

The Proposal notes that the European Commission has identified two problems: the lack of coordination of ITS across the European Union and the slow, risky and ineffective deployment of ITS. Furthermore, although the use of ITS is increasing, ITS deployment is geographically limited, and continuous and uninterrupted ITS services must be achieved throughout the European Union (Preamble).

Furthermore, the Proposal notes that, as a consequence of societal and technological developments, cooperative, connected and automated mobility requires more attention in the future (point 3 preamble). To this end, it identifies the deployment of intelligent transport systems as a key measure to create a connected and automated multimodal mobility system. For such purpose, the Proposal refers to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Sustainable and Smart Mobility Strategy – putting European transport on track for the future, of 9 December 2020[45], which stated that from its adoption until 2030, automated mobility would be deployed on a large scale (paragraph 9).

As mentioned above, the Proposal amends Art. 2.1.d.IV of Directive 2010/40/EU to include cooperative, connected and automated mobility services (CCAM) as a new priority area for the development and use of specifications and standards.

Among the contents of the Proposal, Art. 2 of Directive 2010/40/EU is amended to include cooperative, connected and automated mobility services as a new priority area for the development and use of specifications and standards (new Art. 2.1.d.IV).

The Proposal to amend Directive 2010/40/EU also proposes a new Art. 4.19 to define Cooperative Intelligent Transport Systems, or C-ITS, as those "intelligent transport systems that enable ITS users to cooperate by exchanging secure and trusted messages". In addition, a new Art. 4.20 is introduced to define a "C-ITS service" as an ITS service provided through cooperative-ITS.

Unlike the aforementioned 2016 Communication, the Proposal to amend Directive 2010/40/EU does not include a list of what C-ITS services are. In the "initial list", the communication cited, for example, slow-moving traffic warnings, road works warnings and weather conditions among the hazardous location notifications. In terms of signage applications, the Communication cites vehicle signage and vehicle speed limits, among others. It also foresees a "second list" of C-ITS services, such as information on fuelling stations or on-street parking management and information[46]. The future delegated regulation will then have to determine what the necessary C-ITS services are.

Indeed, should the Proposal be successful, the consideration of cooperative, connected and automated mobility as a new priority area will assure the future adoption of a new Commission Regulation for this area. The aim is to ensure a coordinated and efficient deployment of ITS in the Union as a whole, for which purpose specifications should be introduced, including, where appropriate, standards, setting out more detailed provisions and procedures, in addition to those already adopted (point 8 preamble). Priority should be given first to the four main areas of ITS development and deployment.

Prior to the adoption of the Delegated Regulation, the Commission will have to take into account the Annexes to the Proposal. The measures include the need to ensure the authenticity and integrity of messages for the majority of C-ITS services. The aim is to establish a common European C-ITS trust model for all C-ITS stations, irrespective of the communication technologies used. This model is to be implemented through the adoption of a policy on the use of Public Key Infrastructure (PKI) (preamble, paragraph 11). PKI is a combination of software, services and processes and asymmetric cryptographic technologies which enable organisations to secure C-ITS communications[47].

The Preamble of the Proposal states that future specifications on cooperative, connected and automated mobility should build on the experience and results already achieved in the field of ITS, C-ITS and cooperative, connected and automated mobility, notably in the context of the abovementioned C-ITS and CCAM platforms, the European Forum for Multimodal Passenger Mobility[48] and the

[45] COM/2020/789 final,
[46] COM(2016) 766 final, par. 3.1.
[47] COM(2016) 766 final, par. 3.2.
[48] At https://bit.ly/3GJP83x , accessed on 6 February 2023.

European eCall Implementation Platform[49]. These entities are listed in the Register of Commission Expert Groups and Other Similar Entities[50].

3. Classification and type-approval of autonomous and semi-autonomous vehicles

The EU's CCAM policy is based on the need to treat connectivity, cooperation and automation as complementary technologies which need to be brought together to achieve the objectives[51]. The joint vision of the European Union, through the CCAM, considers that the deployment of vehicles will significantly contribute to improving road safety and road transport efficiency, as well as ensuring the competitiveness of EU industry[52]. However, another policy option would be possible, as the process of "automating" vehicles is progressing without the need for their "connection" to 5G or satellite networks or their "cooperation" with other vehicles and road infrastructure.

There are already numerous Advanced Driving Assistance Systems (ADAS) available on the market. These include, for example, forward collision warning, autonomous emergency braking, lane departure warning and parking assistance[53].

Autonomous vehicles can be classified in terms of their technology into a number of categories ranging from non-automated vehicles (level 0) to fully automated vehicles (level 5). For example, in Spain, Instruction 15/V-113 of the Directorate General for Traffic of the Ministry of the Interior of 13 November 2015[54], as amended by Written Directive SGGMT 7/2020, incorporates into Spanish law the driving automation classification system created by the Society of Automotive Engineers (SAE), which is publicly available[55].

Table 1

Summary Table on Levels of Automation (Copyright © 2014 SAE International).

