5GMOBIX

5G for cooperative & connected automated MOBIlity on X-border corridors

D6.4

Plan and preliminary report on EU policies and regulations recommendations

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Control sheet

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ABBREVIATIONS

Abbreviation	Definition
CBC	Cross Border Corridor
CCAM	Cooperative, Connected and Automated Mobility
DoA	Description of Action
EC	European Commission
GA	General Assembly
TS	Trial Site
TSL	Trial Site Leader
WP	Work Package
WPL	Work Package Leader
X-border	Cross-border
SAE L4	Semi-autonomous vehicles LEVEL 4: No human interaction required
EU	European Union
EC DGs	European Commission Directorates-General
JRC	Joint Research Centre
UNECE- WP29	United Nations Economic Commission for Europe
ARCADE	Aligning Research & Innovation for Connected and Automated Driving in Europe
CSA	Coordination and Support Action
CAD	Cooperative and Automated Driving
5G-PPP SB	5G-Public Private Partnership
5G-AA	5G Automotive Association
CAM	Computer-aided manufacturing
ITS	Intelligent Transport Systems
V2X	Vehicle-to-everything wireless communications
UN	The United Nations

ICT	Information and Communications Technology
CARTRE	Coordination of Automated Road Transport Deployment for Europe
US	UNITED STATES
AD	Automated Driving
KETs	Key Enabling Technologies
ENSEMBLE	ENabling SafE Multi-Brand platooning for Europe
GDPR	General Data Protection Regulation
AV	Autonomous Vehicle
EEA	European Economic Area
DPO	Data Protection Officer
CERTs	Computer emergency response team
EC	European Commission
ECHR	European Charter of Human Rights
OEM	Original Equipment Manufacturer
UNECE	The United Nations Economic Commission for Europe
E/E	Electrical and/or electronic
ADAS	Advanced Driver Assistance Systems
V&V	Verification and Validation
DSC	Dynamic Stability Control
5GAA	5G Automotive Association
ETNO	European Telecommunications Network Operators' Association
GSM	Global System for Mobile Communications
GSA	Global mobile Suppliers Association
ECCC	European Electronic Communications Code
BEREC	Body of European Regulators for Electronic Communications
NRAs	National Regulatory Authorities

IoT/M2M	Internet of Things / Machine to Machine
OTA	Over-the-air
SIM	Subscriber identity module
ITU	International Telecommunication Union
MS	Members States
ECN/ECS	Electronic Communications Networks or Services
RE	Radio equipment
OBUs	On-Board Units
RSUs	Road-Side Units
DSRC	Dedicated Short-Range Communications
CE	Conformité Europënne
FCC	Federal Communications Commission
GCF	Global Certification Forum
PTCRB	PTCRB CERTIFICATION
RED	Radio Equipment Directive
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardization
ETSI	European Telecommunications Standards Institute
ERM	Electromagnetic compatibility and Radio spectrum Matters
EMC	Electromagnetic Compatibility
SRD	Short-Range Devices
BRAN	Broadband Radio Access Networks
SRD	Short Range Devices
HIPAA	Health Insurance Portability and Accountability Act of 1996
HITRUST	Health Information Trust Alliance
GPO	The Government Printing Office

RF	Radio frequency
WLAN	Wireless Local Area Network
NFC	Near-field communication
PCS	Process Control Systems
ISM	Industrial, scientific, and Medical
LTE	Long Term Evolution
CEF	Connecting Europe Facility
WRC-19	2019 World Radio Communication Conference
5G-PPP	The EU Public-Private Partnership
NBPs	National Broadband Plans
NIS	Network and Information Systems
MNOs	Mobile Network Operators
FDI	Foreign Direct Investment
ENISA	European Union Agency for Cybersecurity
MNOs	Mobile Network Operator
SDOs	Standards Developing Organizations
CAD	Connected and Automated Driving
5G PPP	5G Infrastructure Public Private Partnership
SMEs	Small and Medium-sized Enterprises
DSIs	Digital service infrastructures
EATA	European Automotive – Telecom Alliance
5GAA	5G Automotive Alliance
EATA	European Automotive and Telecoms Alliance
UK	UNITED KINGDOM
MITMA	The Spanish Ministry of Transports, Mobility and Urban Agenda
MoU	Memorandum of Understanding

ACEA	European Automobile Manufacturers' Association
CEDR	Centre for Effective Dispute Resolution
ASECAP	European Association of Operators of Toll Road Infrastructures
SLA	Service-Level Agreement
ADAS	Advanced Driving Assistance Systems
VRUs	Vulnerable Road Users
Euro NCAP	European New Car Assessment Programme
QoS	Quality of Service
KPIs	Key Performance Indicators
NAS	Network-attached storage
CAPEX	Capital expenditures
Abbreviation	Definition
CBC	Cross Border Corridor

EXECUTIVE SUMMARY

Deliverable *D6.4 "Plan and preliminary report on EU policies and regulations recommendations"* presents a complete cycle of requirements gathering, analysis, target group and framework identification, and finally a synthesis exercise. This has resulted in a first step in a comprehensive overall view on the major issues that are of concern to the relevant stakeholders in deployment of 5G CCAM solutions, such as the Automotive Industry, Road Operators, the ICT sector and more. As a result, the following short-term (2020) regulatory needs were identified:

- A common European understanding on necessary digital infrastructure quality/coverage for Level 3;
- Joint approach between telecom and vehicle industries to support CAD;
- Common European understanding on safety & security validation (when are the systems safe enough);
- Coordinated European and Member State programs to support global competitiveness;
- Adaption of road traffic rules in Member States;
- Align General Data Protection Regulation within the European member states to ensure privacy.

To achieve that, it is crucial that existing and future policies are implemented in order to:

- Align roadmaps and priorities for a coordinated 5G deployment across all EU Member states;
- Make provisional spectrum bands available for 5G ahead of the 2019 World Radio Communication Conference (WRC-19);
- Promote early deployment in major urban areas and along major transport paths;
- Unite leading actors in working towards the promotion of global standards;
- National strategies and plans by EU Member States, available national data on 5G deployment including coverage and quality;
- Preparation and execution of spectrum assignments by public authorities as well as 5G public funding for network deployment and R&I;
- Reduce the cost and increase the speed of deployment of very high capacity networks, notably by removing unnecessary administrative hurdles;
- Common message sets/protocols dedicated to police interactions shall be standardized in international level for suspicious events;
- Roaming, and the obvious implication for Cross Border 5G CCAM applications and scenarios;
- Open Internet, and the implications for Cross Border CCAM solutions providers.

Furthermore, this document presents results on the first 5G-MOBIX Stakeholder Survey. The related questionnaire was distributed inside the 5G-MOBIX consortium first and second among external partners and email lists like the ERTICO newsletter. This document presents the feedback collected from 52 participants with 28 coming from academia and R&D centres.

Short analysis of the answers to the questionnaire, as well as additional input and analysis from ongoing and recent initiatives have resulted in the identification of the following challenges, and mainly the lack of a regulatory framework for CCAM solutions and vehicles, involving a common European understanding on necessary digital infrastructure, a joint telecom/vehicle industry approach on supporting CAD, awareness on interoperability issues and cross-border items, a common European Security & Safety validation, and the need for a progressive adaptation of road traffic rules in Member States.

The major technical aspects being addressed by the 8 participants coming from the automotive sector include V2X communication technologies and performance items, service and application requirements, and most importantly, Cybersecurity, Privacy and Digital infrastructure aspects for CCAM.This document intends to get an update after the X-Border trials if new aspects or issues arise in the ongoing tests.

1. INTRODUCTION

1.1. 5G-MOBIX concept and approach

5G-MOBIX aims to showcase the added value of 5G technology for advanced Cooperative, Connected and Automated Mobility (CCAM) use cases and validate the viability of the technology to bring automated driving to the next level of vehicle automation (SAE L4 and above). To do this, 5G-MOBIX demonstrates the potential of different 5G features on real European roads and highways, create, and use sustainable business models to develop 5G corridors. 5G-MOBIX also utilizes and upgrades existing key assets (infrastructure, vehicles, components) and the smooth operation and co-existence of 5G within a heterogeneous environment comprised of multiple incumbent technologies such as ITS-G5 and C-V2X.

5G-MOBIX executes CCAM trials along cross-border (x-border) and urban corridors using 5G core technological innovations to qualify the 5G infrastructure and evaluate its benefits in the CCAM context. The Project defines deployment scenarios, identifies and responds to standardization and spectrum gaps.

5G-MOBIX first defines critical scenarios needing advanced connectivity provided by 5G, and the required features to enable some advanced CCAM use cases. The matching of these advanced CCAM use cases and the expected benefits of 5G are tested during trials on 5G corridors in different EU countries as well as in Turkey, China and Korea.

The trials will also allow 5G-MOBIX to conduct evaluations and impact assessments and to define business impacts and cost/benefit analysis. As result of these evaluations and international consultations with the public and industry stakeholders, 5G-MOBIX identifies new business opportunities for the 5G enabled CCAM and proposes recommendations and options for its deployment.

Through its findings on technical requirements and operational conditions 5G-MOBIX consortium expects to actively contribute to standardization and spectrum allocation activities.

1.2. Purpose of the deliverable

The purpose of the deliverable is to:

- Monitor specification, deployment, trial and evaluation activities to identify challenges relating to deployment and x-border issues to:
  - Transform the expression of issues into topics of discussions with the related organizations;
  - Assess key emerging topics in 5G topics springing with direct interaction with stakeholders (authorities and service providers;
  - Provide corresponding recommendation to policy makers and regulators;

- Analyse the issues detected to transform them first in topics of discussions pushed to the relevant EU bodies (private or public) to provide recommendations to those bodies.

  - Expound and push 5G-MOBIX issues and recommendations and follow up the discussions to get concrete results - provide topics of discussions on real x-border issues and resulting recommendations to EU-wide policy makers and regulators to:

- Ensure liaison with the EU policy and regulation platforms and the related EC DGs (MOVE, CONNECT, JRC);
- Liaison with the industry associations regarding automotive and telecommunications.
- Guidance of the national legislative procedures, as well as contribution to the EU regulative processes, is the main target;
- Monitor and provide inputs to the discussion about spectrum allocation in the EU and beyond.

1.3. Intended audience

The current document is publicly disseminated and is available as a free download on the 5G-MOBIX website [1]. It is meant primarily as a handbook that introduces 5G for CCAM stakeholder opinions and discusses challenges that can be addressed by proposed recommendations in regulatory and policy level. Thus, this document aims to serve not just as an internal guideline and reference for all 5G-MOBIX beneficiaries but also for the larger communities of 5G and CCAM development, as well as national and EU regulators and other policy makers.

Interested readers may also refer to:

- D6.1 "Plan and Preliminary Report on deployment enablers" for discussion on the current state and evolution of 5G for CCAM
- D6.2 "Plan and Preliminary Report on the business models for cross border 5G deployment enabling CCAM" for an analytical discussion on business models, covering the entire 5G CCAM value chain,
- D6.3 "Plan and Preliminary Report on the standardisation and spectrum allocation needs" for an extensive analysis of standardisation and spectrum allocation,

These documents are also available as a free download on the 5G-MOBIX website.

2. PLAN AND METHODOLOGY

2.1. Plan

In this section, we give an overview of the devised plan to meet the aforementioned objectives from section 2.1. We divided our plan in two main steps with multiple underlying subtasks, as illustrated in Figure 2, which can be summarized as follows:

2.1.1. Methodology of the 5G-MOBIX regulation recommendations

Deliverable 6.4 includes four phases to identify the issues of 5G-enabled CCAM, including cross-border prospects, to generate detailed analyses on the means of overcoming the previously stated issues, and providing recommendations for policymakers and regulators as well as valuable feedback for the industry.

Phase 1 of the deliverable consists of monitoring specifications and issues that are related to the deployment of the Trial Sites and in the Cross-Border Corridors, that relate to policy, cooperation and regulatory matters. The issue previously mentioned is clustered according to the specific domain of research and expertise form which it derived. The provided questionnaire which will provide impartial feedback on the issues and potential means of creating the fundamental legislative and regulatory background necessary for the further development of 5G supported autonomous vehicles.

The questionnaire realization is done in a holistic manner, with respect to all parties involved and includes specific chapters for all the organizations and domains that must be taken into consideration. The resulting data is impartial due to the variety of answers and the empty field option that must be completed by the individuals that answer the questionnaire. In general, the output of the first phase will include the self-assessment of the issues, the development of communication bridges between the various domains within the work package partners, and prepare the basis for the further instrument of assessment.

The second phase of the survey consists of the internal review of the questionnaire, improvements, and development of the wording which is used to improve the understanding and clearance of the ambiguous questions of the questionnaire while keeping the support for all types of stakeholders implied in 5G-MOBIX and other like projects domains of expertise essential inquiries.

The further aspect that is considered in the second phase is the research and documentation of other related projects, which work with the 5G and autonomous vehicles, to accomplish the overall view regarding the issues, areas of implementation, and domains of integrations of the technology in the real world. The finalized projects will offer important feedback regarding the already studied data and acquired information from the industry and policy makers while the projects, which are still in progress, will provide information on the latest required policies, technological accords, and infrastructure. The output of this phase will provide the preliminary conclusions regarding the data gathered from the stakeholders through the questionnaire and the elaboration of the first online version of the survey.

The third phase of the deliverable has the purpose to identify a list of EU-wide policy makers and regulators in order to develop a dialog, which will improve the pre-existing regulations and will move further the base policies for the addressed issues as well to create the fundamental standardization regarding future laws over telecommunications, road operations, and network existing and future infrastructure. The relevant CAD and 5G projects are identified and the means of communication with the representatives are done for data exchange and external improvements and feedback. The phase is also strongly correlated with the external roll of the survey which permits unbiased feedback and data gathering regardless of the company or domain of the answering stakeholder; the overcome of these limitations will improve the overall transparency of the process while targeting the indispensable information.

The main output for the third phase consists of the validation of the gathered data internally, and confirmation/information of the final survey feedback; the final part of this phase will coincide with the analyses of the external roll gathered information, which is transposed as recommendations and suggestions from the industry, academy and other entities to the EU-wide policy makers and regulators.

Figure 1: Methodology.

2.1.2. Participatory Collection of Requirements

This step is mainly concerned with collecting all the information and challenges from the different stakeholder audiences involved, while facing deployment and x-border coordination. This step is divided into the following individual subtasks performed in T6.4:

- Using the cross-border issues identified in WP2 as a starting point, 5G-MOBIX further examines the current regulatory frameworks across the EU and identifying the gaps that need to be addressed. An overview of the current regulatory frameworks can be found in Section 3.2.
- Classifying of potential issues by clusters, e.g., regulation, certification, etc. An overview of this classification can be found in Sections 3.2, and 3.3.
- Designing and realizing an online questionnaire with the purpose of collecting inputs from the identified stakeholders and groups of relevance to the project, on the prioritization of clustered issues and barriers. The design and contents of the questionnaire are explained in more details in subsection Monitoring Instruments (2.4)
- Distribution of the questionnaire to 5GMOBIX partners to collect initial inputs from internal and external stakeholders.
- Update the questionnaire after the initial feedback and distribute it to a wide range of stakeholders outside the consortium.
- Analysis of the results from the second round of inputs to the questionnaire

2.1.3. Providing recommendations for policy makers and regulatory entities

The objective of this step is to analyse the collected data and provide recommendations for the appropriate regulatory bodies. This step is divided into the following subtasks:

- Analysis of the internal survey results to draw conclusions about the requirements for addressing the issues raised through the partners' initial analysis This is the first step towards analysing the issues into topics and transposing them into recommendations.

A summary of the recommendations from different clusters of stakeholders is present in sections 5.1-5.4. Moreover, sections 5.5-5.6 detail how these issues are transposed into recommendations for the different policy and regulatory authorities involved.

During the latter stages of communication and validation of our outputs, T6.4 plans to:

- Identify the first candidate list of EU policy makers and regulators to be addressed.
- Identify contact partners to these bodies and organizations, and ensure liaison with the EU policy and regulation platforms and the related EC DGs (MOVE, CONNECT, JRC)
- Interaction with the relevant bodies to push 5G-MOBIX issues and recommendations and follow up the discussions to accomplish concrete results.

