AUTOCITS – Regulation study for interoperability in the adoption of autonomous driving in European urban nodes

Rodrigo Castiñeira, Jose Naranjo, Mauro Gil, Felipe Jimenez, Pedro Serra, Alerto Valejo, Alireza Asvadi, Cristiano Premebida, Mohammad Abualhoul, Fawzi Nashashibi

AUTOCITS – Regulation study for interoperability in the adoption of autonomous driving in European urban nodes

Rodrigo Castiñeira [a*], Jose Eugenio Naranjo [b], Mauro Gil [a], Felipe Jimenez [b], Pedro Serra [c], Alerto Valejo [c], Alireza Asvadi [d], Cristiano Premebida [d], Mohammad Y. Abualhoul [e], Fawzi Nashashibi [e]

[a] *Indra Sistema S.A (Indra), C/ Mar Egeo, 4, 28108. San Fernando de Henares. Madrid, Spain**
[b] *Instituto Universitario de Investigación del Automóvil (INSIA), University Polytecnic Madrid Spain*
[c] *Instituto Pedro Nunes (IPN), Rua Pedro Nunes, 3030-199 Coimbra, Portugal*
[d] *Dept of Electrical and Computer Engineering, University of Coimbra (UC), 3030-290 Coimbra, Portugal*
[e] *Institut National de Recherche En Informatique Et En Automatique (INRIA), Paris, France*

1 Abstract

The technological advances of autonomous and connected road vehicles have been shown an accelerating pace in the recent years. On the other hand, the regulations for autonomous, or driverless, road vehicles across Europe still deserve much attention and discussion. In this paper, we introduce the AUTOCITS project which has the main goals of conducting studies on the regulations for the adoption of autonomous cars in Europe, and also to carry out C-ITS Pilots in Madrid, Paris and Lisbon.

AUTOCITS aims to contribute, directly or indirectly, to European related policy and reference documents on vehicle automation, regulations, connected and automated driving, and related road infrastructure issues due to the trend towards higher levels of connectivity and automation, where information provided via C-ITS can be truly catalyst for connected and autonomous driving. The project will specially focus on the communication links performance and connectivity between automated vehicles using C-ITS applications connectivity and automation;, in particular, applications increase surrounding environment awareness in relation to infrastructure and ensure both road and driver safety requirements issues and using the regulation framework.

AUTOCITS is an innovation project (CEF Program) that aims to facilitate the deployment of autonomous vehicles in urban nodes by developing intelligent transport services based on cooperative systems (C-ITS) that will enable vehicles, users and infrastructures to communicate, exchange, and share information.

2 Introduction

A series of initiatives have taken place in Europe since the publication of the C-ITS platform report in January 2016, which have highlighted the interest of the European Commission in making the EU a world leader in autonomous driving, following the ideas set out in the European Commission's strategy in Annex I of directive 2010/40/EU or later in 2011 White Paper on Transport "Roadmap to a Single European Transport Area - Towards a Competitive and resource efficient transport system", which already indicated the need for 2020 to harmonize and deploy road safety technologies, such as driving aids, intelligent speed limits, etc. Cooperative systems are considered as catalysts for the actual deployment of autonomous driving, in order to overcome the limitations inherent in a vehicle circulating without any interaction with others. For this reason, various deployment projects are being carried out involving both technologies: V2X communications and vehicles automation.

EU Commissioner for Transport Ms. Violeta Bulc said in the presentation of the C-ITS report in January, 2016: "Digitisation of transport is a priority of my mandate as it has the potential to create new growth and smarter mobility. I want to see connected cars on European roads by 2019 and today's report (C-ITS Platform Report) is an important milestone towards that objective. It is nevertheless only a first step, more deliverables will come throughout 2016". In this regard, AUTOCITS (www.autocits.eu) aims to contribute to this mentioned C-ITS

* Corresponding author. Tel.: T +34 682 14 42 60.
E-mail address: rcastineira@indra.es

Platform report as well as to other related policy and reference documents on connected and autonomous road vehicles.