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration / Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
***Human driver* monitors the driving environment**						
0	**No Automation**	the *full-time* performance by the *human driver* of *all aspects* of the dynamic driving task, even when enhanced by warning orintervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the driving mode-specific execution by a *driver assistance system* ofeither *steering* or *acceleration/deceleration* using information about the driving environment and with the expectation that the *humandriver* perform *all remaining aspects* of the dynamic driving task	Human driver and system	Human driver	Human driver	Some driving modes

[49] At https://bit.ly/3H558OZ, accessed on 6 February 2023.

[50] The expert group locator is available at https://bit.ly/3iCDGif, accessed on 6 February 2023.

[51] COM(2016) 766 final, introduction.

[52] COM(2016) 766 final, par. 4.

[53] Á. Aparicio Benayas, La nueva movilidad será autónoma, conectada, compartida y eléctrica, Cesvimap: Publicación técnica del Centro de Experimentación y Seguridad Vial Mapfre 102 (2017) p. 46, with quote from the speaker Rubén Aparicio-Mourelo Alonso, deputy manager of CESVIMAP, R&D manager, in the series of conferences on New Mobility Patterns at the Catholic University of Ávila.

[54] See Dirección General de Tráfico: https://bit.ly/3Gc6uHt, accessed 6 February 2023.

[55] See V. Ilková, A. Ilka, Legal Aspects of Autonomous Vehicles - an Overview, in: Proceedings of the 2017 21st International Conference on Process Control (PC) (Štrbské Pleso, Slovakia, June 6-9 2017, pp. 428-429; Z. Altunyldiz (rapporteur), Legal aspects of 'autonomous vehicles, Committee on Legal Affairs and Human Rights of the Council of Europe, 2020, par. C.1.2.5; SAE website, at https://bit.ly/3RoOgox, accessed on 6 February 2023.

2	**Partial Automation**	the driving mode-specific execution by <u>one or more</u> *driver assistancesystems* of both *steering* and *acceleration/deceleration* using information about the driving environment and with the expectation that the *human driver* perform *all remaining aspects* of the dynamic driving task	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the driving mode-specific performance by an *automated drivingsystem* of *all aspects* of the dynamic driving task with the expectation that the *human driver* will *respond* appropriately to a *request tointervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene	System	System	**System**	Some driving modes
5	**Full Automation**	the *full-time performance* by an *automated driving system* of *all aspects* of the dynamic driving task under *all* roadway and environmental *conditions* that can be managed by a human driver	System	System	System	**All driving modes**

However, there are other ways of classifying autonomous driving, as there is still no international standard that unifies the different interpretations of this phenomenon. For example, in the United States, the National Highway Traffic Safety Administration (NHTSA) of the US Department of Transportation (DOT) classifies it into four levels[56].

The key question is the timeframe for the implementation of the various phases of automation. European Parliament Resolution of 15 January 2019 on autonomous driving in European transport, focusing on road transport (cars, trucks, buses and coaches)[57], states in paragraph (J) of its Preamble that there are levels of automation, with levels 1 and 2 already being on the market, while conditional, high and full automation levels (when a vehicle becomes self-driving) are expected to be available only in 2020-2030. In addition, driver assistance systems are therefore important as an enabling technology on the path towards full automation.

Autonomous cars are already a technological reality, as demonstrated by well-known manufacturers (e.g. Tesla Inc. and Google). Tesla will remove ultrasonic sensors from the Model 3 and Model Y in the coming months, and from the Model S and Model X in 2023, going on to relying only on camera vision[58]. However, recent accidents involving Tesla's semi-autonomous vehicles may be causing reputational damage to the concept of autonomous driving[59].

In Germany, since the first half of 2022, some Mercedes vehicles have already been approved for Driver Pilot and can be driven in highly automated mode at speeds of up to 60 km/h in situations with a high volume of traffic or in traffic jams on the appropriate motorway sections in Germany (SAE level 3)[60].

In Spain, at the presentation of the CECOT business association's report**,** Jorge Ordás**,** Deputy Director-General for Mobility and Technology of the Directorate-General for Traffic**,** stated in relation to autonomous vehicles and their circulation on the Spanish road network that by 2023 there would be a regulation that would allow vehicles to reach at least SAE level 3 of autonomy[61].

In the European Union, Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of

[56] B. A. Browne, Self-Driving Cars: On the Road to a New Regulatory Era, Journal of Law, Technology & the Internet 8(1) (2017), pp. 1-2.
[57] Official Journal of the European Union, C 411/2 of 27 November 2020.
[58] At https://bit.ly/3klYUkT, accessed on 6 February 2023.
[59] At https://reut.rs/3CPcR1c, accessed on 6 February 2023.
[60] At https://bit.ly/3Xukdz6, accessed on 6 February 2023.
[61] At https://bit.ly/3hX3zsG, accessed on 6 February 2023.

systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC, introduces a set of market surveillance rules for ensuring a genuine internal market for vehicles in the EU, including for driverless vehicles[62].

In addition, for the standardised deployment of autonomous cars, roads must be adequately prepared for them. Upgrading road infrastructure is mandatory, but it is a slower and more costly process that likewise takes place at a slower and more costly pace than in-vehicle automation[63]. Theoretically, the pilots carried out suggest that autonomous vehicles could be more suited to certain types of roads, such as motorways, than to smaller roads or roads with a higher concentration of elements, such as other cars, street furniture and pedestrians.