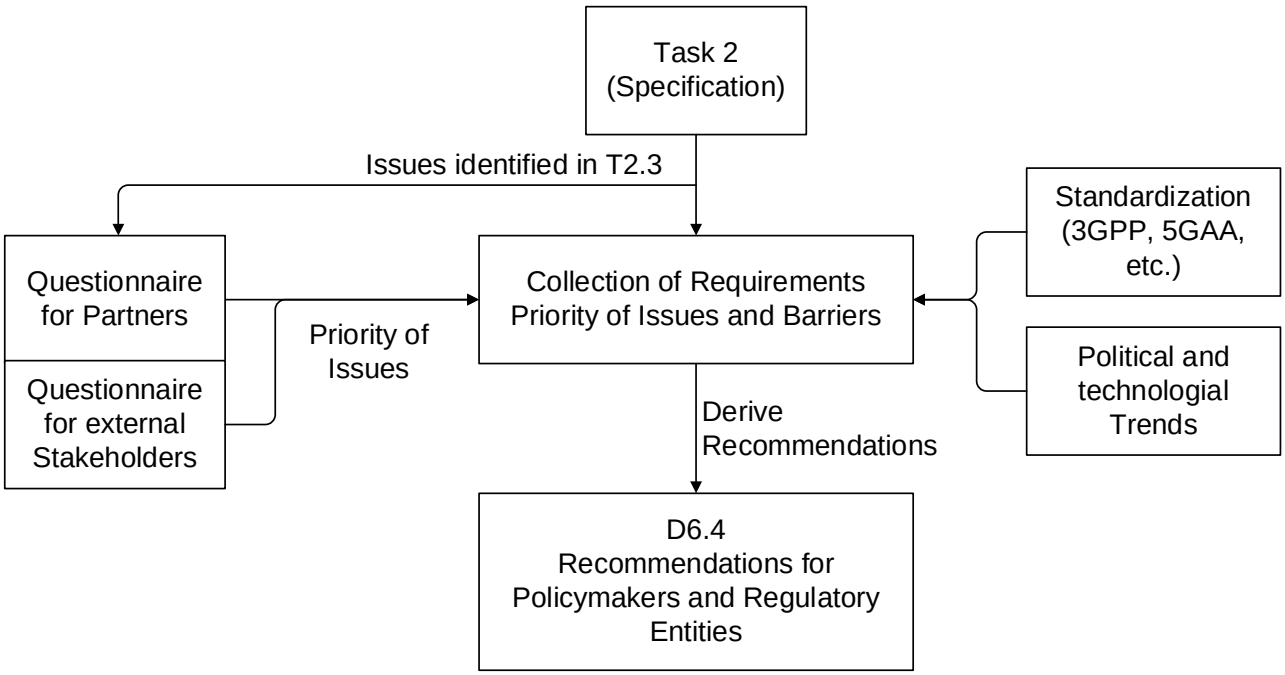


Figure 2: Project plan including subtasks.

2.2. Monitoring instruments

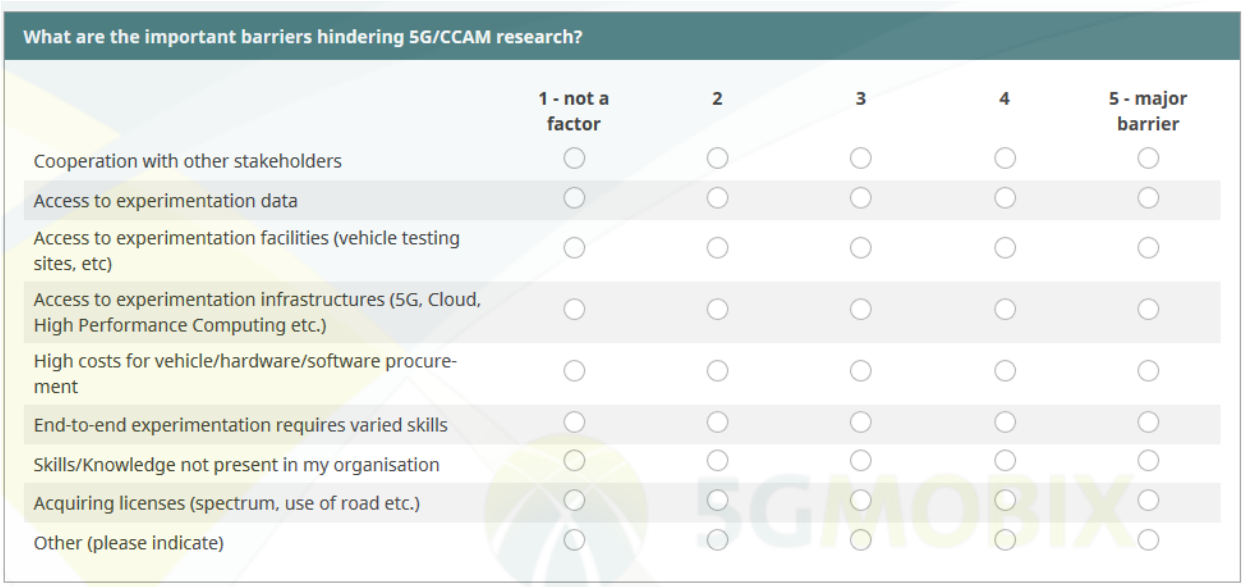
As the main instrument of monitoring and acknowledge the demands in matters of infrastructure, protocols of telecommunications, automotive base, and road operating means, the purpose of the work package 6.4 questionnaire is to facilitate the communication between the experts and professionals in the above areas and regulatory authorities. Thus, by improving the link between the demands of the industry and the provided legislative background in the area of telecommunications and road infrastructure and sharing of such platforms, networks and assets as well as the bases for autonomous driving and international telco protocols for such purposes will increase the rate of integration and adaptability of the technology within the existing infrastructure and will enable the future use and implementation in real life scenarios.

The questionnaire is divided in multiple sheets, starting from the area of expertise of the questioned company/ individual, following through the questions directly related to their domain of expertise. This is meant to keep the context and specialist speech content and to avoid eventual confusion regarding the questions and answers of the stakeholders.

The first chapter describes the participant domain of expertise, the group of stakeholders, the interest and expectations regarding the results and further development of CCAM, 5G and autonomous vehicle technology, the country of origin for the company which is also required for the international purpose of the 5GMobix project. This concept of questionnaire narrows down the number of questions to the crucial ones while combining a wide range of domains and possible answers. The results will offer feedback and fundamental knowledge as well as an overview of the vision of industry, academy and regulatory authorities on the behalf of the technology further development.

The current document is publicly disseminated and is available as an online survey on the 5G-MOBIX website. It is meant primarily as a research instrument for an overall view of the technology, infrastructure, laws, regulations and business models for the CCAM and 5G technology. Secondly this document aims to serve not just as an internal guideline and reference for all 5G-MOBIX beneficiaries but also for the larger communities of 5G and CCAM development, as well as national and EU regulators and other policy makers.

The questionnaire is disseminated among the consortium members, in the liaison projects 5GCroCo, 5G-CARMEN, 5G-EVE, 5GENESIS, 5G-VINNI, 5G-DRIVE, C-ROADS, CONCORDA, ICT4CART, INFRAMIX, AUTOPILOT, 5G!PAGODA, ONE5G, 5G-TOURS, 5GROWTH, 5G-HEART and 5G IA. In addition, it is disseminated in the ERTICO newsletter with more than 4000 subscriber.



What are the important barriers hindering 5G/CCAM research?

	1 - not a factor	2	3	4	5 - major barrier
Cooperation with other stakeholders	○	○	○	○	○
Access to experimentation data	○	○	○	○	○
Access to experimentation facilities (vehicle testing sites, etc)	○	○	○	○	○
Access to experimentation infrastructures (5G, Cloud, High Performance Computing etc.)	○	○	○	○	○
High costs for vehicle/hardware/software procure-ment	○	○	○	○	○
End-to-end experimentation requires varied skills	○	○	○	○	○
Skills/Knowledge not present in my organisation	○	○	○	○	○
Acquiring licenses (spectrum, use of road etc.)	○	○	○	○	○
Other (please indicate)	○	○	○	○	○

Figure 3.: Screenshot from the questionnaire asking about barriers

2.3. Data and gap analysis

ERTICO ITS Europe have conducted relevant analysis of the EU policy and regulatory landscape for a number of current and previous projects, which will be part of the comprehensive literature review to be conducted providing input into the final report. This research will be built upon and updated to reflect the most recent steps forward in autonomous vehicle regulation at UN, EU and member state levels.

The European Commission has published in 2016 a series of strategies and action plans to support the deployment of key enabling technologies and in particular the connectivity infrastructure paving the way for automated vehicles: The Communications on *"5G for Europe: An Action Plan"* (COM(2016) 588), the European C-ITS Strategy and *"A Space Strategy for Europe"* (COM(2016) 705). The Commission's *5G Action Plan* laid down an ambitious deployment timeline with an early roll-out in at least one major city in each member state in 2020 and uninterrupted coverage over all urban areas and major transport paths by 2025. The Action Plan aims at fostering the competitiveness of European industry by supporting the deployment and take-up of 5G networks, enabling among other things the timely assignment and availability of radio spectrum, creating more favourable conditions for small cell deployment and developing investment incentives and favourable framework conditions. "Mission critical services" for transport and vehicles will become feasible thanks to the higher performances achievable by 5G, including advanced services based on cloud, edge computing, vehicle-to-vehicle and vehicle-to-infrastructure connectivity that are important for automation. Standardisation, spectrum and regulatory work for 5G are being carried out through the 5G-PPP, an initiative between the ICT industry and the European Commission, and the 5G Automotive Association (5GAA).

Under the EU funded Coordination and Support Action CARTRE (Coordination of Automated Road Transport Deployment for Europe, 2016 – 2018) [2] coordinated by ERTICO, project partners conducted an exploration of the policy environment for automated and autonomous vehicles, published in October 2018 under the form of a position paper [3].

Key obstacles the CARTRE team and stakeholder network identified for the development of autonomous vehicles included non-existent, incomplete or different national legislative approaches across countries. This is a major obstacle on the path to the market introduction of automated and especially autonomous vehicles. It was recommended to create a regulatory framework which is as unified as possible for the benefit of the European internal market. Type approval regulation is a key area for regulatory development.

The risks of both over regulating, in terms of stifling innovation, and in under regulating, including having unsafe and environmentally damaging motorized vehicles on the roads were highlighted. The report further highlights the difference between the directions of EU, Japanese, Chinese and US policy approaches to the regulation of autonomous vehicles.

The following short-term (2020) regulatory needs were identified:

- A common European understanding on necessary digital infrastructure quality/coverage for Level 3.
- Joint approach between telecom and vehicle industries to support CAD.
- Need for cross-border pilot operation projects for a quick rollout of Level 3.
- Common European understanding on safety & security validation (when are the systems safe enough).
- European push in setting up the framework for a safe level 4 series development (new UN Regulation, so-called horizontal regulation on accelerator, brakes, steering, lighting, vehicle access).
- Coordinated European and Member State programs to support global competitiveness.
- Adaption of road traffic rules in Member States.

Long term (2040) vision on policy and regulatory requirements for European harmonization identified were as follows:

- Pan-European approach on overall mobility solutions for cities including electric autonomous shared mobility.
- Political framework for the rollout of electric autonomous shared mobility into rural areas (mobility for all).
- Clear common approach for cities to coordinate private and public transport
- Role of traffic management.
- Safe coexistence of automated vehicles and non-motorized road users.

Issues identified included reducing obstacles to forster introduction of enabling regulations; development of a common EU perspective; updates and harmonization of traffic rules; addressing data sharing and privacy issues; and addressing liability, especially insurance issues. More specifically for connectivity, the CARTRE position paper dedicated to this topici recommended the development of "flexible regulatory

approaches to allow industry and public bodies to generate the considerable investments needed to deploy V2X connectivity in vehicles and infrastructure (road and telecoms) in a sustainable manner, in line with public policy priorities".

The ARCADE project (Aligning Research & Innovation for Connected and Automated Driving in Europe), successor of CARTRE, which started in October 2018, is currently looking further into Policy and Regulations related to Connected and Automated Driving across Members States and in particular European harmonization. Information on the status in Member States, future regulatory needs as well as guidelines for projects are being gathered in the Knowledgebase [4], which the project is maintaining. ARCADE develops and updates a roadmap for Connected Automated Driving which has provided key input to the ERTRAC CAD roadmap 2019 [5], the STRIA CAT 2.0 [6] and is providing input to the Single Platform for Open Road Testing and Pre-deployment of CCAM.

The ARCADE roadmap and ERTRAC CAD roadmap conclude that the focus for the coming 10-year period in the development paths will be on highly automated vehicles (SAE L4) in mixed traffic. A selection of use cases has been identified to illustrate this development in the roadmap. Key priorities have been identified by the thematic areas within ARCADE together with the ARCADE stakeholder network.

While the ARCADE roadmap is principally focusing on future research needs, some of the identified challenges and requirements for R&I are related to policy and regulatory aspects. The roadmap report reiterates the need to define flexible regulation for Automated Driving, enabling different solutions, within the boundaries of safety, to build a common framework for connected automated vehicles for Europe and to make cross-border testing easy. Regarding connectivity in general, the following key priorities that need to be supported by policy and regulatory measures, have been identified:

- Definition of connectivity requirements for AD functions (performance, Quality of Service, resilience, etc.)
- Standardisation and further deployment of V2X technologies.
- (Cyber) secure and safe communications respecting privacy and various levels of trust.
- Interoperability of communication technologies / hybrid connectivity solutions.
- Correctness and latency for multiband configuration. Common communication specifications and standardization will be required for multiband exchange for freight vehicles.
- Specification of Day 2 and Day 3 C-ITS services.

The Single Platform for Open Road Testing and Pre-deployment of CCAM launched by the European Commission in 2019 comprises two Working Groups focusing on connectivity related topics:

- WG 5: Cybersecurity and access to in-vehicle data linked to CCAM
- WG 6: Connectivity and digital infrastructure for CCAM

Working Group 6 in particular has as main objectives to promote collaboration between the various actors of the CCAM community regarding communication technology, to establish an interoperable connectivity framework, and to coordinate testing and pre-deployment activities. Activities include gathering and exchanging experiences, best practices and knowledge on how spectrum can be efficiently allocated to various technologies; and addressing technical and legal issues that are relevant to data storage and cloud access in the testing and pre-deployment phase. The group identified as priority the need to have an updated inventory and mapping of current, relevant, initiatives and standards. Inventory on Priority Road Transport Services [7] An important work item thus consists in categorizing the communication technologies/issues for services (Day category, communication type, possible provision with cellular technology, availability of the service, critical for road safety, latency needs…) .

The EU project HEADSTART has developed two complementary studies regarding user needs and technical and functional requirements for autonomous vehicle adoption, which provide useful insights for this study. HEADSTART Report D.1.2. "Stakeholders and user group needs", [8] provides a brief overview of the current standards and regulations concerning safety for testing CAD at the national and international level as well as relevant standards.

HEADSTART Report D1.3 "Technical and functional requirements for Key Enabling Technologies (KETs [8]) which include Connectivity, Cybersecurity and Positioning, looks at the policy framework regarding cybersecurity requirements. It highlights as key sources the US Department of Transportation voluntary guidance, best practices and design principles for cyber vehicle physical systems, the SAE J3061 "Cybersecurity Guidebook for Cyber-Physical Vehicle Systems" and the work ongoing as part of the UNECE World Forum for the harmonization of vehicle regulations (WP.29). The "Proposal for a Recommendation on Cyber Security [9] includes some cybersecurity requirements for over-the-air (OTA) update use cases. Included, as Annex A is a draft regulation on cyber security.

Research undertaken in the EU project CARTRE has analysed the needs at short and long term in order to enable the deployment of highly automated vehicles. The EU project ENSEMBLE (Enabling Safe Multi-Brand platooning for Europe) built upon the work of the CARTRE project to develop a report which provides an overview of the regulatory framework for truck platooning, including elements relevant for autonomous truck platoons (D6.10 ENSEMBLE regulatory framework – state of the art, 2019). [10] The report presents a Regulatory Matrix in order to provide a classification of all regulations, directives and standards that might need a revision or modification to make the type-approval of platoons possible. This matrix has been shared with a number of OEMs in order to align ideas and concepts, and to detect possible missing items or gaps.

2.4. Stakeholder engagement

Mitchell, Agle et al.[11] were among the first that attempted to formalize stakeholder analysis and provide the basis for stakeholder theory, which they describe as a "popular heuristic for describing the management environment". They proposed a classification of stakeholders based on three characteristics, namely: (a) their power to influence, (b) the legitimacy of each stakeholder's relationship with the organization, and (c)

the urgency of the stakeholder's claim on the organization. Other factors used to estimate salience include Power, Influence, Interest, Closeness, etc. 5G-MOBIX bases its stakeholder engagement on the well-known classification method.

Figure 4 presents a preliminary stakeholder analysis for 5G for CCAM, which will be further elaborated during the course of the Study to address specific stakeholders per CBC.