The remaining of this paper is organized as follows. Section 2 briefly introduces the AUTOCITS project and explains the structure and aims of the three pilots that will be deployed. Section 3 provides an overview of the project. Section 4 presents the initial results of the analysis of the regulation framework related to autonomous driving at European and international level. Section 5 explains each of the pilot projects to achieve interoperability between C-ITS services. Section 6 provides the description of the International Cooperation Group. Section 7 concludes with a discussion on the next results that are expected to achieve.

3 The Project

The AUTOCITS project, co-financed by the European Union through the CEF Program, proposes 3 pilots with different cooperative systems in 3 European locations: Madrid, Paris and Lisbon. The scenarios presented in the project include the following main characteristics:

- Include different types of roads in urban environments (urban roads, motorway connections, etc.);
- Provide an open testing environment where several C-ITS services, connected, instrumented and autonomous vehicles will be tested;
- Different parties involved in the different levels of traffic management will be considered, involving both transport operators and traffic authorities together with industrial and academic entities in Spain, France and Portugal;
- Demonstrate the maturity of C-ITS services in urban environments, based on the state-of-the-art deployment of C-ITS deployments on European highways;
- Enable the assessment of the potential C-ITS services to increase road safety and improve traffic.

AUTOCITS includes autonomous driving tests in both open and closed traffic environments to assess the applicability of traffic regulations and V2X services under different conditions and scenarios. Different elements will be addressed for the deployment of cooperative services and autonomous driving, such as: real-time monitoring, vehicular communications, maneuver strategies in complex traffic situations, and high-level strategies in control center for the management of autonomous driving.

In addition, the project studies the technical and legal requirements for an interoperable transnational navigation, contributing to different standardization groups, the creation of certification processes and homologations. Thus, the AUTOCITS project is organized around two types of activities:

- *Regulation study:* study of regulations on autonomous driving at European and international level
- *Pilot deployment*: deployment of three pilots in urban nodes to assess the link between C-ITS services and autonomous driving

4 Regulation Study

The regulation study follows the guidelines set out in recent years by the European Commission and, although there is currently no harmonized regulatory framework, there are a number of initiatives working towards this. In the study of the regulations for the circulation of autonomous vehicles in conditions of free traffic in urban nodes, it has been analysed the regulation framework mainly at European level - starting with the countries involved in the project (Spain, France and Portugal) and other advanced European regulations-, but other international regulations has been also considered, such as the US, Singapore, South Korea, China, Japan or Australia.

Another entity that has been taken into account for this initial study is the activity GEAR2030, a group of experts created by the Commission in January 2016 to coordinate the challenges of autonomous driving. This initiative has delivered a publication highlighting that no major legal impediments to the deployment of partially automated vehicles (Level-3) are identified, but for higher levels of automation and automobile connectivity, changes in UE legislation are required (such as traffic rules, connectivity, driving license, road safety, liability framework, traffic signs, insurance, theft and cybersecurity, privacy and data protection, etc.).

Table 1 shows the initial results of the regulation study, an analysis of the most advanced regulations in Europe. It is relevant to highlight the importance of this exercise as several analyses have been found about the deployment of C-ITS services or automated driving but none of them addressing the regulation framework. The analy-

sis has considered aspects such the link to the Vienna Convection, the current legislation and the testing procedures, the status of the current legislation and its requirements, of European and international countries, being the results of the European countries shown in the table. A more detailed analyses of the current regulations can be found at www.autocits.eu:

Elements	Spain	Paris	Portugal	UK	Germany	Sweden	The Netherlands	Italy	Denmark
Linked to Vienna Convention	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Current Legislation	Code for Vehicles and Traffic Law and Code for Traffic Rules	Code for Vehicles and Traffic Law	Portuguese Road Code	The Highway Code, road safety and vehicle rules	German Highway Code	Code for Vehicles and Traffic Law	Reglement verkeersregels en verkeerstekens	Codice della Strada and Regolamento di Attuazione	Code for Vehicles and Traffic Law
Testing Procedures	Yes. Autonomous driving is allowed, regulation in November 2015	Yes. Autonomous driving is allowed for testing purposes	Agreement between road administrations and concessionaires	Yes. Autonomous driving is allowed for testing purposes.	Yes. A section of the A9 autobahn is to be set up	Yes. Autonomous driving is allowed for testing purposes	Yes. Autonomous driving is allowed for testing purposes	Generally are not allowed on public roads for safety reasons	Yes. Autonomous driving is allowed for testing purposes
Certification Procedures	Vehicle manufacturer shall provide certification	Authorities shall provide a certification	No certification / procedures	No certification / procedures	No certification / procedures	Yes	Companies must first that the tests will be conducted safely	-	Permission to the Transport, Construction and Housing Ministry
Laws to be modified	Code for Vehicles and Traffic Law and Code for Traffic Rules	Code for Vehicles and Traffic Law and Code for Traffic Rules	-	The Highway Code, road safety and vehicle rules	Federal Government, Draft Act to Amend the Road Traffic	-	-	Codice della Strada and Regolamento di Attuazione	-
Initial Modifications for SAE3-5	Regulation on assisted parking of motor vehicles	Fully autonomous discussed in context of road safety	-	Liability Initiatives	Law in the Cabinet: Automated driving on the way	-	-	-	-

Table 1 Initial Results of the Regulation Study within the AUTOCITS project.

Based on the analysis of the current legislations in the European countries, it has been drawn that the countries that are not linked to the Vienna convention are the more progressed ones in terms of testing possibilities, as they present less legislative obstacles and restrictions. But regardless of the Vienna Convention's ratifications, although Spain and UK are non-ratified members, some member states have made the amendments and/or exceptions necessary to allow testing and deployment, under specific conditions, of AVs in real-world traffic scenarios. This indicates that the interest of the countries in this direction is becoming more and more evident. AUTOCITS will continue monitoring the different regulation activities in order to provide authorities with guidelines at the end of the project.

5 Pilots

The AUTOCITS project will carry out a comprehensive assessment of cooperative systems and autonomous driving through a set of pilots in the Atlantic Corridor of the European transport network. The pilots will be deployed at several European test sites in Madrid, Paris and Lisbon. Therefore, the characteristics for each pilot site have some differences that will be presented in the following sub-sections. In addition to their heterogeneous appearance the test sites are operated by different entities with different vehicles and different infrastructure equipment.

In these three pilots, the connected and autonomous vehicles will circulate along the urban traffic interconnection zones with interurban in the pilot cities to analyze the continuity of autonomous driving and V2X information flow when moving from one urban area to another and to ensure interoperability between countries. They will receive information from the control center through ITS (Road Side Units) equipment and through hybrid communications using the ITS-G5 (Vehicular Communications) and LTE (Mobile Communications) communications technologies in an approximation to what it would imply the 5G communication, which seeks to integrate the different communication technologies on a single specification

5.1 Madrid Pilot

The selected pilot in Madrid includes the highway between the M50 and the M40. It is a dedicated high occupancy reversible lane whose direction is configured according to the needs of the traffic, and involves traffic flow of about 20,000 vehicles per day. Three C-ITS services have been selected to be deployed in the pilot of Madrid, being part of the C-ITS Day one service set defined by the C-ITS platform:

- **Slow or stationary vehicle(s) & traffic ahead warning**: The function aims at avoiding (fatal) rear end collisions which are often caused by traffic jams on highways. With help of V2X-communication, vehicle systems are able to warn the driver even before the traffic jam could be noticed by the driver himself. Thus, the driver is informed in time and can react smoothly and safe.
- **Road works warning**: The traffic management center, through V2I communications, provides information about a construction zone to vehicles by broadcasting messages to vehicles in the vicinity of the dangerous location.
- **Weather conditions**: Information about bad weather conditions ahead is generated by the traffic management center and communicated to oncoming traffic to avoid entering of areas with adverse weather conditions at too high speed.

These C-ITS services have been selected because they are representative use case extensions of the functionalities the current traffic management centers perform that can be deployed under the existing infrastructure and available services. Additionally, they are based in V2I communications and allow demonstrating the benefits of the upgrading of the existing technology installed in the Spanish roads.

These services will allow the traffic control center (TCC) to send incidents or events to the connected and to the autonomous vehicles to enhance the information sent to the drivers through the variable message signs. The final objective of these services is to improve mobility and road safety by sending warnings of stopped vehicles, vehicles broken down, information of adverse road conditions such as icy surface, etc.), or other information such as traffic information road works, etc.