Autonomous vehicles rely entirely on artificial intelligence (AI) systems[64], with advanced sensor and radar systems to provide full 360° information about the context in which the vehicle operates. This information, together with that provided by digital satellite and on-board maps, must be processed to enable the vehicle to identify its location, plan and follow the route, and recognise and respond appropriately to traffic signs and driving hazards. This processing is carried out by AI systems using algorithms that are based on historical databases and are constantly updated to redefine the vehicle's operation in real-life conditions.

Autonomous vehicles are robots and giving robots the responsibility of transporting passengers or goods on public roads has huge safety implications. Although autonomous driving is expected to be safer than human driving, it is imperative that a great deal of regulatory work be done first to ensure full respect for the right to life, including provisions on potential threats and risks.

4. Research project on "Autonomous Driving and Legal Certainty in the Area of Transport".

Fully autonomous vehicles, SAE level 5, is a matter for the future. However, connected and partially automated vehicles are already raising legal issues due to their development and implementation[65].

It is well known that there is great technological interest in autonomous driving and connected mobility. The literature has mainly dealt with the technical issues of autonomous driving, as a search of these terms in Google or on academic websites such as Academia or ResearchGate shows.

The same is not true of the legal aspects. In Spain, there are no complete works in Spanish that deal with the legal phenomenon as a whole and only a few that deal with the sectoral aspects. The same is true outside of Spain. For example, one can consult the work edited by Maurer (2015), which includes only a few legal contributions and focuses predominantly on technical aspects. In English, some legal research on autonomous driving has been published.

The hypothesis taken as the starting point of the Research Project "Autonomous Driving and Legal Certainty in the Area of Transport", funded by the Ministry of Innovation and Science through the Knowledge Generation 2021 Programme of the Ministry of Science and Innovation in the modality of Non-Oriented Research Type B. PID2021-123070NB-I00 (2022-2025) is the European Commission's digital policy strategy on Cooperative, Connected and Autonomous Mobility (CCAM).

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[62] COM (2018) 293 final, par 3.1.

[63] C. Pitarque, X. Daura, Autopistas inteligentes y movilidad integrada, Carreteras: Revista técnica de la Asociación Española de la Carretera, 219 (2018), p. 53.

[64] See H. Lipson, M. Kurman: Driverless: Intelligent Cars and the Road Ahead, The MIT Press, 2016; J. A. Pattinson, H. Chen, S. Basu, Legal issues in automated vehicles: critically considering the potential role of consent and interactive digital interfaces, Humanities & Social Sciences Communications of University of Leeds 7:153 (2020), pp. 1-2.

[65] J. Andraško, O. Hamulák, M. Mesarčík, The digital development of the European Union: data governance aspects of cooperative, connected and automated mobility, Journal of Internet, Law and Politics Extra 34 (2021).

The Project is structured according to the list of questions compiled by the European Commission alongside others added by foreign legal authors[66] and the results of the previous research of the Project research team itself, made up of 24 researchers from 10 Spanish and foreign universities with extensive scientific experience and long experience and broad knowledge of their respective branches of law, in a clearly cross-disciplinary Project.

Table 2
Summary Table on specific objectives of the Project and research sub-groups

Ethics and fundamental rights and autonomous driving; privacy rights and data protection
Freedom of enterprise and competition law in autonomous driving
Planning and administrative controls of autonomous cars
Criminal liability for autonomous driving on land
Artificial intelligence and civil liability for damage caused by autonomous cars
Manufacturer's liability and autonomous driving
Insurance regime for semi-autonomous/automated cars and the risk of cyber attacks
Autonomous vessels: regulation, accidents, liability and insurance
Unmanned aircraft and urban air mobility. Liability and insurance

It is clear that this Project deals with a new area of research. There is no other Legal Research Group in Spain specifically focused on autonomous driving and the legal issues it raises across the legal system as a whole.

In conclusion, with legal certainty, which is the overall objective of the Research Project, the speed of implementation of cooperative, connected and automated driving would be multiplied and thus the benefits inherent in this technology would be achieved more rapidly.

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[66] See K. Noussia, Autonomous vehicles: legal considerations and dilemas, in: P. Marano, K. Noussia (Eds), Insurtech: A legal and Regulatory View, Springer Nature Switzerland AG 2020, pp. 253-270; Altunyldiz (rapporteur), Legal aspects of 'autonomous vehicles, Committee on Legal Affairs and Human Rights of the Council of Europe, 2020; V. Ilková, A. Ilka, Legal Aspects of Autonomous Vehicles - an Overview, in: Proceedings of the 2017 21st International Conference on Process Control (PC) (Štrbské Pleso, Slovakia, June 6-9 2017; J. A. Pattinson, H. Chen, S. Basu, Legal issues in automated vehicles: critically considering the potential role of consent and interactive digital interfaces", Humanities & Social Sciences Communications of University of Leeds, 7:153 (2020).

6. References