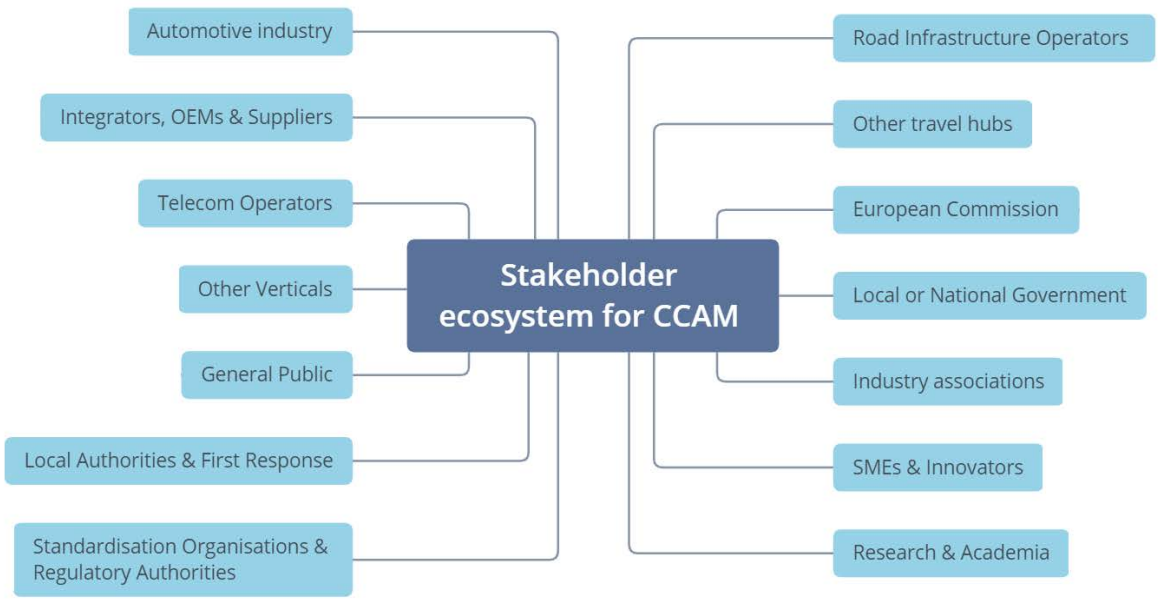


Figure 4.: High-level overview of Stakeholder ecosystem.

The precise objective of the stakeholder engagement strategy will be:

- To introduce 5G-MOBIX WP6 results to the relevant parties as identified both by the project partners and the wider EC business and research communities, by using traditional dissemination channels and in collaboration with the communication manager since it will follow the project dissemination roadmap
- To receive stakeholder feedback regarding the methodology of WP6, using data collection activities (such as a Survey, direct contact etc.) both external and internal to the project consortium.
- To validate key results of WP6 and discuss on the results from the stakeholders' point of view, by holding at least one online workshop.

With respect to receiving stakeholder feedback and validating our results, the communication strategy compiled with the cooperation of WP7 will be focused on a classification of stakeholders stating which stakeholders to monitor, manage closely, keep informed and choosing appropriate channels to do so (Table 1 Communication tools utilized to reach stakeholders for the purpose of this Study.). At minimum, 5G-MOBIX intends to collect inputs through direct contact, the first 5G-MOBIX Survey launched in Q3 2020 and analysed in Q4 2020, as well as an online workshop during Q4 2020. If a stakeholder is under-represented in the results of WP6, more activities with more targeted scope will be scheduled within the project lifetime. Dissemination material (such as infographics, blog posts etc.) will also be planned within 2021 to provide a

brief overview of the issues and recommendations identified in T6.4, so they can be easily communicated, while avoiding the use of jargon.

Table 1 Communication tools utilized to reach stakeholders for the purpose of this Study.

Activity	Communication tools	Target Audience
Keep Informed	5G-MOBIX website, newsletter, social media, blog posts, Infographics etc.	All
Manage Closely	Invitation to 5G-MOBIX online workshop Invitation to participate to 5G-MOBIX survey (questionnaire) Direct contact more activities with smaller participation but more targeted can be envisioned (e.g. under personal invitations etc.)	Stakeholders that are under-represented in the 5G-MOBIX CBCs,
Monitor	Direct contact Input requests with key CBC participants Invitation to participate to 5G-MOBIX survey (questionnaire) Invitation to 5G-MOBIX online workshop	Stakeholders that are well-represented in the 5G-MOBIX CBCs

3. REGULATION AND CERTIFICATION

3.1. Cross-border issues identified in D2.1

During the development and detailing of the 5G-MOBIX use cases, an initial set of cross-border issues related to several types of regulation has been identified. The table below reproduces the relevant issues from the wider overview that also includes non-regulatory issues in D2.1 [12]. The analysis in this section goes beyond these identified issues and takes a look at existing regulations and public policies that can affect 5G/CCAM, following in subsection 3.2.

Table 2: Issues relevant for regulation from D2.1.

ID	Issue name	Short description
SDP0	Personal data processing under different data protection regulations	Different data protection regulations apply when processing personal data of data subject in Europe, Turkey, China and Korea. Therefore, many legal, organisational and technical challenges need to be overcome for lawful processing of this data. This is the general case of SP1 and SP2.
SDP1	Legal	Without proper legal basis, lawful processing of personal data could not be achieved. Indeed, legal issues arise at the enforcement of the GDPR to CCAM. For example, CAM and DENM messages (and other CCAM messages) are considered personal data but are required for the normal functioning of the CCAM systems.
RC1	Autonomous Vehicle regulation Compliance	GDPR and homologated systems for ADAS are properly implemented and applied, also to support difficulties of identifying AVs from Non-AVs on roads
RC2	Road & traffic regulation Compliance	Traffic signs and rules have a different regulation requiring different computer vision training or application of different operative limits to vehicles' dynamics
RC3	Sensor Compliance	Heterogeneous homologation of sensors
RG1	Geo-dependent spectrum	Neighbouring countries can have different radio frequency spectrum
RL1	Law enforcement interaction	Absence of procedures for law enforcement interaction with AVs
RN1	Neutrality regulation	Incompatibility of Network Neutrality directives with applied traffic prioritization techniques

3.2. Overview of existing regulatory frameworks

3.2.1. General Data Protection Regulation

General Data Protection Regulation: Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (Text with EEA relevance)[13].

The EU General Data Protection Regulation is in place to safeguard the rights of the data subjects and enable them to better control their personal data. The Regulation aims to alleviate the fragmentation in data protection law across EU member states and replace the previous Directive with a unified set of rules. The GDPR features an improved territorial scope since it applies to controllers/processors of personal data that are established in the Union, regardless of the location of the processing. Article 4 makes the following definitions:

Key definitions in Article 4
'personal data' means any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person; **'processing'** means any operation or set of operations which is performed on personal data or on sets of personal data, whether or not by automated means, such as collection, recording, organisation, structuring, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, restriction, erasure or destruction; **[…]** **'profiling'** means any form of automated processing of personal data consisting of the use of personal data to evaluate certain personal aspects relating to a natural person, in particular to analyse or predict aspects concerning that natural person's performance at work, economic situation, health, personal preferences, interests, reliability, behaviour, location or movements; **[…]** **'controller'** means the natural or legal person, public authority, agency or other body which, alone or jointly with others, determines the purposes and means of the processing of personal data; where the

purposes and means of such processing are determined by Union or Member State law, the controller or the specific criteria for its nomination may be provided for by Union or Member State law;

'processor' means a natural or legal person, public authority, agency or other body which processes personal data on behalf of the controller;

[…]

'consent' of the data subject means any freely given, specific, informed and unambiguous indication of the data subject's wishes by which he or she, by a statement or by a clear affirmative action, signifies agreement to the processing of personal data relating to him or her;

The data for each individual vehicle or driver that are being processed by a CCAM services may include personal data in the form of IP addresses, emails, login credentials and other communication metadata such as position, that could also fall under the new ePrivacy Regulation. 5G-MOBIX services may collect personal data, however, they do not profile a natural person's behaviour. 5G-MOBIX does not inspect the contents of communications to assess personal aspects of a natural person's behaviour (e.g. driving patterns, health etc.). The basic principles that underline the GDPR (Article 5) regard:

- The lawfulness, transparency and fairness of processing;
- The limitation of its purpose (data must be collected for clear and explicit reasons);
- The principle of data minimization (data collected should be adequate to perform the specific purpose but limited to what is necessary);
- The accuracy of the data;
- The minimization of storage that permits identification of the data subject for no longer than necessary;
- The security and confidentiality of the data.

Article 6 further analyses the lawfulness of processing while Article 7 details the consent processes that should apply.

Article 6 Lawfulness of processing

Processing shall be lawful only if and to the extent that at least one of the following applies:

the data subject has given consent to the processing of his or her personal data for one or more specific purposes;

processing is necessary for the performance of a contract to which the data subject is party or in order to take steps at the request of the data subject prior to entering into a contract;

processing is necessary for compliance with a legal obligation to which the controller is subject;

processing is necessary in order to protect the vital interests of the data subject or of another natural person;

processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the controller;

processing is necessary for the purposes of the legitimate interests pursued by the controller or by a third party, except where such interests are overridden by the interests or fundamental rights and freedoms of the data subject which require protection of personal data, in particular where the data subject is a child.

In the context of 5G-MOBIX, processing for the explicit purpose of providing CCAM features (as defined in the Commission Guidelines 1/2020 on processing personal data in the context of connected vehicles and mobility applications, also see section 3.2.2) can considered lawful. Article 7 of the GDPR also states that when consent is given in the context of a written declaration which also concerns other matters (e.g. a contract) it must be presented in a form that is easily distinguishable and comprehensible, otherwise the declaration will not be considered binding. This means that consent must be clear and informed.

GDPR dedicates Articles 12-23 to the description of the Rights of the Data Subject and how they shall be exercised, including the right for access, erasure, restriction, rectification, portability and the right to be forgotten. It further specifies, that if the stored information is not identifiable, then the data subject is responsible to provide additional information to identify their data. Portability is another important aspect, since it is aligned with EU's competition law. If a person's data are not portable among different CCAM providers, then customer lock-in conditions are created as the customer might not able to freely change providers. The data subject rights however, do not apply if a component does not retain any data [14].

Articles 24-43 relate to the responsibilities of the data controller, the data processor, and establishes the role of the Data Protection Officer. This information should be transparent to the user as well. The data subject should be able to contact the DPO or the Data Processor regarding their data. Article 26 describes the case for Joint Controllers. This case could be applicable to 5G/CCAM if the telco provider is operating third party services for CCAM, e.g. if a telco provider is deploying an ITS service on behalf of a road operator that collect driver information under the consent of the driver, joint Controllers from the road operator and telco side are needed. The text also includes rules on data sharing (Articles 44-50). If data are shared with third parties (or monetized) the data subject should consent. Sharing data with Law Enforcement or CERTs should be enabled for alignment with other Directives as well. Other issues covered in the GDPR include the role of independent supervisory authorities (Articles 51-59), Liabilities and penalties (Articles 77-84) etc.

An important aspect that applies to 5G-MOBIX is the exchange of data with third countries. GDPR dedicates Art.44-50 to cross-border sharing of information. Any country within the EEA applies the GDPR. For countries outside the EEA, the first important step is to assess whether there is a standing Adequacy Decision. The European Commission has the power to determine, on the basis of article 45 of Regulation (EU) 2016/679 whether a country outside the EU offers an adequate level of data protection. At the proposal of the European Commission, the European Data Protection Board provides an opinion on the status of

personal data protection in a specific country. If representatives of EU countries provide their approval, the EC adopts the Adequacy Decision.

The effect of such a decision is that personal data can flow from the EEA to that third country without any further safeguard being necessary. Transfers to the country in question will be assimilated to intra-EU transmissions of data. At any time, the European Parliament and the Council may request the European Commission to maintain, amend or withdraw the adequacy decision. These adequacy decisions do not cover data exchanges in the law enforcement sector, which are governed by the "Police Directive" (article 36 of Directive (EU) 2016/680). In the case of the GR-TR trial, which features a hard border, there is no adequacy decision yet regarding data exchange with Turkey. Chapter 5 of the GDPR states other cases where exchange of information might be considered legitimate such as binding corporate rules and derogations. Unless a data exchange can fall under any of the cases explained in Chapter 5 of the GDPR, it will not be legitimate.

3.2.2. Guidelines 1/2020 on processing personal data in the context of connected vehicles and mobility related applications

The European Data Protection Board, adopted in January 2020, a set of "Guidelines 1/2020 on processing personal data in the context of connected vehicles and mobility related applications"[15]. The document makes the following definitions and recommendations regarding the applicable laws.

According to the "Commission Directive 2008/63/ECof 20 June 2008 on competition in the markets in telecommunications terminal equipment (Text with EEA relevance)"[16] the definition of "terminal equipment is given as follows: "equipment directly or indirectly connected to the interface of a public telecommunications network to send, process or receive information; in either case (direct or indirect), the connection may be made by wire, optical fibre or electromagnetically; a connection is indirect if equipment is placed between the terminal and the interface of the network; (b) satellite earth station equipment". The recommendations of the EDPB consider that **the connected vehicle can be considered as "terminal equipment"** under that definition and as such, related provisions of the ePrivacy Directive need apply.

Personal data can be collected through several means, including vehicle sensors, telematics boxes or mobile applications (e.g. accessed from a device belonging to a driver). In order to fall within the scope of the document the EDPB considers that applications need to be related to the environment of driving, such as:

- **Mobility management:** functions that allow drivers to reach a destination quickly, and in a cost-efficient manner, (e.g. GPS navigation, traffic information etc.)
- **Vehicle management:** functions that are supposed to aid drivers in reducing operating costs and improving ease of use (e.g. such as notification of vehicle condition and service reminders)
- **Road safety:** functions that warn the driver of external hazards and internal responses, (e.g. collision protection, hazard warnings, emergency calls etc)

- **Entertainment:** functions providing information to and involving the entertainment of the driver and passengers, (e.g. hands-free phone calls, voice generated text messages, music, video, etc)
- **Driver assistance**: functions involving partially or fully automated driving, (e.g. operational assistance or autopilot etc.)
- **Well-being:** functions monitoring the driver's comfort, ability and fitness to drive (e.g. fatigue detection or medical assistance)

Examples of applications that don't fall within the scope of the document are:

- Applications that suggest places of interest (restaurants, historic monument, etc.) to the user.
- Applications provided by an employer to monitor a company owned vehicle fleet.
- Applications for video capture (e.g. dash cams)
- Applications for C-ITS, as the data collection needs to be extensive and there are still on-going discussions[17].

The Guidelines list the main risks to privacy and security with respect to:

- **Control and asymmetry of data protection:** There is the risk that adequate controls are not available to the driver, and that the driver might not always be the vehicle owner and have the same amount of access. Communications could also be triggered automatically or by default, without the user always being aware of the exact data exchanges that take place.
- **Quality of user consent:** Classic mechanisms used to obtain individuals' consent may be difficult to apply resulting in a "low-quality" consent based on a lack of information or in the factual impossibility to provide fine-tuned consent in line with the preferences expressed by individuals. Consent might also be difficult to obtain for drivers and passengers who are not related to the vehicle's owner in the case of second-hand, leased, rented or borrowed vehicles.
- **Additional Processing & Extensive Data Collection:** When data are collected on the basis of consent, no additional processing for further purposes is legitimate as consent needs to be specific and informed to be valid. Furthermore, there are risks introduced by extensive data collection that could be required in some cases, e.g. Artificial Intelligence etc.
- **Security of personal data:** Given the multitude of vastly different components and technologies, as well as the dynamic nature of service-oriented infrastructures in the CCAM ecosystem, there is a large attack surface and a lot of opportunities for an attacker to gain unauthorised access or otherwise compromise CCAM security.

However, the guidelines also suggest a few best practices per type of data (e.g. biometric, geolocation etc.) and summarises some general best practices as follows (Guideline #74):

- Users should be able to control how their data are collected and processed in the vehicle,
- Information regarding the processing must be provided in the driver's language (manual, settings, etc.),

- the EDPB recommends that only data strictly necessary for the vehicle functioning are processed by default, and data subjects should have the possibility to activate or deactivate the data processing for each other purpose and controller/processor and have the possibility to delete the data concerned
- data should not be transmitted to any third parties (i.e., the user has sole access to the data)
- data should be retained only for as long as is necessary for the provision of the service or otherwise required by Union or member state law,
- data subjects should be able to delete permanently any personal data before the vehicles are put up for sale
- Data subjects should, where feasible, have a direct access to the data generated by these applications.

3.2.3. ePrivacy

The ePrivacy Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002, also known as the EU Cookie Law, sets the rules for the collection of cookies and ensures confidentiality of electronic communications [12]. At the moment, there is a proposal [18] for a revision of the ePrivacy Directive, to better align it with the GDPR, take into account continuing technical innovation, and to transform it into a Regulation. This would mean that the EU Member States would implement the Regulation as-is, as opposed to a Directive, which can be implemented in any way, considered suitable by the Member States. The proposal for the Regulation was released on January 2017. Regarding the applicability of the ePrivacy Directive and the future ePrivacy regulation, 5G-MOBIX makes the following considerations:

Profiling of a user's behaviour through cookies is not considered in any 5G-MOBIX User Stories. Otherwise, consent and additional safeguards to ensure the data subject's rights and non-discrimination should be in place.