The tests in this environment will be carried out according to the regulation approved by the DGT (Spanish Road Authority), which makes available to companies and research centers an open standard for testing, as it is not conditioned by the Vienna Convention.

5.1.1 Madrid C-ITS Infrastructure.

It includes the ITS equipment on road and Traffic Management Center. The infrastructure that the pilot of Madrid will need is formed by the typical subsystems of a Cooperative ITS application. Each of these subsystems, that are interconnected to build up the pilot, will be considered as an ITS station. The following types group the different stations that will be part of the pilot:

- **Traffic central control (TCC).** In charge of the high level information management and operated by the Spanish traffic Agency.
- **ITS Center (C-ITS).** Responsible of analyzing the information retrieved by the TCC and of launching the C-ITS messages when necessary.
- **Roadside ITS Units** (R-ITS or RSU). The ITS V2X equipment installed in the road, including the interconnection with the intermediate networks to connect the road with the ITS center.
- **Vehicle ITS** (V-ITS or OBU). Onboard V2X units able of receiving the C-ITS data. They are installed in the connected vehicles as well in the autonomous ones.
- **Personal ITS** (P-ITS). Devices to transmit to the drivers visual information about C-ITS messages.

5.1.2 Madrid C-ITS equipment

The Madrid Pilot also defines the equipment for communication and data packets definition, including the message exchange architecture and protocols, the communication networks equipment and the associated software to support the services. Four elements have been defined to support the deployment of the C-ITS services of the Madrid pilot:

- **ITS central station:** this server connected to the current DGT TCC will collect incidents, road works, and weather information through the DATEX II interface and will send this information to the RSU-Master to order the broadcast of an event.
- **RSU-Master:** roadside station responsible for broadcasting an event to vehicles coming from the TCC. It is necessary that this device has direct connection with the C-ITS station and is equipped with antennas with ITS G5 (802.11p) technology. The manufacturer "Codha wireless" is the provider of this kind of equipment that will be used in Madrid.
- **RSU-Repeater:** roadside station responsible for repeating events from the main RSU where these do not have coverage. These devices will not have direct connection to the C-ITS station and will not process events; they will only repeat the signal through the ITS G5 antennas. This equipment used as repeaters are the INSIA-V2X technology.
- **OBU-Autonomous and connected cars:** The INSIA-V2X ITS stations will also be used to support the onboard units. The OBUs are equipped with ITS G5 (802.11p) technology in order to receive the RSU information, as well as all sensors and actuators necessary for the connected and autonomous vehicles.

5.1.3 Madrid Connected & Autonomous Vehicles.

Two kinds of vehicles will take part in the Madrid pilot, in order to demonstrate the performance of the C-ITS deployment. C**onnected vehicles**, that are manually driven and equips V2X onboard units and human machine interfaces to transmit to the driver the C-ITS messages. **Autonomous vehicles**, whose automatic driving system is connected to the V2X onboard unit and is able of automatically reacting to the cooperative messages received. Four testbed vehicles will be used in the pilots of connected vehicles. All of those vehicles are equipped with INSIA- OBU V2X units in order to connect and receive information from the installed RSUs, needed to enable the planned deployment of the C-ITS. Two autonomous vehicles are part of the equipment that will take part on the pilots: a Citroën C3 Pluriel and a Mitsubishi iMIEV (Figutr 2). These vehicles are considered of automation level 2 and 3 respectively, and are also equipped with INSIA-OBU V2X units.

5.2 Paris Pilot

The French Pilot defined to deploy a 10-km segment of A13 highway that belongs to the French part of the Atlantic Corridor. The chose pilot location is considered as one of the main traffic veins toward Paris city. As for Day 1 C-TS services deployment, two driving-assistance I2-based services were elected for the French pilot, together with a third V2X service we list as Other hazardous notification as follows:

- **Road works warning:** On-road working zones, such as construction, reparation, or maintenance activities are pre-identified geo-graphically and reported to the Traffic Management Center (TMC). The TMC will then notify all RSU's before and after these zones to start broadcasting these warning messages over I2V.
- **Weather conditions:** Weather conditions updates are acquired by a third-party online-service and fed to the TMC which will identify the geographical location of what can be considered hazardous weather conditions. TMC will process and notify the corresponding RSU about the situation, and trigger warning messages varies from slow-down up to stop traffic in severe hazard situations.
- **Other hazardous notifications:** These kind of notifications are mainly about any in-vehicle local fatal or error may affect the autonomous vehicle behaviour and cause hazardous situation either in traffic flow or lane blocking. In this scenario, the V2X communication is broadcasting a Decentralized environmental Notification Message (DNM) locating and identifying the affected vehicle.