Protection of communication contents under the new regulation will apply to telco traffic (e.g. SMS), as well as other digital communications providers (e.g. Skype, WhatsApp etc.). The new regulation might apply to CCAM services.

A new component is the protection not only of communications content but also of communication metadata, including location. Pending finalisation of the ePrivacy Regulation, additional protections can be considered.

3.2.4. Non-discrimination

Council Directive 2000/78/EC of 27 November 2000 establishing a general framework for equal treatment in employment and occupation.[19]
European Charter of Fundamental Human Rights [20], esp. Article 8(1) on the protection of personal data

Treaty of Amsterdam[21] (1997/1999 establishing the protected grounds against discrimination) & Treaty of Lisbon[22] (2007/2009 making the ECHR Bill of Rights legally binding)
Council of Europe recommendations on profiling: Recommendation CM/Rec(2010)13 of the Committee of Ministers to member states on the protection of individuals with regard to automatic processing of personal data in the context of profiling[23].

Although the non-discrimination body of law in the EU regards access to employment, education etc. that are out of the scope of 5G-MOBIX, we can consider some basic principles and definitions to be freestanding. Access to the Internet can be regarded as a basic service that should be available to all citizens and any discriminatory practices should be abolished. Some key definitions should be in place, for future reference:

- The entry into force of the Treaty of Amsterdam in 1997 enabled the European Commission to legislate on non-discrimination based on defined protected grounds, which include gender, age, race, ethnicity, religion, belief, age, disability and sexual orientation. The GDPR considers data that may expose these aspects of the data subject as "special category" data.
- Protection against discrimination is not only present in EU Law but also within the European Charter of Human Rights (ECHR) that was proclaimed by the European Union and the Member States in 2000. The ECHR declared the fundamental human rights to be protected and became legally binding after the 2009 Treaty of Lisbon.
- Most definitions in EU law and ECHR regard cases of direct discrimination. The EU Agency of Fundamental Rights (FRA), however, further defines indirect discrimination, when a rule that appears to be neutral affects a specific group of citizens in a significantly more negative way, by comparison to others in a similar situation. It also defines harassment and instruction to discriminate as violating the dignity of a person.

Hence, any data processing CCAM component that profiles aspects of the data subject with respect to these protected grounds should have safeguards in place to ensure that processing is lawful and that such information cannot be misused and lead to discriminatory practices. The Council of Europe has published a recommendation on safeguards for processing that leads to profiling, although this predates the GDPR and there was no legal definition of profiling at the time.

3.2.5. Car Safety

The lack of 5G-CCAM regulations represents a challenge for automotive OEMs. As an OEM, you need to know your limits, how to design a CCAM feature etc. Especially for those features that trust connectivity like 5G, it is important have a common sense of development on the market, in order for all vehicles to be able to "speak the same language" on the road. This "speaking" must be safe. OEMs need to ensure that vehicles are safe, before delivering them to their customers, and this is an essential aspect. For this purpose, Cybersecurity step in to prevent unauthorized access to vehicle controllers and communication units. The United Nations Economic Commission for Europe (UNECE) works for related regulations. These regulations are listed below and at the time of this article deliverable, they have not been published yet:

- UN ECE Regulation No. 155 ECE/TRANS/WP.29/2020/79 as amended by 2020/94 and 2020/97
- UN ECE Regulation No. 156 ECE/TRANS/WP.29/2020/80

For conventional vehicle safety, "ISO 26262-1:2018 Road vehicles — Functional safety" standard has been published. This document is intended to be applied to safety-related systems that include one or more electrical and/or electronic (E/E) systems and that are installed in series production road vehicles, excluding mopeds. This document does not address unique E/E systems in special vehicles such as E/E systems designed for drivers with disabilities [24].
For autonomous vehicle safety, "ISO/PAS 21448:2019 Road vehicles — Safety of the intended functionality" standard has been published. This document is intended to be applied to intended functionality where proper situational awareness is critical to safety, and where that situational awareness is derived from complex sensors and processing algorithms; especially emergency intervention systems (e.g.., emergency braking systems) and Advanced Driver Assistance Systems (ADAS) with levels 1 and 2 on the OICA/SAE standard J3016 automation scales. This edition of the document can be considered for higher levels of automation; however, additional measures might be necessary. This document is not intended for functions of existing systems for which well-established and well-trusted design, verification and validation (V&V) measures exist at the time of publication (e.g. Dynamic Stability Control (DSC) systems, airbag, etc.).
A Delegated Act "ITS 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" has been published on 9th January 2018 and various related associations such as 5GAA, ETNO, GSMA, GSA stated their concerns about Delegated Act that is not being technology neutral by ruling out C-V2X technology. On 8th July 2019 the Council of the European Union adopted a decision to object to the proposal for Delegated Regulation on Cooperative Intelligent Transport Systems and currently this study is on-going.
To see highly automated and connected vehicles on the public road standards and regulations must be finalized. So far, there has not been any published standard or regulation that covers highly automated and connected vehicle safety.

3.2.6. European Electronic Communications Code

Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast) Text with EEA relevance.

The European Electronic Communications Code is an EU Directive that regulates electronic communications networks and services. It was adopted in December 2018 to reform the existing regulation framework and is to be adapted by the Member States by 2020. For the mobile operators that provide the 5G networks for CCAM, the European Electronic Communications Code (ECCC) is a central piece of regulation. The EECC contains, among many other things, stipulations on service and network interoperability and the role of specifications and standards, planning and coordination of radio spectrum policy, and the handling of personal data. BEREC, national ministries and NRAs base their policies and oversight of network operators on this key legislation.
Taking into account the need of IoT/M2M service providers and with the view to create competitive market entry conditions (aligned with the EU Digital Single Market), the EU has also legislated on the use of numbering resources within the EECC. The EECC aims to:

- allow the possibility to assign numbers to undertakings other than providers of electronic communications networks or services;
- enable an extraterritorial use of non-geographic numbers within the EU for the provision of non-interpersonal communications services;
- promote, where technically feasible, the over-the-air (OTA) provisioning of numbers for easier switching;
- ensure the efficient use of numbering resources.

As the demand for CCAM services and M2M/IoT communications in general appears to be increasing, there is a worldwide concern that it might consequently cause a scarcity of numbering resources. The International Telecommunication Union (ITU) standardizes such resources (such as telephone numbers, operator identifiers, SIM identifiers and more). The European Electronic Communications Code permits Members States to grant rights of use for numbering resources on a non-discriminatory basis to undertakings other than providers of Electronic Communications Networks or Services (ECN/ECS entities) under Article 93(2), if adequate numbering resources are available to satisfy current and foreseeable future demand. This possibility of assignment is also to support the development of cross-border services in the case of non-interpersonal communications services (Recitals 246 and Article 93(4)). Non-ECN/ECS entities shall demonstrate their ability to manage the numbering resources and to comply with any relevant requirements set out pursuant to Article 94. These conditions are, in fact, pre-conditions that non-ECN/ECS entities have to meet in order to be eligible to receive the right to use numbering resources. This will allow non-ECN/ECS entities (e.g. truck fleets or connected cars services, i.e. with potentially a huge customer base) .However, this is not obligatory, as member states are still free to decide whether to allow or restrict the assignment of numbering resources to non-ECN/ECS entities nationally.

According to a recent BEREC survey in 2019, NRAs from 12 Member States were already assigning or planning to assign numbering resources to stakeholders other than providers of electronic communications services, in specific categories of (mostly E.164) resources such as:

- Special rate services (Freephone, Shared cost numbers, Premium rate numbers);
- Short codes (directory enquiry services, European 116 numbers, public interest numbers);
- Specific services (private network, maritime or aeronautical services, direct dialling or collect call services)
- Personal numbers
- Technical resources (Mobile network codes (E. 212) - such as private networks with dedicated frequencies or providers of fixed wireless internet access services -, Signalling point codes).

These assignments are done as a rule based on single number or a block of few numbers and refer mostly to E.164 numbering resources. Non-ECN/ECS entities use the directly assigned resources for their own purposes and a sub-assignment to third parties is explicitly forbidden by the conditions attached to the rights of use. The ECN/ECS providers do the implementation and activation of numbering resources in the network. The characteristic that the assignment is done on the basis of single number or a block of few numbers implies that there is no need to assess the risk of exhaustion of numbering resources.

3.2.7. Roaming

Regulation (EU) No 531/2012 of the European Parliament and of the Council of 13 June 2012 on roaming on public mobile communications networks within the Union

Amended by:

- Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 laying down measures concerning open internet access and amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services and Regulation (EU) No 531/2012 on roaming on public mobile communications networks within the Union (Text with EEA relevance)
- Regulation (EU) 2016/2286 of 15 December 2016 laying down detailed rules on the application of fair use policy and on the methodology for assessing the sustainability of the abolition of retail roaming surcharges and on the application to be submitted by a roaming provider for the purposes of that assessment
- Regulation (EU) 2017/920 of the European Parliament and of the Council of 17 May 2017 amending Regulation (EU) No 531/2012 as regards rules for wholesale roaming markets Text with EEA relevance.
- Regulation (EU) 2019/2116 of 28 November 2019 setting the weighted average of maximum mobile termination rates across the Union and repealing Implementing Regulation (EU) 2018/1979 (Text with EEA relevance)

The regulation of roaming prices and fair use policies is the subject of several regulations in force. The EU has been taking steps since 2006 to reduce roaming charges, culminating with "Roam Like At Home" rules entering into force in 2017, thus ending subscribers' roaming charges. This work starts with the Roaming Regulation (531/2012), also known as the Eurotariff law, regulates the imposition of roaming charges in the

European Economic Area (EU Member States, Iceland, Liechtenstein, and Norway). It regulates the charges that can be imposed on subscribers by the telco operators, as well as the wholesale rates operators can charge each other to allow their subscribers access another provider's network while roaming It also provides a "fair use policy" under which the use of roaming without extra charges is limited to business and leisure, in order to prevent misuse and add costs to operators. Although the mechanisms to enforce fair use are not entirely clear, the EU has stated that it should be based on the "a principle of residence or stable links EU consumers may have with any EU Member State", where a stable link can be defined as "work commuters, expats who are frequently present in their home country or Erasmus students".

As a consequence of the current legislation, mobile operators still have to pay for wholesale charges while subscriber roaming fees are abolished; this has led to a rise in the subscription prices across many operators in many member states. Furthermore, while the Roaming Regulation disallows operators charging extra for roaming, it does not force them to make roaming available in the first place (i.e. Telcos are allowed to have national-only subscription plans without roaming). Since, the Roaming Regulation is set to expire in 2022, the EU is launching (Sept 2020) a public consultation1 to assess its impact with the view to prolong the Roaming Regulation.

Thus, in the case of 5G CCAM roaming many questions are formed:

- How will 5G CCAM roaming fees be regulated?
- How will 5G CCAM roaming fees be taxed?
- Does CCAM or M2M roaming in general, necessitate new regulation or should the current regulation be amended?
- What would constitute "fair use" for 5G CCAM roaming?
- How can consumers be protected and enjoy absolute transparency in terms of roaming charges?
- How can we ensure international cooperation and a fair roaming policy across hard EU borders?

3.2.8. Open Internet

Open Internet Regulation: Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 laying down measures concerning open internet access and amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services and Regulation (EU) No 531/2012 on roaming on public mobile communications networks within the Union (Text with EEA relevance) [24].

The Open Internet Regulation establishes the circumstances where traffic classification and management are legitimate. It lays down specific net neutrality rules and governs the way ISPs may choose to manage

[1] Public consultation on the review and prolongation of the Roaming Regulation: https://ec.europa.eu/digital-single-market/en/news/public-consultation-review-and-prolongation-roaming-regulation

the traffic that passes through their networks, while ensuring equal and non-discriminatory treatment of traffic. Specifically, the following aspects are particularly relevant to 5G-MOBIX:
(8) When providing internet access services, providers of those services should treat all traffic equally, without discrimination, restriction or interference, independently of its sender or receiver, content, application or service, or terminal equipment. According to general principles of Union law and settled case law, comparable situations should not be treated differently, and different situations should not be treated in the same way unless such treatment is objectively justified.
(10) Reasonable internet traffic management[2] does not require techniques that monitor the specific content of data traffic transmitted via the internet access service.
(12) Traffic management measures that go beyond such reasonable traffic management measures may only be applied as necessary and for as long as necessary to comply with the three justified exceptions laid down in this Regulation.
(13) First, situations may arise in which providers of internet access services are subject to Union legislative acts, or national legislation that complies with Union law (for example, related to the lawfulness of content, applications or services, or to public safety), including criminal law, requiring, for example, blocking of specific content, applications or services.
(14) Second, traffic management measures going beyond such reasonable traffic management measures might be necessary to protect the integrity and security of the network, for example by preventing cyber-attacks that occur through the spread of malicious software or identity theft of end-users that occurs as a result of spyware.
(15) Third, measures going beyond such reasonable traffic management measures might also be necessary to prevent impending network congestion, that is, situations where congestion is about to materialise, and to mitigate the effects of network congestion, where such congestion occurs only temporarily or in exceptional circumstances.

Article 3 further states that traffic management must be reasonable, transparent, non-discriminatory and proportionate. Article 4 details how providers of internet access services shall be transparent in their contracts about traffic management; hence, traffic management through 5G-MOBIX for cybersecurity purposes should be included. Article 5 also mentions that national authorities should be able to monitor compliance with this Directive and record their findings.
A key technical advancement of 5G is the existence of slicing. This allows dedicated "slices" of resources to be shared to different verticals or users. It is unclear whether the current Net Neutrality legislation will apply to slicing and whether new regulation in this area might be required to ensure that slicing is used under fair business practices. Another point that needs to be clarified how the National Regulating Authorities will be able to monitor operators for breaches of the Open Internet Regulation in the case of slicing and CCAM.

3.2.9. Critical Infrastructures & Law Enforcement

[2] This refers to the traffic management of network packets, not to be confused with road traffic management.

Data protection in criminal investigations: Directive (EU) 2016/680 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data by competent authorities for the purposes of the prevention, investigation, detection or prosecution of criminal offences or the execution of criminal penalties, and on the free movement of such data, and repealing Council Framework Decision 2008/977/JHA.
Network Information Security (NIS) Directive: Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union.

Although these directives do not apply directly to 5G-MOBIX, they are relevant as service providers may be required to cooperate with law enforcement in a criminal investigation or with appropriate cybersecurity agencies in case of a cyberattack. A CCAM service may expose APIs for exchange of information with relevant third parties under these directives, although the exact use of such APIs would be defined by the provider and their internal policies regarding statutory process (unless access is court-mandated).
Specifically, the NIS Directive aims to develop the principles for European cyber-crisis cooperation. Since it is a Directive, the Member States can select the specific of its implementation, leading to concerns on fragmentation and disparities among Member States. NIS states that a certain level of cooperation and cyber security readiness is expected from operators of critical services, defined as (article 4):

(a) an entity provides a service which is essential for the maintenance of critical societal and/or economic activities;
(b) the provision of that service depends on network and information systems; and
(c) an incident would have significant disruptive effects on the provision of that service.

This applies to critical infrastructures (including banking, health, transport etc.), providers of telecommunication basic services (DNS providers etc.), digital service providers (e.g. marketplaces), cloud infrastructure providers etc. As the effects of a cyberattack against critical 5G/CCAM infrastructure could be extremely destructive, cyber-crisis cooperation is a critical capability that needs to be fostered among the 5G/CCAM actors.

3.2.10. UN Regulations on Cybersecurity and Software Updates

UN Regulation on Cybersecurity and Cyber Security Management Systems
UN Regulation on Software Updates and Software Updates Management Systems

The UN Regulation on Cybersecurity and Cybersecurity Management Systems[3] provides a framework for the automotive sector to put in place the necessary processes to:

- Identify and manage cyber security risks in vehicle design;
- Verify that the risks are managed, including testing;
- Ensure that risk assessments are kept current;
- Monitor cyber-attacks and effectively respond to them;
- Support analysis of successful or attempted attacks;
- Assess if cyber security measures remain effective in light of new threats and vulnerabilities.
- All of these will be audited by national technical services or homologation authorities.

The UN Regulation on Software Updates and Software Update Management Systems provides a framework for the automotive sector to put in place the necessary processes for:

- Recording the hardware and software versions relevant to a vehicle type;
- Identifying software relevant for type approval;
- Verifying that the software on a component is what it should be;
- Identifying interdependencies, especially with regards to software updates;
- Identifying vehicle targets and verifying their compatibility with an update;
- Assessing if a software update affects the type approval or legally defined parameters (including adding or removing a function);
- Assessing if an update affects safety or safe driving;
- Informing vehicle owners of updates;
- Documenting all the above.

All of these will be audited by national technical services or homologation authorities.