The three French C-ITS services are selected to cope with both Spanish and Portuguese essential functionalities and to establish interoperability between the three pilots. Moreover, the chosen services are demonstrating both I2V and V2X and using CAM and DENM standardized messaging for vehicular communications.

5.2.1 Paris C-ITS Infrastructure

The infrastructure of the pilot contains several connected subsystems that allow proper information exchange

and ensures the C-ITS services functionality. The following sub-systems are defining the pilot general infrastructure:

- **ITS Central Station:** The central station is a server connected to the Y-cloud and meant to collect incidents, updates, events, road works, and weather information through the Y-Smart middleware and then send this information to the RSU's to trigger the broadcast of the specific event.
- **Roadside ITS (R-ITS or RSU**): Roadside stations are installed along the pilot and responsible for passing the TMC event to vehicles. This unit has a direct connection with the C-ITS station over 4G and with the surrounding vehicles over ITS G5.
- **Vehicle ITS (V-ITS or OBU):** On-board V2X units able of receiving the C-ITS data. They are installed in both connected and autonomous vehicles.
- **Personal ITS (P-ITS):** HMI interface devices used to display visual information to the drivers about C-ITS messages.

5.2.2 Paris C-ITS equipment

Four elements have been defined to support the deployment of the C-ITS services in the Paris pilot, including the communication equipment, the message exchange architecture and protocols, the communication networks equipment and the associated software to support the services:

- **ITS central station:** this server connected to the Y-cloud and will collect incidents, updates, events, road works, and weather information through the Y-Smart Middleware provided by YoGoKo and then send this information to the RSU- Master to trigger the broadcast of an event.
- **RSU-Master:** Roadside stations Y-RSU are deployed by the French Pilot, where the equipment that hosts this software will be of the local French manufacturer "YoGoKo wireless". The units certified to communicate over ITS G5, 4G and read in-vehicle read CAN-bus.
- **OBU-Autonomous and connected cars:** The YoGoKo boxes Y-Box OBU's are equipped with ITS G5(802.11p) technology and fully compatible with the RSU's to transceive the RSU information, as well as all sensors and offering actuators necessary for the vehicle.

5.2.3 Paris Connected & Autonomous Vehicles.

For the French Pilot Four identical vehicles of model Citroen- C3 will be used in the French pilots as connected vehicles. Each **connected vehicle** has a single highly accurate GPS, an on-board computer and direct access to the CAN bus, with 3/4G Internet access together with an OBU supporting the 802.11p. All the four vehicles are also equipped with OBU V2X units, IMU, Camera, V2X antennas and some other sensors. Moreover, one **autonomous vehicle** will take part on the French pilots. The vehicle is a Citroën C1 Evie, fully electric autonomous vehicle. This vehicle is fully equipped with communication and represents an excellent opportunity to test the interoperability between different pilot sites.

5.3 Lisbon Pilot

The Lisbon's Pilot will be held at two locations. The first location will be at highway A9 - CREL ("Circular Regional Exterior de Lisboa"), beginning near National Stadium in Jamor and ending at A1. This A9 intercepts with others highways, like A5, A16, A8 and A10, and major regional roads, like IC19, IC22. The section of the highway where the pilot will be deployed is a fragment with 7km between the beginnings, near of National Stadium and exit number 2C, intersection with A16. This selected site in Lisbon involves a traffic flow of about 19 500 vehicles per day. In the second location, autonomous shuttles will be used in an urban node over a national road that connects the beginning of A9 to the Faculty of Human Kinetics, enabling also the test of C-ITS services under an urban environment. For Lisbon's pilot, three C-ITS services have been selected to be deployed:

- **Slow or stationary vehicle(s) & Traffic ahead warning:** This service provides warning messages regarding slow or stationary vehicle on the road (due to an accident, a breakdown, traffic ahead or any other reason), diminishing the risk of accident associated to such dangerous situations, e.g. avoiding the risk of cause a succession of collisions and also contribute to traffic management. In this case, it is required that connected vehicles detects potential dangerous conditions and broadcast the situation using V2X communication;
- **Weather conditions:** The weather information service is broadcasted using V2X communication, allowing the connected vehicles to receive warnings messages that may have impact in their vehicles safety, e.g.: tyres adhesion, visibility or extreme weather conditions;

- **Other hazardous notifications:** This case aims to inform the connected vehicles of any hazardous location either temporary or permanent to reduce the risk of accident, like surface condition and obstacle on the road. For this the vehicle must be capable to detect the hazardous location and broadcast this information.

These C-ITS services, in the same way as in the pilot sites of Madrid and Paris, have been selected to demonstrate the benefits over the existing technology installed in the Portuguese roads (e.g. variable message signs), by providing information for and from the autonomous and connected vehicles, and thus improving mobility efficiency and safety. Moreover, another relevant aspect that will be tested is the interoperability of the C-ITS, as vehicles from other pilot sites will be used on Lisbon pilot.

5.3.1 Lisbon C-ITS Infrastructure

The Lisbon pilot site will include a Traffic central control (TCC) and ITS equipment. The TCC system operates using a third-party Cooperative ITS application, gathering information coming from different ITS equipment along several highways, and it is operated by the company that has the A9 highway concession, being therefore responsible for to manage the traffic management. The infrastructure needed for Lisbon's pilot at A9 highway is composed by the typical subsystems of a C-ITS application. Each of these sub-systems, that are interconnected to build up the pilot, will be considered as an ITS station and they could be grouped as follow:

- **Centre ITS station:** This station is the gateway of TCC with the C-ITS application, receives the information on DATEX II format from TCC and deals with the alerts broadcasted through the RSUs and OBUs.
- **Roadside ITS (RSU):** This station is the one that acts as a bond between the Centre ITS station and the vehicles on the road, by exchanging information between the vehicles and the control centre, disseminating alerts from the control centre to the vehicles, depending on what kind of C-ITS service is deployed.
- **Vehicle ITS station (OBU):** This station equips the vehicle and has two roles. As an emitter it is responsible for collecting information from vehicle sensors to provide information on both the condition of the vehicle and different incidents that may take place in the road; as a receiver it is responsible to receive the events sent from the R-ITS (RSU) or from other V-ITS stations.

5.3.2 Lisbon C-ITS equipment

The C-ITS services to be deployed at Lisbon pilot site will need the following equipment:

- **ITS-G5 from A-to-Be:** This equipment can work as RSU or OBU, depending of the services to be installed.
- **INSIA- OBU V2XOBU used in UPM autonomous car:** The "INSIA" partner will supply an autonomous car equipped with an INSIA- OBU V2XOBU, able to interpret the information that RSU disseminates and to act accordingly.

5.3.3 Lisbon Connected & Autonomous Vehicles.

The Lisbon pilot will have three types of vehicle technologies:

- **Autonomous Vehicles (AV) -** One autonomous vehicle, a Mitsubishi iMIEV testbed from Madrid Pilot Site, representing a good opportunity to test the interoperability between pilot sites.
- **Instrumented Vehicles -** One instrumented vehicle from ATLASCAR research group from the Department of Mechanical Engineering of the University of Aveiro.
- **Autonomous Shuttles -** Two autonomous shuttles based on an ITS technology called MOVE developed by IPN; they are driverless electric vehicles, designed to be easily used for small trips at low speed, with the aim to be a "horizontal lift" able to connect buildings of private or semi-private spaces.

The autonomous and instrumented vehicles to be deployed in the highway, depending on the technology level of each one, would be tested under three conditions: dedicated lane, shared lane and road without restrictions (intended scenario). The autonomous shuttle would be tested under only one condition, dedicated lane. The test events used on these scenarios, some will be simulated (they will be generated virtually at the Traffic Management Centre and broadcasted by the Road Side Unit) and others will be realistic (e.g. the vehicles used for this purpose will be at the roadside and will generate the event messages).