These Regulations were adopted on June 2020 by UNECE's World Forum for Harmonization of Vehicle Regulations, require that measures be implemented across 4 distinct disciplines:

- Managing vehicle cyber risks;
- Securing vehicles by design to mitigate risks along the value chain;
- Detecting and responding to security incidents across vehicle fleet;

- Providing safe and secure software updates and ensuring vehicle safety is not compromised, introducing a legal basis for so-called "Over-the-Air" (O.T.A.) updates to on-board vehicle software.

According to UNECE's press release, the regulations will apply to passenger cars, vans, trucks and buses. They will enter into force in January 2021. Japan has indicated that it plans to apply these regulations upon entry into force. The Republic of Korea has adopted a stepwise approach, introducing the provisions of the regulation on Cybersecurity in a national guideline in the second half of 2020, and proceeding with the implementation of the regulation in a second step. In the European Union, the new regulation on cyber security will be mandatory for all new vehicle types from July 2022 and will become mandatory for all new vehicles produced from July 2024. Together, the EU, the Republic of Korea and Japan accounted for some 32 million vehicles produced in 2018, representing just over one third of global production.

3.2.11. Radio equipment

Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC (Text with EEA relevance)Text with EEA relevance
Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast) Text with EEA relevance

Directive 2014/53/EU focuses on the harmonisation of laws across the EU relating to radio equipment (RE). It is complemented by the EECC and applies to radio equipment available in the market, excluding RE exclusively used for public security, defence and State Security. It requires that RE will be constructed to ensure the protection of health and safety of persons and domestic animals, including the protection of property and that an adequate level of electromagnetic compatibility (as set out in Directive 2014/30/EU). It states that RE within certain categories or classes must comply with the following essential requirements:

a) radio equipment interworks with accessories, in particular with common chargers;
b) radio equipment interworks via networks with other radio equipment;
c) radio equipment can be connected to interfaces of the appropriate type throughout the Union;
d) radio equipment does not harm the network or its functioning nor misuse network resources, thereby causing an unacceptable degradation of service;
e) radio equipment incorporates safeguards to ensure that the personal data and privacy of the user and of the subscriber are protected;
f) radio equipment supports certain features ensuring protection from fraud;
g) radio equipment supports certain features ensuring access to emergency services;
h) radio equipment supports certain features in order to facilitate its use by users with a disability;

i) radio equipment supports certain features in order to ensure that software can only be loaded into the radio equipment where the compliance of the combination of the radio equipment and software has been demonstrated.

According to the Directive: "The Commission shall be empowered to adopt delegated acts in accordance with Article 44 specifying which categories or classes of radio equipment are concerned by each of the requirements set out in points (a) to (i)."

Furthermore, it states that MS shall not impede the free movement of radio equipment and sets out various obligations for the manufacturers such as drawing up technical documentation, assessing conformity and compliance (e.g. affixing the CE marking), ensuring that it can be operated in at least one Member State without infringing applicable requirements for the use of spectrum and many more.

In the context of 5G-MOBIX this directive should also apply not only to 5G equipment but to radio-enabled On-Board Units utilised in automated vehicles as well as to road-side units (OBUs/RSUs). Importers and distributors are also under obligation to place only compliant radio equipment on the market and ensure that the conformity assessment has been carried out (more information on this procedure is provided in Section 3.3.2). Thus, the Directive imposes obligations to all members of the related supply chain.

3.2.12. Certification

This section describes the certification requirements applicable to radio equipment that enables ITS functionality inside the vehicle (i.e. On Board Units -OBUs) or as part of road infrastructure (i.e. Road Side Units – RSUs).

In the context of 5G-MOBIX, radio equipment will usually be equipped with cellular technology (LTE or 5G) and / or DSRC technology (ITS-G5). Other radio technologies that may be used in vehicles / road infrastructure, and so, subject to be certified are Wireless LAN (WLAN – including Wi-Fi-, Bluetooth, NFC, wireless charging, etc.)

There are two major certification schemas applicable to products in general and radio equipment in particular, regulatory certification schemas and private certification schemas. Regulatory certification schemes are mandatory and are defined and controlled by local authorities (i.e. governments). Private certification schemes are normally set by the industry or by specific telecom operators, or automotive players.

In general, any radio equipment needs to fulfil certain regulatory requirements before it can be placed on the market. These requirements intend to ensure that the equipment fill essential requirements in terms of health, safety, electromagnetic compatibility, and use of the radio spectrum.

Each government sets its own requirements, and they may be different in different countries or areas. The European regulatory framework (CE marking) and the U.S regulatory framework (FCC) have become reference regulatory frameworks in the world and most radio equipment fulfils these requirements before going to market.

Private certification schemes focus on requirements not covered by regulatory requirements. These certifications are carried out after regulatory certification is complete (as failing regulatory certification may imply design changes in the product). The fulfilment of private requirements usually gives the right to use a logo that shows compliance to those requirements.

Commonly, cellular devices undergo industry private certifications GCF and/or PTCRB, as these schemes are usually an entry requirement for the majority of network operators. Additionally, network operators have their own homologation programs where additional tests are performed, mainly testing the behaviour of the telecom devices with the network operator network equipment and configurations.

In the same way, vehicle manufacturers may have their own homologation programs, with their own set of tests, before they accept any device as part of their vehicles.

Figure 5 shows an example of well-known regulatory and private certification schemes around the world. In the case of ITS radio equipment the applicable private certification schemes are industry certification, network operator's homologation and vehicle manufacturer's homologation.

Figure 5.: Certification schemes for V2X radio equipment.

3.3. Overview of existing certifications

An important aspect to address at this point is the difference between compliance and certification. Certification requires the existence of a trusted third party (e.g. an accredited organization) that audits a 5G or CCAM system and, upon a successful inspection, grants a certification mark. This section describes the most relevant existing certifications of regulatory compliance.

3.4. Regulatory certification

3.4.1. Certification according CE marking

Telecommunication products must be CE marked before they can be sold in the European Economic Area (EEA) market. CE marking requirements are covered by a number of directives. CE marking shows that a product had been assessed and meets EU safety, health and environmental protection requirements.

The product's manufacturer takes sole responsibility for declaring the product conformity with all CE marking requirements. The manufacturer must elaborate a technical dossier proving that the product fulfils all the EU-wide requirements.

The CE marking requirements are defined in directives that cover different products or product sectors.

The Radio Equipment Directive (RED), directive 2014/53/EU, establishes the regulatory framework for radio equipment to be made available in the market and put into service in the Union. RED Directive applies to equipment that uses the radio frequency spectrum, (i.e., which intentionally transmits or receives radio waves for communications or radio-determination and operating below 3 GHz - no lowest frequency limit is defined -).

The RED directive principles for product compliance are:

- Compliance with essential requirements.
- Procedures for Conformity assessment.
- Presumption of conformity with essential requirements provided by Harmonised Standards.
- Participation of a Notified Body if there are no radio Harmonised Standard.

A harmonised standard is a standard created upon a request from the European Commission to a recognised European Standards Organisation: CEN, CENELEC, or ETSI to demonstrate that products, services, or processes comply with relevant EU legislation. The table below list the conformance requirements established for radio equipment by the RED directive that need to be fulfilled by any telecom equipment to be used as part of ITS systems and the related harmonized standards that may be used as test method to

show compliance. The technologies covered are cellular (5G, 4G, 3G, 3G and 2G), Bluetooth, Wireless LAN (WLAN) -including Wi-Fi-, NFC and Wireless Charging.

Table 3: RED requirements and harmonized standards for ITS radio equipment.

Requirement	Technology	Harmonized standard	Description
Electrical Safety (RED, Article 3.1a)	All	EN 62368-1:2014 / EN 60950-1:2006 + A11:2009 + A12:2011 + A1:2010 + AC:2011 + A2:2013	Information technology equipment - Safety - Part 1: General requirements.
Health (RED, Article 3.1a)	All	EN 50360:2001 + AC:2006 + A1:2012	Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz - 3 GHz).
		EN 62311:2008	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz).
	Bluetooth, NFC, Wireless charging	EN 62479 2010 (if power less than 20 mW)	Assessment of the compliance of low-power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz).
EMC (RED, Article 3.1b)	All	EN 301 489-1 v2.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.
	Cellular	EN 301 489-52 v12.1.1	Part 52: Specific conditions for Cellular Communication Mobile and portable (UE) radio and ancillary equipment.
	NFC, Wireless charging	EN 301 489-3 v2.1.1	Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 246 GHz.
	Bluetooth, WLAN	EN 301 489-17 v3.1.1	Part 17: Specific conditions for Broadband Data Transmission Systems.
Radio Spectrum (RED, Article 3.2)	2G	EN 301 511 v12.5.1	Global System for Mobile communications (GSM); Harmonized EN for mobile stations in the GSM 900 and GSM 1800 bands.
	3G & LTE	EN 301 908-1 v11.1.1 EN 301 908-2 v11.1.1 EN 301 908-11 v11.1.2 EN 301 908-13 v11.1.2 EN 301 908-14 v13.1.1 EN 301 908-15 v11.1.2	IMT cellular networks; EN 301 908-11 (Repeaters supporting 3G/LTE) EN 301 908-14 (Base Stations supporting LTE only) EN 301 908-15 (Repeaters supporting LTE only) EN 301 908-18 (Base Stations supporting LTE and (2G/3G)).
	DSRC PC5	EN 302 571 v2.1.1	Intelligent Transport Systems (ITS); Radio communications equipment operating in the 5 855 MHz to 5 925 MHz frequency band;

Requirement	Technology	Harmonized standard	Description
	Bluetooth, WLAN 2.4GHz	ETSI EN 300 328 v2.2.2	Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques.
	WLAN 5GHz	ETSI EN 301 893 v1.7.1	Broadband Radio Access Networks (BRAN); 5 GHz high performance RLAN.
	NFC	ETSI EN 300 330 v2.1.1	Short Range Devices (SRD); Radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz
	Wireless charging	ETSI EN 303 417 v1.1.1	Wireless power transmission systems, using technologies other than radio frequency beam, in the 19 - 21 kHz, 59 - 61 kHz, 79 - 90 kHz, 100 - 300 kHz, 6 765 - 6 795 kHz ranges.

3.4.2. Privacy certifications

Some operational examples of successful privacy certifications in various domains include:

- **PrivacyTrust** (formerly eTrust) [25]:a private company that provides privacy certifications for websites and online businesses. A PrivacyTrust certification indicates that a website has been reviewed by the company and is aligned with their privacy and data protection requirements. Similar certifications are available by other providers such as WebTrust, etc. although they are not focused on GDPR or software-oriented architectures
- The **Health Information Trust Alliance** (HITRUST) [26] is a US-based association of organisations, that certifies products for compliance with the Health Insurance Portability and Accountability Act of 1996 [1] (HIPAA). HIPAA sets rules for the handling of medical data in the US. HITRUST, therefore, is able to certify products for HIPAA compliance. It is therefore a case where an appropriate body certifies legal compliance for data protection, although its scope is not as broad as the EU GDPR.

In 5G-MOBIX's case**, certification requires the existence of a trusted third party that inspects the CCAM service and verifies that it is compliant with GDPR** and that the information provided in its specifications are accurate. According to the GDPR **Article 42**:

> *"the Member States, the supervisory authorities, the Board and the Commission shall encourage the establishment of data protection certification mechanisms and of data protection seals and marks".*

The certification should be voluntary and transparent, and the certification body should be granted cooperation and access to the processing. **Article 43** of the GDPR states **that certification bodies should be accredited** (ISO 17065). As GDPR is implemented in each Member State, it is expected that multiple data protection certification providers will be accredited with the relevant national authorities. Thus, it will be

possible in the future for CCAM service developers to get their products certified for GDPR compliance. At this time, it is uncertain if certifications will be available across all member states by the date of the project's completion.

3.4.3. FCC – Federal communication commission

The Code of Federal Regulations, Telecommunications (title 47 of the United States Code of Federal Regulations) holds the U.S. federal regulations for telecommunications.

The Government Printing Office (GPO) publishes and maintains the official rules in the Federal Register.

The FCC regulates radio frequency (RF) devices in electronic -electrical products capable of emitting radio frequency energy by radiation, conduction, or other means in the range of 9 kHz to 3 GHz.

Equipment needs to comply with the requirements established in the FCC rules, independently of the technology it uses.

The table below details the FCC requirements that need to be fulfilled by telecommunication devices to be used in vehicles and Road Side Units, to enable ITS communication. Related technologies are cellular (5G, 4G, 3G, 3G and 2G), Bluetooth, Wireless LAN (WLAN) - including Wi-Fi-, NFC and Wireless Charging.

Table 4: FCC requirements for ITS radio equipment.

RQMT	**47 CFR Regulation**	**Section**	**Description**	**Band**
EMC	Part 2	2.950 (h)	Measurements for unintentional radiators	Any
	Part 15 Subpart B	15.107	Unintentional radiators. Conducted limits	Any
		15.109	Unintentional radiators. Radiated emission limits	
		15.111	Unintentional radiators. Antenna power conduction limits for receivers	Band 17 / XVII Band 05 / V / GSM850 Band 12 / XII Band 13 / XIII Band 14 / XIV
Radio	Part 2	2.950 (g)	Measurements for intentional radiators	Any
		2.1041	Measurement procedure - Certification	
		2.1046	RF power output	
		2.1047	Modulation characteristics	
		2.1049	Occupied bandwidth	
		2.1051	Spurious emissions at antenna terminals	
		2.1053	Field strength of spurious radiation	
		2.1055	Frequency stability	
		2.1057	Frequency spectrum to be investigated	
	Part 15 Subpart C	15.204	External radio frequency power amplifiers and antenna modifications. For WLAN, Bluetooth and NFC devices	Any
		15.209	Radiated emission limits - General requirements. For WLAN, Bluetooth and NFC devices	2.4 GHz 5.1 GHz 5.2 GHz 5.4 GHz 5.8 GHz

RQMT	47 CFR Regulation	Section	Description	Band
				13.56 MHz (NFC)
		15.212	Modular transmitters. For WLAN, Bluetooth, NFC and Wireless charging devices	Any
		15.215	Occupied bandwidth. For WLAN and NFC devices	2.4 GHz 5.8 GHz 13.56 MHz (NFC)
		15.217	Operation in the band 160-190 KHz (Only applicable to equipment operated according to "Intentional radiators - Alternative conditions"). For wireless charging devices	148.5-300 kHz
		15.225	Intentional radiators. For NFC devices.	13.56 MHz (NFC)
		15.247	Intentional radiators. Operations within the bands (for WLAN devices and Bluetooth devices)	2.4 GHz
		15.249	Operation within the 5725-5875 MHz band. For WLAN and Bluetooth devices	5.8 GHz
	Part 15 Subpart E	15.407	Unlicensed National Information Infrastructure Devices: General technical requirements. For bands: For WLAN devices	5150-5250 MHz, 5250-5350 MHz, 5470-5725 MHz & 5725-5850 MHz
	Part 22 Subpart H	22.335	Frequency stability	869-894 paired with 824-849 MHz GSM850; 3G & LTE band 5
		22.913	Effective radiated power limits	
		22.917	Emission limitations	
	Part 24 Subpart E	24.232	Power and antenna height limits	1850-1910 MHz & 1930-1990 MHz PCS1900; 3G & LTE bands 2 and 25
		24.235	Frequency stability	
		24.238	Emission limitations for Broadband PCS equipment	
	Part 27	27.5	Frequencies	Band 07 / VII Band 17 / XVII Band 04 / IV Band 12 / XII Band 13 / XIII Band 38 / D Band 40 / E Band 41 n71
		27.50	Power limits and Duty Cycle	
		27.53	Emission Limits	
		27.54	Frequency Stability	
		27.55	Power Strength Limits	
		27.75	Basic interoperability requirement	n71
	Part 18	18.301	Operating frequencies (Only required for equipment operated according to "ISM Equipment" conditions)	Wireless charging: 100-300 KHz 6.78 MHz
		18.305	Field strength limits (Only required for equipment operated according to "ISM Equipment" conditions)	
		18.309	Frequency range of measurements (Only required for equipment operated according to "ISM Equipment" conditions)	
	Part 30	30.4 (c)	Frequencies	5G: n257, n258, n260
		30.202	Power limits	

RQMT	47 CFR Regulation	Section	Description	Band
		30.203	Emission limits	
		30.208	Operability	
	Part 90	90.210	Emission masks	n79
		90.213	Frequency Stability	
		90.1213	Band plan	
		90.1215	Power limits	
		90.531(g)	Band plan	Band 14 / XIV
		90.539(e)	Frequency Stability	
		90.542	Broadband transmitting power limits	
		90.543:	Emission Limitations	
	Part 90 Subpart M	90.375	DSRC RSU. RSU license areas, communication zones and registrations	5850-5925 MHz (DSRC)
		90.377	DSRC RSU. Frequencies available; maximum EIRP and antenna height, and priority communications.	
		90.379	DSRC RSU… ASTM E2213-03 DSRC Standard (ASTM-DSRC Standard).	
	Part 95 Subpart L	95.3159	DSRC OBU. OBU channel sharing and priority of use.	
		95.3161	DSRC OBU. OBU transmitter certification.	
		95.3167	DSRC OBU. OBU transmit power limit.	
Health/ SAR	Part 27 Section 27.52	1.1307	Actions that may have a significant environmental effect	Band 07 / VII Band 17 / XVII Band 04 / IV Band 05 / V / GSM850 Band 12 /XII Band 13 / XIII Band 38 / D Band 25 / XXV Band 40 / E Band 41 Band 02 / II / PCS1900- WLAN: 5.1 GHz 5.2 GHz 5.4 GHz 5.8 GHz
		1.1310	RF radiation exposure limits	
		2.1091	RF radiation exposure evaluation: Mobile devices	
		2.1093	RF radiation exposure evaluation: Portable devices	
		KDB Publication 941225	SAR test procedures for devices incorporating Long Term Evolution (LTE) capabilities	
Electrical Safety	No requirements // UL mark or equivalent			

4. CURRENT POLICY STATE-OF-PLAY

5G-enabled CCAM presents a complex ecosystem of stakeholders and technical innovations. This section focuses on existing public policy frameworks that affect 5G CCAM.

The EU's strategy is developed and translated into policies and initiatives by the European Commission, who organizes that strategy around six priorities. One of these EC's priorities is "A European fit for the digital age". This European approach to digital transformation is based on three pillars:

- Technology that works for the people.
- A fair and competitive digital economy.
- An open, democratic and sustainable society.

Europe will aim to become a global role model for the digital economy; support developing economies in to going digital and develop digital standards and promote them internationally, with a clear focus in data, technology, and infrastructure. Connectivity is one of the fundamental actions required by digital transformation. The deployment of fibre and 5G networks offers economic opportunities and supports digital transition, enabling innovation in all relevant sectors. One of those sectors is connected transport and mobility.

EC is collaborating to achieve the EU's ambitious vision for connected and automated mobility in a Digital Single Market. The evolution in digital technologies, is quickly changing vehicles, so policies related to digital technology, including cybersecurity, radio communications, data use, liability, privacy, etc. are becoming more relevant for the transport sector. The EC is supporting the deployment of CAM with:

- Developing policies, initiatives and roadmaps.
- Developing European standards.
- Co-funding research and innovation projects and pilots.
- Introducing European legislation.

Connectivityand in particular the deployment of 5G networks, is enabling and driving those efforts. This chapter discusses some of the existing public policy, funding frameworks and other initiatives with relevance to 5G for CCAM. This section includes an extract of information available in the EU website, where more detailed information can be found:

- 5G policies and initiatives resulting from connectivity strategies follow the roadmap defined in the "**5G for Europe Action Plan**", while the mobility strategy is compiled in the "**Europe on the Move**" sets of initiatives with special focus in **Cross Border Corridors**.
- The progress of the Europe's 5G Action Plan is assessed and monitored by the **European 5G Observatory**.

- The softwarised, cloud-native nature of 5G make it an attractive target for cyberattacks. Policies should be in place to minimise such risks.
  - **5GPPP** is launching R&I projects like 5GMOBIX funded by the Horizon 2020 programme. Horizon Europe will continue funding R&I projects from 2021.
  - **CEF** (2014-2019) and **CEF2** (2021-2027) are instruments funding infrastructure investments in Europe.
  - Some of this policies and initiatives have been presented in detail at events or in publications like the **"5G Strategic Deployment Agenda for Connected Automated Mobility".**

4.1. 5G for Europe Action Plan

The 5G Action Plan [27] is a strategic initiative, which concerns all stakeholders, private and public, small and large, in all Member States of EU, to meet the challenge of making 5G a reality for all citizens and businesses by the end of 2020. A very high-capacity networks like 5G will be a key asset for Europe to compete in the Global market, with worldwide 5G revenues for mobile operators expected to reach €225 billion annually by 2025. On 14 September 2016, the Commission launched a plan to boost EU efforts for the deployment of 5G infrastructures and services across the Digital Single Market by 2020. The action plan set out a clear roadmap, for public and private investment on 5G infrastructure in the EU.

To achieve that, the Commission proposed the following measures:

- Align roadmaps and priorities for a coordinated 5G deployment across all EU Member states, targeting early network introduction by 2018, and moving towards commercial large-scale introduction by the end of 2020 at the latest;
- Make provisional spectrum bands available for 5G ahead of the 2019 World Radio Communication Conference (WRC-19), to be complemented by additional bands as quickly as possible, and work towards a recommended approach for the authorisation of the specific 5G spectrum bands above 6GHz;
- Promote early deployment in major urban areas and along major transport paths;
- Promote pan-European multi-stakeholder trials as catalysts to turn technological innovation into full business solutions;
- Facilitate the implementation of an industry-led venture fund in support of 5G-based innovation;
- Unite leading actors in working towards the promotion of global standards.

The EU Public-Private Partnership (5G-PPP) launched in 2013 put Europe clearly in the forefront of the current research phase, as compared to other regions. The research results are now feeding the global standardisation process and being used to prepare the first large scale trials and demonstrators in Europe, in cooperation with several key sectors. The 5G Action Plan is leveraging these initial research successes.

The new European Electronic Communications Code [28] and the 5G action plan are closely related: they are both aimed at fostering the competitiveness of our industry in the Digital Single Market. They will both

support the deployment and take-up of 5G networks, notably as regards the timely assignment and availability of radio spectrum, more favourable conditions for small cell deployment or sectorial issues preventing the deployment of particular services, investment incentives and favourable framework conditions, while the recently adopted rules on Open Internet provide legal certainty as regards the deployment of 5G applications.

5G will enable:

- Industrial transformation through wireless broadband services provided at Gigabit speeds. 5G should offer data connections well above 10 Gigabits per second, latency below 5 milliseconds and the capability to exploit any available wireless resources (from Wi-Fi to 4G) and to handle millions of connected devices simultaneously).
- The support of new types of applications connecting devices and objects (the Internet of Things) and versatility, by way of software virtualisation allowing innovative business models across multiple sectors (e.g. transport, health, manufacturing, logistics, energy, media and entertainment).

It opens up prospects for new pervasive mobile virtual services, important for the economy and society ranging from virtual reality for remote collaboration to on-line health monitoring or connected cars, and possibly drone delivery or automated driving.

4.2. European 5G Observatory

The European 5G Observatory monitors market developments and preparatory actions taken by industry stakeholders and EU's members in the context of 5G rollout in Europe and beyond. The Observatory enables the EC to assess the progress of Europe's 5G Action Plan and take action to fully implement it [29].

As 5G gets closer to market deployment, the European 5G Observatory provides updates on all market developments, including actions undertaken by the private and public sectors, in the field of 5G. All developments will be analysed in view of their strategic implications on the objectives of the 5G Action Plan and other public policy objectives. The Observatory focuses primarily on developments in Europe, along with major international developments that could influence the European market.

The Observatory monitors the following developments:

- Main 5G market developments including planning and commercial launch of 5G products and services with major impact.
    - New developments regarding key 5G products and components as well as technology choices made by key actors including regarding standards and use of spectrum bands.
    - 5G pre-commercial trials and partnerships between actors of the 5G value chain.
    - National strategies and plans by EU Member States, available national data on 5G deployment including coverage and quality.

- Preparation and execution of spectrum assignments by public authorities as well as 5G public funding for network deployment and R&I.

Plans to establish the European 5G Observatory were announced in February 2018, to closely monitor the progress of the European 5G Connectivity objectives for a competitive Digital Single Market by 2025. The observatory provides regular updates of the latest trends in 5G deployment and publishes quarterly reports on the 5G progress.

In line with the 5G Action Plan for Europe, EU countries have already agreed on a 5G roadmap to coordinate the availability of new 5G frequencies. A number of Member States have published national strategies on 5G in the context of national broadband plans (NBPs).

IDATE DigiWorld has been selected to carry out the 5G European observatory for the European Commission.

4.3. 5G Cybersecurity toolbox

5G is expected to be a major enabler for multiple digital services, including CCAM. 5G can be a key factor towards the development of a digital economy in the coming years, affecting many citizens' lives. However, due to the less centralised architecture and its cloud-native, softwarised nature it can offer a valuable target to attackers. Thus, it is crucial to ensure a secure roll-out with built-in security and robustness features using a coordinated approach at national and EU level.

Thus, the NIS Cooperation Group has worked on a 5G Cybersecurity toolbox containing a common set of measures to mitigate cybersecurity risks and achieve a level of resilience. The toolbox proposes a set of Strategic and Technical Measures to ensure the deployment of secure 5G networks [30].

Key measures include:

- Strengthening security requirements for Mobile Network Operators (MNOs) at Member State level.
- Assessing the risk profile of suppliers and applying restrictions in terms of key assets such as exclusion of a high-risk supplier.
- Ensuring that MNOs adopt a multi-vendor strategy and avoiding dependency on a single supplier.
- Maintaining a diverse and sustainable 5G supply chain.
- Using relevant EU programs and funding.
- Facilitating standardization and certification.
- Making use of other existing frameworks, e.g. relating to the screening of Foreign Direct Investment (FDI) etc.

On July 2020 ENISA [31] issued a report on "Member States' Progress in Implementing the EU Toolbox on 5G Cybersecurity". The report concludes that most Member States (MS) have been taking important steps to implement the Toolbox. Most MS carried out gap analyses and launched processes to review and upgrade existing security measures, as well as advanced in the preparation of more advanced security measures.

Work is still on-going, however, in order to properly define the scope of the measures and many political and regulatory decisions still need to be made. Although most Member States do not share specific details for national security reasons, the report presents a high-level analysis:

- Most MS are in the process of strengthening power for regulatory authorities, in order to allow powers to regulate procurement of equipment, based on security-related grounds.
- There is still a need to address how cybersecurity audits will be conducted.
- Regarding the restriction on suppliers based on their risk profile, the identification of criteria is on-going in many MS, although it is a complex and sensitive matter. It is recommended that the assessment takes into account the international trade context and prioritises specific key assets (such as MANO). Another issue to be considered is the transition period as operators might already use equipment from high-risk vendors, particularly during the upgrade cycle from non-standalone to standalone 5G.
- A number of MS have not yet adopted measures to limit the ability of MNOs to outsource particular functions and activities.
- Many MS are facing challenges in defining the process to impose multi-vendor strategies for individual MNOs or at national level.
- Several Member States have recently taken steps to introduce or reinforce existing national Foreign Direct Investment (FDI) screening mechanisms. FDI screening is not yet in place in 13 MS, and steps should be taken to introduce it in view of the approaching application of the EU screening framework as of October 2020. FDI screening should be applied in cases where the 5G supply chain is involved.
- The process of reviewing and reinforcing network security requirements for operators is well-advanced. Progress is slower in when defining security requirements and technical measures since the development of many technologies is still on-going. The role of standardisation is instrumental in this respect and European participation in relevant SDOs is a necessity
- It is crucial that MS exchange information and best practices regarding 5G cybersecurity and ensure the cooperation of the Commission and ENISA towards the monitoring of the implementation of the Toolbox as well as the implementation of EU-wide actions.
- Ensuring that 5G projects supported by public funding take into account cybersecurity.

4.4. Europe on the Move: Third Mobility Package

The EC launched Europe on the Move in 2017, a set of initiatives aimed to modernise European transport and mobility in a transition to digitalisation and clean energy. It is based on three pillars: Socially fair & Competitive; Clean; and Connected Transport and Mobility. Actions were taken in three phases. The third package of measures, presented in May of 2018, is related to connected and autonomous mobility. It included proposals about safe mobility, clean mobility, and connected & automated mobility [32].

The proposal about automated mobility [On the road to automated mobility: An EU strategy for mobility of the future COM/2018/283 [33] describes CAM as a new opportunity for Europe and gives the EU's own vision. It introduces the funding options: Horizon 2020 programme for R&I projects and CEF for deployment

initiatives. It emphasises aspects like innovation, safety, liability issues, connectivity, cybersecurity, and data protection [33]–[35].

4.5. Cross-border corridors for Connected and Automated Mobility

Within the European 5G vertical strategy, Connected and Automated Driving (CAD) is considered as a flagship use case for 5G deployment along European transport paths, in view of creating complete ecosystems around vehicles, beyond the safety services targeted by the Cooperative-Intelligent Transport System (C-ITS) roadmap of Europe [36].

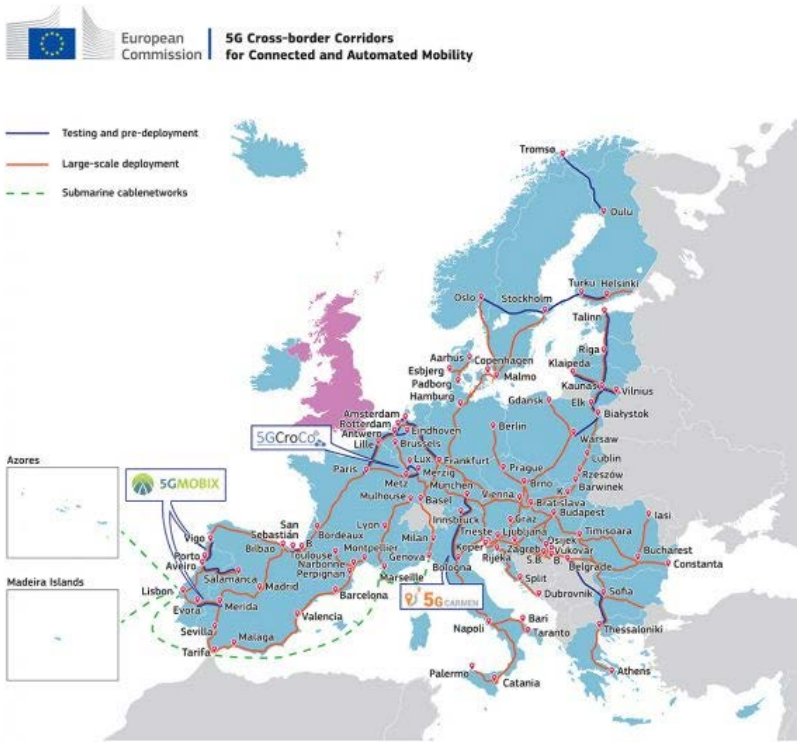


Figure 6. 5G Cross-border Corridors for Connected and Automated Mobility

29 European countries are committed to the development of large-scale testing sites of connected and automated driving on European motorways in the form of cross-border corridors.

4.5.1. Europe's 5G Corridors

A collaborative network of cross-border corridors between European countries will enable a better environment for the testing and deployment of 5G technology.

Member States and industry first agreed to establish cross-border corridors in September 2017, during the round table on Connected and Automated Driving (CAD) in Frankfurt. A number of Member States have gone on to sign and/or announce bilateral agreements among themselves for more test corridors.

Thanks to these 5G corridors, Europe is currently the biggest experiment area in 5G technology. This affirms Europe's ambition to lead in large-scale testing and early deployment of 5G infrastructure, enabling connected and automated driving (or mobility). Only a pan-European effort will create a secure and safe environment for citizens to enjoy the benefits of connected and automated mobility.

4.5.2. Initiatives for 5G cross-border corridors large-scale testing

As part of the European Commission's 5G Public Private Partnership (5G PPP), the EU supports and co-funds three 5G cross-border corridor projects for large-scale testing of connected and automated mobility (CAM), which are co-funded under Horizon 2020 and include 5G MOBIX. The three projects, launched in November 2018, trial 5G technology applied to CAM over more than one thousand kilometres of highways across four borders:

- 5G-CARMEN: 600 km of roads across an important north-south corridor from Bologna to Munich via the Brenner Pass.
- 5GCROCO: over highways between Metz, Merzig and Luxembourg, crossing the borders of France, Germany and Luxembourg.
- 5G MOBIX: along two cross-border corridors, one between Spain and Portugal and other between Greece and Turkey.

Further funding opportunities are currently planned by the Commission both under the last phase of Horizon 2020 and the next EU budget proposal. In particular, as part of the next Connecting Europe Facility programme (CEF2 Digital) for 2021-2027There are also several important initiatives/projects and cooperation agreements in place among Member States:

- **France, Germany and Luxembourg** have announced a joint corridor between Luxembourg, Metz and Merzig.
- **Norway, Finland and Sweden** with the E8 corridor between Tromsø (Norway) and Oulu (Finland) and the E18 corridor between Helsinki, Stockholm and Oslo.
- The **Netherlands and Belgium** have agreed to the Rotterdam – Antwerp - Eindhoven corridor.
- **Spain and Portugal** signed a letter of intent to have two joint corridors between Vigo and Porto and between Evora and Mérida, allowing connected automated driving to be tested across borders.
- **Slovenia, Hungary and Austria** signed a memorandum of understanding on cross-border cooperation in developing and testing electric, integrated and autonomous vehicles.
- **Bulgaria, Greece and Serbia** signed a letter of intent on the corridor Thessaloniki – Sofia – Belgrade to develop experimental 5G cross-border corridors that will allow for the testing of driverless vehicles.
- **Poland and Lithuania** signed a letter of intent on 5/9/2018 to cooperate on technical, legal and policy of the cross-border CAD corridor 'via Baltica' (Warsaw, Kaunas, Vilnius).
- **Lithuania**, **Latvia** and **Estonia** signed a memorandum of understanding for the 'Via Baltica - North'.