6 International Cooperation Group

In other to involve different experts outside the project, AUTOCITS has created the International Cooperation

Group (ICG) that brings together experts from the automated and autonomous driving field, which represents one of the target audiences that AUTOCITS aims to reach and crate synergies to disseminate the action activities. It involves Road Operators (both private and public), Road Authorities, Insurance Companies, Car manufacturers and other entities, that can join through the project webpage. This stakeholders group has been created in order to have an on-going open dialogue within the sector. Members of this group are invited to attend the workshops organized by project partners and main action results (Press Release, Deliverables, etc). With this group, the Action aims to incorporate their guidelines and recommendations into the project results.

7 Conclusion

The AUTOCITS project starts from the premise that in the coming years, autonomous driving will replace conventional driving as we know it today, with the aim of increasing the efficiency and safety of transportation. Today there is a defined strategy for this, but there is a process of harmonization and standardization to go, which guarantees, on the one hand the reliability and safety of automated driving, and on the other, interoperability at different levels between different countries, different manufacturers, different technologies, etc. From AUTOCITS we expect to contribute in the following points:

- **C-ITS services as catalysts for autonomous driving**: With the deployment of C-ITS services in the three pilots, the project seeks to provide a vision of how C-ITS services can facilitate the deployment of autonomous vehicles and especially in the connection between the main road network with urban nodes, where the complexity of the environment requires additional technologies to those of the vehicle.
- **Progress in interoperability**: C-ITS services has been defined in the pilots to ensure interoperability that will be validated through a set of cross-tests between Spain, Portugal and France. Initial tests between different RSUs from different manufactures have been performed so far.
- **Encouraging cooperation and knowledge**: Through the International Collaboration Group, AUTOCITS seeks to capture the vision of the transport sector on how C-ITS services can contribute to the deployment of autonomous driving and in which aspects Autonomous vehicles regulations should evolve.
- **Collaboration with the C-ROADS platform**: During the project, AUTOCITS has shared its initial results with this platform to contribute to the specifications and agreements for harmonized and interoperable infrastructure deployments; as well as with the C-ITS platform to identify new services that facilitate the deployment of the autonomous vehicle
- **Advances in standardization**: Road Works Warning messages allow infrastructure to send parameters such as recommended speed, change of lane, etc. that can be used to enhance autonomous driving. Further modifications on other standardised messages could be suggested at ETSI (European Telecommunications Standards Institute) in order to allow cooperative systems to send added-value information from traffic control centers, in order to facilitate autonomous driving, and that currently do not contemplate the ETSI standards.
- **Added value:** Tests with connected and autonomous vehicles allow us to analyze what added value information can be provided to the control centers to improve mobility management. So far, it has been identified how road works information stored in the control centers can be sent in advance to vehicles to enhance their safety maneuvers.
- **Contribute to the new regulatory framework**: unlike other previous studies more focus on technical aspects of autonomous driving, AUTOCITS has performed a global analysis on legal aspects in order to generate recommendations in order to contribute to a more homogeneous legislation in European countries

8 Acknowledgments

We cordially thank all our colleagues from the AUTOCITS project for their contributions, inspiring discussions and fruitful collaborations. Research leading to these results received funding from the Connected Europe Facility (CEF) Program under grant agreement no. 2015-EU-TM-0243-S (www.autocits.eu).

9 References

- Jiménez, F., et al., 2012. Libro Verde de los Sistemas Cooperativos. ITS Spain and Technical University of Madrid.
- C-ITS Deployment Platform, "Final Report", January, 2016: http://ec.europa.eu/transport/themes/its/doc/c-its-platform-final-report-january-2016.pdf.
- C-Roads Platform, 2016. https://www.c-roads.eu/platform.html

- White Paper on Transport "Roadmap to a Single European Transport Area - Towards a Competitive and resource efficient transport system"
- Executive summary of AUTOCITS deliverable documents D4 (AUTOCITS Pilots Design) and D5 (Report on international and European and International regulation for autonomous driving), available at http://www.autocits.eu/, 2017.