- **Italy and the three presidents of Euroregion Tirol-Südtirol-Trentino** have confirmed their intention to work, in cooperation with other interested Member States, on the development of the 5G Corridor on the Brenner-pass motorway.

Overall, thanks to the support of enhanced cross-border cooperation and the support of EU Research and Innovation funding, a new map of 5G cross-border corridors is progressively taking shape in Europe [36].

4.6. 5G Strategic Deployment Agenda for Connected & Automated Mobility

The "**5G Strategic Deployment Agenda for Connected Automated Mobility"** sets the "shared view of a wide group of industry stakeholders supporting the objectives of the 5G Strategic Deployment Agenda (SDA)". The aim is to support Connected and Automated Mobility (CAM) in Europe and set the basis for "future-proof 5G infrastructure, technologies and vehicles".

The current proposal for the SDA envisions that deployment of 5G is a major enabler for commercial (e.g. infotainment) as well as safety services, due to improved speed and reliability. In addition, the service-based approach is expected to transform vertical industries and spark economic growth. The 5G SDA for CAM revolves around the **deployment objectives, cooperation models and regulatory innovations** as its main elements [37]. These were defined during the first open stakeholder workshop that took place in February 2019. The common principles that underline the SDA were hence defined:

- **Deployment of 5G should follow an evolutionary path:** In order to account for future market needs and technical developments, the deployment of 5G should follow an evolutionary path. 5G should co-exist and be interoperable with other networks like 4G LTE.
- **Service Continuity across borders and actors:** As many CCAM services (e.g. guidance, auto-overtake etc.) can be considered "mission critical", there needs to be reliable, uninterrupted connectivity and coverage, with service continuity across borders and actors.
- **End-to-end cybersecurity:** A high level of end-to-end cybersecurity is necessary to ensure trust in CCAM services, but it also needs to be held to high performance and reliability criteria.
- 5G for CAM needs to be a **Multi-service/Multi-application platform** with standardised interfaces and data formats.
- **Coordination among public & private actors in V2X** for the deployment of 5G infrastructure is necessary. Starting from major corridors and highways, the benefits of 5G for CAM can be demonstrated. Coverage can then be extended to secondary roads and urban areas.
- **Public authorities and administrations** in charge of roads should collaborate for the deployment of connectivity along major corridors.
- **Cooperative planning & cost optimisation** is necessary to deliver improved networks in a cost-effective way.
- **Digital transformation** for industry verticals must be accelerated [38].

Figure 7.:The 5G SDA common principles

4.7. 5G Infrastructure Public Private Partnership (5G PPP)

The 5G Infrastructure Public Private Partnership (5G PPP) is a joint initiative between the European Commission and European ICT industry (ICT manufacturers, telecommunications operators, service providers, SMEs and researcher Institutions). The 5G-PPP is now in its third phase where many new projects were launched in Brussels in June 2018. 5G MOBIX with 5GCroCo and 5GCARMEN were the projects selected in part 2, automotive projects, of that third phase.

The 5G PPP will deliver solutions, architectures, technologies and standards for the ubiquitous next generation communication infrastructures of the coming decade. The challenge for the 5G Public Private Partnership (5G PPP) is to secure Europe's leadership in the particular areas where Europe is strong or where there is potential for creating new markets such as smart cities, e-health, intelligent transport, education or entertainment & media. The 5G PPP initiative will reinforce the European industry to successfully compete on global markets and open new innovation opportunities. It will "open a platform that helps us reach our common goal to maintain and strengthen the global technological lead" [39].

The key challenges for the 5G Infrastructure PPP are:

- Providing 1000 times higher wireless area capacity and more varied service capabilities compared to 2010.
- Saving up to 90% of energy per service provided. The main focus will be in mobile communication networks where the dominating energy consumption comes from the radio access network.
- Reducing the average service creation time cycle from 90 hours to 90 minutes.
- Creating a secure, reliable and dependable Internet with a "zero perceived" downtime for services provision.

- Facilitating very dense deployments of wireless communication links to connect over 7 trillion wireless devices serving over 7 billion people.
- Ensuring for everyone and everywhere the access to a wider panel of services and applications at lower cost [39].

4.8. Connecting Europe Facility (CEF)

The Connecting Europe Facility (CEF) is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level. It supports the development of high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services. CEF investments fill the missing links in Europe's energy, transport and digital backbone.

The CEF benefits people across all Member States, as it makes travel easier and more sustainable, it enhances Europe's energy security while enabling wider use of renewables, and it facilitates cross-border interaction between public administrations, businesses and citizens.

In addition to grants, the CEF offers financial support to projects through innovative financial instruments such as guarantees and project bonds. These instruments create significant leverage in their use of EU budget and act as a catalyst to attract further funding from the private sector and other public sector actors.

The CEF is divided into three sectors: Energy, Telecom and Transport.

4.8.1. CEF Telecom

The Connecting Europe Facility (CEF) in Telecom is a key EU instrument to facilitate cross-border interaction between public administrations, businesses and citizens, by deploying digital service infrastructures (DSIs) and broadband networks. Supported projects will contribute to the creation of a European ecosystem of interoperable and interconnected digital services that sustain the Digital Single Market.

4.8.2. CEF Transport

The Connecting Europe Facility (CEF) [40] for Transport is the funding instrument to realise European transport infrastructure policy during the period 2014-2020. It aims at supporting investments in building new transport infrastructure in Europe or rehabilitating and upgrading the existing one.

CEF Transport focuses on cross-border projects and projects aiming at removing bottlenecks or bridging missing links in various sections of the Core Network and on the Comprehensive Network (link), as well as for horizontal priorities such as traffic management systems.

CEF Transport also supports innovation in the transport system in order to improve the use of infrastructure, reduce the environmental impact of transport, enhance energy efficiency and increase safety [41].

4.9. Connecting Europe Facility (CEF2) Digital

The Connecting Europe Facility (CEF2) Digital programme aims to support and catalyse investments in digital connectivity infrastructures of common interest during the period 2021-2027.

Europe can fully reap the benefits of the digital transformation if high-quality access to Gigabit networks is made available to all people, businesses and "socioeconomic drivers" such as schools, universities, hospitals, transport hubs and public administrations.

The Connecting Europe Facility (CEF2) Digital programme will support and catalyse investments in digital connectivity infrastructures of common interest, during the period 2021-2027.

Actions foreseen under the programme include:

- The deployment of and access to very high-capacity networks, including 5G systems, capable of providing Gigabit connectivity in areas where socioeconomic drivers are located.
- The provision of very high-quality local wireless connectivity in local communities that is free of charge and without discriminatory conditions.
- Uninterrupted coverage with 5G systems of all major transport paths, including the trans-European transport networks.
- Deployment of new or significant upgrade of existing backbone networks including submarine cables, within and between Member States and between the Union and third countries.
- Implementing digital connectivity infrastructures related to cross-border projects in the areas of transport or energy and/or supporting operational digital platforms directly associated to transport or energy infrastructures [42], [43].

4.10. C-ITS Platform

Following the 2010 ITS EU Directive and its subsequent regulation on issue like road safety, real-time-traffic and multimodal travel information, providing the necessary legal and technical framework to steer and ensure the interoperability of deployed ITS services, the EC decided in 2014 to take a more prominent role in the deployment of connected driving, setting up a C-ITS Deployment Platform. The Platform was conceived as a cooperative framework including national authorities, C-ITS stakeholders and the Commission, in view to develop a shared vision on the interoperable deployment of C-ITS in the EU. Hence, it was expected to provide policy recommendations for the development of a roadmap and a deployment strategy for C-ITS in the EU and identify potential solutions to some critical issues.

After a first phase towards its first milestones in connected and autonomous vehicles in the EU, the second phase developed a shared vision on the interoperable deployment of Cooperative Intelligent Transport Systems (C-ITS) towards cooperative, connected and automated mobility (CCAM) in the European Union.

This included making tangible progress in topics like security, data protection, compliance assessment and hybrid communication, essential to the interoperability of C-ITS deployment and relevant for the preparation of Delegated Acts on C-ITS. The Platform work was closed in 2017 but the EU rejected the Delegated Act in 2019 after considerations of lack of neutrality from industry telecommunications and automotive stakeholders.

The EC recommendation to make the Wi Fi-based (802.11p) ITS-G5 standard mandatory requirement for vehicle-to-X (V2X) capabilities, did not leave any room for the Cellular-V2X (C-V2X) technology favoured by the GSMA community. When rejected, this opened the door for C-V2X, that many considered a better option in areas like day one services like VRU safety.

4.11. Other initiatives

4.11.1. European Automotive – Telecom Alliance (EATA)

The EC initiated a number of High-Level Round Table discussions to strengthen the digital dimension of CAM. These discussions brought together the industrial players from the digital and automotive sectors to develop joint road maps and establish cross-border deployment actions. Among the main achievements of the Round Table is the creation of the "European Automotive – Telecom Alliance" (EATA) to promote the wider deployment of connected & automated driving.

The first target of the Alliance was to implement the pre-deployment project for testing CAM in a real setting.

4.11.2. 5G Automotive Alliance

In parallel, the industry joined up to create the 5G Automotive Alliance (5GAA) to specifically promote 5G in the automotive sector. A Memorandum of Understanding amongst EATA and 5GAA was signed at the Mobile World Congress (February 2017).

4.11.3. C-ROADS Platform

Through the C-Roads Platform, funded under CEF, authorities and road operators join together to harmonize the deployment activities of cooperative intelligent transport systems (C-ITS) across Europe. The goal is to achieve the deployment of interoperable cross-border C-ITS services for road users.

According to the C-ROADS main website[4], the governance structure can be described as follows:

- The C-Roads Platform is steered by the C-Roads **Steering Committee** which is composed by Member State representatives. With the support of the **Supporting Secretariat**, decisions for achieving the goal of the implementation of interoperable end-user services are done.

- In this respect specifications, which are proposed and recommended by specific Working Groups, are approved. These specifications are the basis for the single pilot activities. This especially goes with technical decisions, which influence deployment and procurement decisions at pilot sites.
- **Working Groups** are installed as decision support for the Steering Committee to ensure proper decisions towards interoperable deployments. Individual experts participating in the single pilots work together in these Working Groups to prepare proposals and recommendations.
- Also, members of the single pilot activities as well as of the C-Roads-Working Groups actively contribute to the work of the EU-C-ITS-Platform.

Additionally, the European Commission and the Innovation and Networks Executive Agency as well as associated member State representatives are invited to follow and actively participate to discussions at all C-Roads Platform levels. The C-ROADS platform deals with cross-border interoperability of C-ITS services. C-ROADS provides specifications of C-ITS Day 1 I2V services. In addition to ITS-G5, C-ROADS has defined an IP-based protocol for communication between back ends, allowing service continuity across borders. C-ROADS collaborates with the Car2Car Consortium, in order to assure that the specifications are accepted by the vehicle industry.

4.11.4. CAR2CAR Consortium

The CAR2CAR consortium focuses on wireless vehicle-to-vehicle (V2V) communication applications based on ITS-G5 and concentrates all efforts on creating standards ensuring the interoperability of cooperative systems spanning all vehicles classes, across borders and brands. The Consortium works in close cooperation with the European and international standardisation organisations like the European Telecommunications Standards Institute (ETSI) and European Committee for Standardisation (CEN).

4.12. Post-Covid-19 Releases

Europe is in transition between two long term budgeting periods: From CEF to CEF2 and from Horizon 2020 R&I programme to Horizon Europe, involving new projects' calls. On the other hand, Europe is struggling to overcome the Covid-19 pandemic. The post-COVID era will bring new trends and needs in mobility, transport and communications: Increase in last mile delivery operations due to increased online commerce activity; demand increase of individual and/or driverless transportation of passengers and goods; increase of use of broadband services for remote work, online meetings, home schooling, TV streaming; etc. Post-COVID rescue packages and bailout funds will be implemented via projects so we will see new developments and projects during the following years.

This subsection includes some references to updates in the policies and initiatives described in this section and some references to local initiatives in countries where 5G MOBIX is working.

4.12.1. State of the Union 2020

After the State of the Union Address in September 2020 the EC issued a recommendation to boost investment in very high-capacity broadband connectivity infrastructure, including 5G, which is the most fundamental block of the digital transformation and an essential pillar of the recovery. It boosts fast network connectivity and develop joint approach to 5G rollout. The timely deployment of 5G networks will offer significant economic opportunities for the years to come, as a crucial asset for European competitiveness, sustainability and a major enabler for future digital services.

The recommendation included a toolbox of best practices that should aim to:

- Reduce the cost and increase the speed of deployment of very high capacity networks, notably by removing unnecessary administrative hurdles.
- Provide timely access to 5G radio spectrum and encourage operators' investments in expanding network infrastructure.
- Establish more cross-border coordination for radio spectrum assignments, to support innovative 5G services, particularly in the industry and transport fields.

The recommendation also sets out guidance for best practices to provide timely access to radio spectrum for 5G as well as ensure stronger coordination of spectrum assignment for 5G cross-border applications. This is particularly important to enable connected and automated mobility, as well as the digitisation of industry and smart factories. Enhanced cross-border coordination will help to provide Europe's main transport paths, particularly road, rail and in-land waterways, with uninterrupted 5G coverage by 2025. However, until mid-September 2020, Member States (and the UK) had assigned on average only 27.5% of the 5G pioneer bands. It is therefore essential that Member States avoid or minimise any delays in granting access to radio spectrum to ensure timely deployment of 5G.

The recommendation also promotes the rollout of sustainable high-speed networks by reducing deployment costs through harmonized measures to ensure network providers and operators can share infrastructure, coordinate civil works and obtain the necessary permits for deployment.

4.12.2. Spanish Connected, Safe and Sustainable Mobility Strategy 2030

The Spanish Ministry of Transports, Mobility and Urban Agenda (MITMA) presented in September of 2020 **es.movilidad**, the Connected, Safe and Sustainable Mobility Strategy 2030 that will guide the next ten years actions in mobility, infrastructure and transport. The strategy is built around nine axes, including smart mobility, European connectivity, safe mobility, low emissions mobility, and inclusive mobility, among others. The first phase will include a laboratory of ideas to define some of the required initiatives.

The Ministry is working in a new Mobility Law that includes connected and automated mobility.

4.12.3. France – Spain cooperation in CAM

France and Spain ministers of transport signed in September 2020 a Memorandum of Understanding (MoU) on connected and automated driving aimed to develop the collaboration in future driving. The main objectives are:

- Bigger interoperability of systems and standardization.
- Development of the use cases of shared mobility, transport and logistics.
- Adaptation of regulations and infrastructures to new systems of connected mobility.
- Introduction of cooperative communication systems and 5G connectivity in transport [44].

The MoU will boost cooperation between different ongoing research projects and will facilitate autonomous driving cross border tests between both countries.

The Spanish Ministry of Transport is open to autonomous driving tests in open traffic roads and the Spanish Secretary of Telecommunications and Digital Infrastructure has stated that the development of cross border corridors is a key priority [45], [46].

5. PRELIMINARY RESULTS

The following chapters describe recommendations from the stakeholders (road operator, car/truck industry and network operators) to the regulation and policy entities for enabling an X-border traffic with automated vehicles.

5.1. Recommendations from ICT Sector

Although specific recommendations on the ICT side were provided in D6.1 "Plan and Preliminary Report on deployment enablers", some important aspects that touch upon regulation and cooperation can also be summarised here. In order to create a fast growing market of CCAM services, there need to be improved cooperation when it comes to the **standardisation of interfaces and data formats** to ensure interoperability but also data portability. The concerns over the use of data-intensive services based on Artificial Intelligence and highly-automated ITS are highly relevant to the future of CCAM. Improved and complex functionalities may require the use of massive data collection over periods of time. This needs to be performed under the confines of the GDPR and the new ePrivacy Regulation. The need of **ethical data proxies** can be a potential solution to this problem, as data intermediaries that provide encryption, anonymization/pseudonymisation on the fly, and manage who is authorised to access this data and under authenticated access only.

The democratisation of data access can in turn lead to the development of more intelligent CCAM services. The next step would be to make these services available through the **creation of a digital marketplace**. This would assume that there are ways to properly specify the deployment requirements of each service (including boundary conditions that can lead to failure) and a way to negotiate **Service Level Agreements** (SLAs) with the service provider. SLA assurance can then be monitored, and a penalisation model can be applied to providers that fail to comply with the SLA contract. Blockchain technology can be applied to Smart Contracts and provide a basis for future SLA negotiations and monitoring.

On the side of the Telco operators, **flexible spectrum licensing and payment methods** seem to be a key concern as these can potentially affect the investment on new infrastructures.

Suggestion for recommendation:

- A specific plan needs to be in place from any member state prior to the spectrum auctions to enable telco operators to make appropriate plans for 5G deployments. A flexible mechanism should be in place to enable leasing of additional frequencies and the additional licensing processes for the development of infrastructure (e.g. antenna placement etc.) should be fast.
- Cross-border harmonisation issues may arise in cases of countries that do not implement the ECC/DEC/(15)01 decision on "Harmonised technical conditions for mobile/fixed communications networks (MFCN) in the band 694-790 MHz including a paired frequency arrangement (Frequency Division Duplex 2x30 MHz) and an optional unpaired frequency arrangement (Supplemental Downlink)"

e.g. Bulgaria. Frequency harmonisation is a necessary component of CCAM, otherwise there is the risk that automated capabilities will not be available across a hard border.

- More guidance should be provided by higher level authorities on **how data should be stored**, transferred, shared etc.
- Attention should be given to **data Integrity**. Governments should push for regulating stakeholders on the type of data they provide across platforms, ensure that these data are reliable and of good quality, and set requirements regarding data quality

5.2. Recommendations from road operators

The introduction of automated vehicles in public road networks presents a new challenge for road operators in the relation between infrastructure and road users. Although the rules and context of vehicle operation is expected to remain the same, the automation of driver tasks must include all the safety and compliance demands a human driver should abide to. Some rules can be computationally modelled, and some others fall into the behavioural and cultural domain.

The road environment community od stakeholders has also evolved to a more shared space, where soft modes and new mobility forms are increasing the complexity of the road and the coexistence of different classes of vehicles and pedestrians. Road Operators are committed to the introduction of high-level automation in both vehicles and infrastructure but given top priority and concern to all matters having an impact on road safety.

Considering the regulatory issues that may have strong influence in supporting cross-border automated vehicles in the next generation of connected mobility and the policy measures that may be taken to support them, the main issues and suggestions for policy recommendations from a Road Operator perspective are depicted below in detail.

- **Higher levels of automation, that have road infrastructure requirements such as surface marking or telecommunications support, should require validation to be active.** The validation could be achieved by including AD levels in HD Map information or by broadcasting allowed AD levels in I2V services and are currently under discussion in the C-ROADS platform. A common regulation must exist to define the compliance of vehicles with infrastructure conditions, including cross-border borders.
- **Extended sensors allow the increased visibility and awareness of a vehicle's surrounding,** shared information measures must be implemented to define the level of trust, reliability and precision of extended sensor information. Policies regarding the handling of Road Infrastructure sourced sensor information and shared vehicle awareness information must define the priority and validity of overlapping or conflicting data.

- Safety and reliability of AV handling and manoeuvre is heavily reliant on global positioning systems and HD Map information, which do not have enough precision for kinetic calculations. For most high precision AV functions, **local positioning systems and HD Maps should be adopted, supported by infrastructure location reference services.**
- It is not expected that vehicles can include all traffic laws and regulations into its AV functions. Specifications and specific **regulations must be developed in a common format to describe the general laws and regulations, as well as the laws and regulations applicable locally for specific conditions**. This description should take the Vienna convention and existing standards as base for a I2V service or HD Map data layer to allow the vehicles to receive traffic law compliance instructions for ADAS systems.
- From a traffic management point of view, platooning is a specific vehicle formation that already exists with human driving. The rules for platoons of vehicles, for example in emergency and military formations, restricts the flow of traffic for remaining drivers. **Specific regulations must be created for the existence and limits of automated platooning, and the ADAS for all vehicles member of a platoon must comply with manoeuvre enforcement measures** that reduce the impact for remaining road users.
- Road traffic is based on the principle that each vehicle has the responsibility to perform according to the rules of traffic while ensuring observance to safety conditions in the surrounding. Remote driving allows for an operator to replace the driver, being limited to the capabilities of the vehicle sensors and communications, much like the highest level of SAE driving. **Specific regulations must be created to define the conditions in which remote driving is allowed and to assure the liability for operators in case of incident or non-compliance to traffic laws.**
- The rise of automated interaction with vehicles driving components, along with the meaningful interference of digital telecommunication services in ADAS, shall require the creation of specific regulation for **black box information and road accident recording.** Such information is not only required for legal and liability purposes, but also as a key factor to improve the resilience and reliability of AV.
- The technology of AV for higher levels of SAE autonomous driving and remote driving can, and should be, used as additional **safety measures regarding human failure**. Systems such as detection of illegal substance abuse or sudden illness can be regulated as future mandatory base functions of AV, along with the support for contingency stops and automated malfunction response manoeuvres with or without road infrastructure support.
- The coexistence of AV with other conventional vehicles on the road requires the creation of specific regulation regarding the need to support additional safety measures in AV, prioritization of road traffic, maximizing road safety and performance. Using high level automated functions in environments with pedestrians or vulnerable road users (VRUs) shall require **certification/validation or rating of safety levels for a vehicle to operate in automated mode, similar to the Euro NCAP**.
- To reach the full potential of CCAM technologies in road vehicles, the conventional vehicles must become, more and more, connected vehicles. This technology should not only benefit new

vehicles manufactured with specific applications for connected mobility. In particular for awareness and safety functions, there must **be a development policy that allows this technology to be available for conventional vehicles by retrofitting them with connected V2X systems.**

- The communication in V2V and V2I must safeguard all aspects of **privacy and secure data handling, making available only the relevant data to the involved parties**. Some AV functions rely on the detection and tracking of specific vehicles, by recording and processing data that is needed to remain trackable for a certain span of time. Specific regulation must be developed to handle the ability of automated systems to perform data processing in closed context, assuring the privacy of tracked and recorded data.
- Higher level functions of CCAM like overtaking or lane merging, in mass transit or high-performance roads, may require **arbitration between the involved parties depending on the implementation model.** Road Operators may provide such arbitration and manoeuvre coordination. For that purpose, it shall be necessary to create specific regulation that provides a framework for infrastructure action and vehicle abidance by ADAS, including the possibility of non-compliance by any party involved.

In the case of **Real-Time Multi-tier Processing and Remote driving**, recommendations include:

- **KPI verification of sensor operation.** Some of the usual KPIs are vehicle manoeuvres, safety measures, environmental impact or network efficiency within the car. Checking the data at the beginning of the process ensures that the system works properly.
- **Raising the level of data processing.** With traditional data storage methods, the results must be stored on a NAS-based system and then transferred to workstations. This process has two drawbacks:
    - Large amounts of data must be moved, which requires considerable bandwidth and operating time.
    - Individual workstations do not offer the massive computing power required to return results quickly enough.
    - Employ work environments that allow processing and storage to be scaled to hundreds of petabytes (e.g. open source Hadoop for programming distributed applications that handle large volumes of data)
- **Making the most of advanced analytics.** The new analysis tools can read different data formats thrown up by cars and provide appropriate levels of access to metadata (e.g. video recordings valid for both analysing vehicle right-hand drive behaviour and determining the accuracy of a model representing the vehicle's perception of its physical environment). The more sensors that can cover a type of information, the final decision will be based on the action that indicates the largest number of sensors in case of inconsistency. However, much work remains to be done in this regard in terms of ethics and prioritizing actions when lives are at stake. Furthermore, there is a need for further harmonisation in data standards, interoperability and ensuring data quality is still lacking.

In the case of Autonomous Vehicle Regulation Compliance and QoS Support, recommendations include:

- **Definition of an international regulation and an associated set of drivers** who must outperform both the on-road equipment and the ADAS in order to guarantee the quality of the service.
- **Definitions, associated measurement methods and guidance objectives for road-centred parameters**
- Definition of the **exact metrics (e.g. minimum performance, maximum latency, etc.) that information has to transfer during the handover procedure in cross-border environments**. This handover must operate independently of the equipment, vehicle and external factors. It must be possible to ensure that the minimum requirements are met in order to be able to switch from assisted driving to manual driving without risk to users.

5.3. Recommendations from car industry

This section aims to describe the requirements of automated vehicles for cross-border operation by identifying the possible regulation issues that automated vehicle may encounter during soft or hard border crossings and then proposing solutions from the perspective of OEMs. In 5G-MOBIX project, we study five different use cases comprised of advanced driving, vehicles platooning, extended sensors, remote driving and vehicle QoS support that classified under 3GPP TS 22.186 R16. In this section, we provide the regulation issues that are already identified with additional concerns and respective solutions, as discussed with 5G-MOBIX partners.

- **EU policies in support of the reduction of technological expenses in vehicles**. Perception and localization related capital expenditures (CAPEX) are standing as an obstacle for autonomous vehicles to be readily available on the market. Road operators may provide this information. Thus, cost/benefit balance can be ensured for OEMs.
- **Compliance with at least FCC and CE marking regulations**. This should guarantee that the vehicle is able to operate legally in most of the countries
- Definition of **an international regulation and an associated set of test cases that an autonomous vehicle has to pass** in order to be authorized to drive on public roads. Similar to EuroNcap test protocols that evaluate the performance of ADAS systems.
- Use of **geo-fencing to restrict the AD functions** to operate only on the operational design domain where they have been authorized.
- **Regulations allowing Platooning applications in hard-border crossings to be switched to remote driving** by an operator or a cloud, because at hard-border settings platooning should be dissolved for security controls.
- Vehicles on-the-road should **share their safety distance level for emergency braking situations** or other applications and corresponding information.
- **Regulations and homologation processes in different countries should be unified.** Compliance to several regulations can be costly from the perspective of OEMs.

- There should be **unified messaging list for each CCAM application and each vehicle should transmit and receive these messages among themselves.** Moreover, since not all CCAM applications are supported by each vehicle, the ability to support related CCAM application should also be provided as a separate message.
- In case of different traffic laws of neighbouring countries**, autonomous vehicle should be capable to adapt its driving condition with the help of the information provided by RSUs and HD maps.**
- To increase the speed of the security control process in border settings, **additional sensors to monitor the goods on vehicles may be mandatory**. Sharing related vehicular information in advance may decrease the inspection time.
- Enabling regulation for the use of Autonomous cars for on-demand transport services in a sustainable Mobility-as-a-Service scheme – this can alleviate impact of epidemic and pandemic occurrences such as Influenza or COVID-19.
- CCAM applications that are **ensuring safety of VRUs should be mandatory** for all vehicles, because in regions where mostly high-level AVs exist, pedestrians tend to expect AVs to brake automatically. Thus, in case of duality, fatal accidents could emerge as expectations of pedestrians would not meet the ability of vehicle.
- All AVs must be able to **perform safe stop in case an unknown environment** is encountered.
- All AVs should be **reachable by traffic management centres** in order to exchange information to optimize traffic and there should be a specific messaging list for this purpose.
- All hardware and software components of AVs **should be compliant in a global manner.** For example, allowed frequencies for radar and LIDAR sensors should not vary from one country to another as vehicles cross the border.
- Common **message sets/protocols dedicated to police interactions shall be standardized in international level for suspicious events.**
- Align **infrastructure maintenance entities with map providers** so that whenever the first do changes the second can update its database. Add a **certificate to the map information** so that when it is updated in the car the source can be trusted.

5.4. Questionnaire Results

Task 6.4, in cooperation with T6.1-T6.3 created a first Stakeholder survey, provided in the form of a questionnaire, to gather inputs on the stakeholder motivations, status of cooperation with other stakeholders etc.

The online questionnaire was set up by Fraunhofer IAO, using the online survey tool "LimeSurvey", hosted on a server of the Fraunhofer IAO to ensure a high level of data security standards. The questionnaire has been disseminated within the 5G-MOBIX consortium in September 2020. The possibility for contributions

has been extended to gather more feedback from the project partners. During October 2020, the questionnaire was also disseminated externally:

- On the 5G-MOBIX website and on social media.
- With the sister projects in ICT-18/ICT-53
- With 5G-PPP, 5G-IA and 5GAA.
- Through the http://connectedautomateddriving.eu news and on their social media.

The following screen shots show the implemented online survey:

Figure 8.: Online survey: Start screen

Figure 9.: Online survey: General question (Type of stakeholder, company size, main area of expertise and country.

The question "Type of of stakeholder was used to filter the following questions so that each type of stakeholder gets specific questions. So, it was ensured that the questions fit to the expertise of the participants but all answers are stored in one data file. In the following, the questions for one stakeholder are shown.

5G MOBIX

5G-MOBIX: 5G for cooperative & connected automated MOBIility on X-border corridors

Automotive Industry

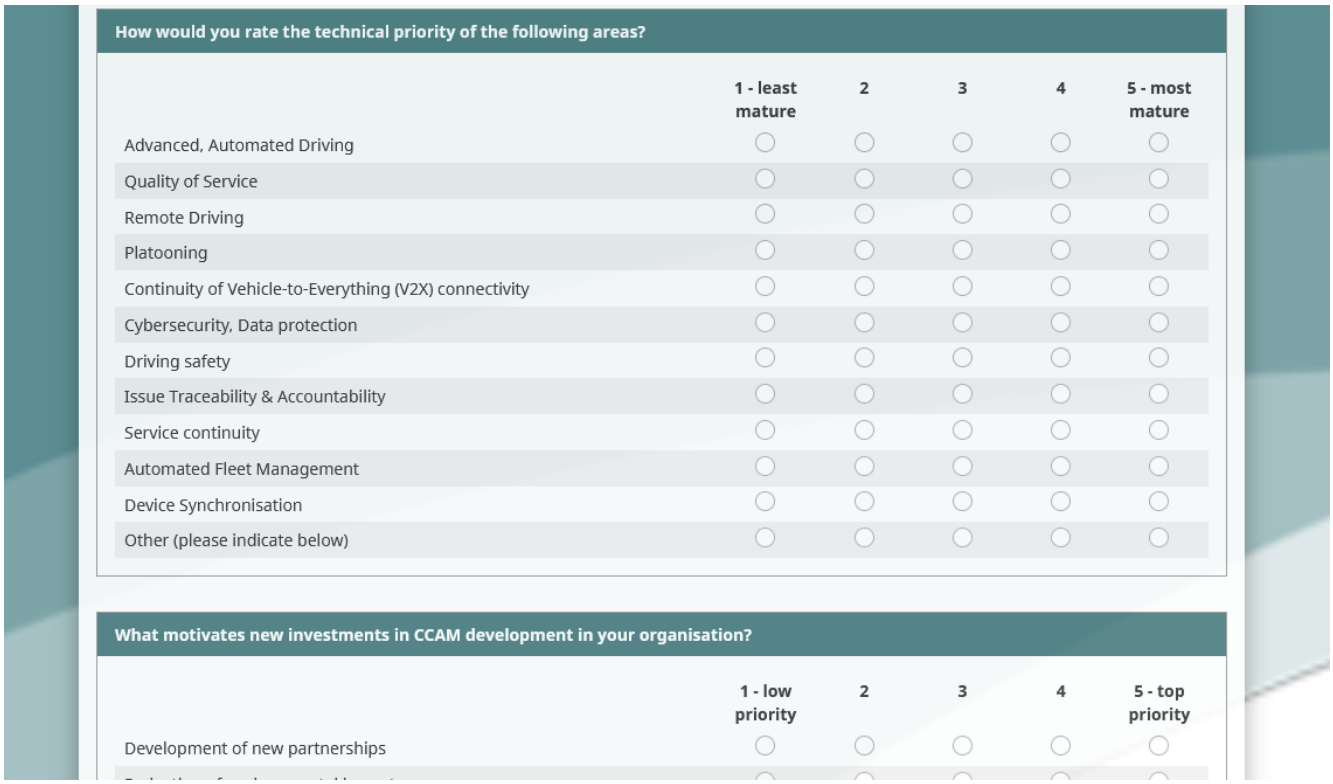
How would you rate the status of technical maturity in the following areas?

	1 - least mature	2	3	4	5 - most mature
Advanced, Automated Driving	○	○	○	○	○
Quality of Service	○	○	○	○	○
Remote Driving	○	○	○	○	○
Platooning	○	○	○	○	○
Continuity of Vehicle-to-Everything (V2X) connectivity	○	○	○	○	○
Cybersecurity, Data protection	○	○	○	○	○
Driving safety	○	○	○	○	○
Issue Traceability & Accountability	○	○	○	○	○
Service continuity	○	○	○	○	○
Automated Fleet Management	○	○	○	○	○
Device Synchronisation	○	○	○	○	○
Other (please indicate below)	○	○	○	○	○

How would you rate the technical priority of the following areas?

	1 - least mature	2	3	4	5 - most mature
Advanced, Automated Driving	○	○	○	○	○
Quality of Service	○	○	○	○	○
Remote Driving	○	○	○	○	○

Figure 10.:Online survey: Part 1 of the questions for the "Automotive Industry"



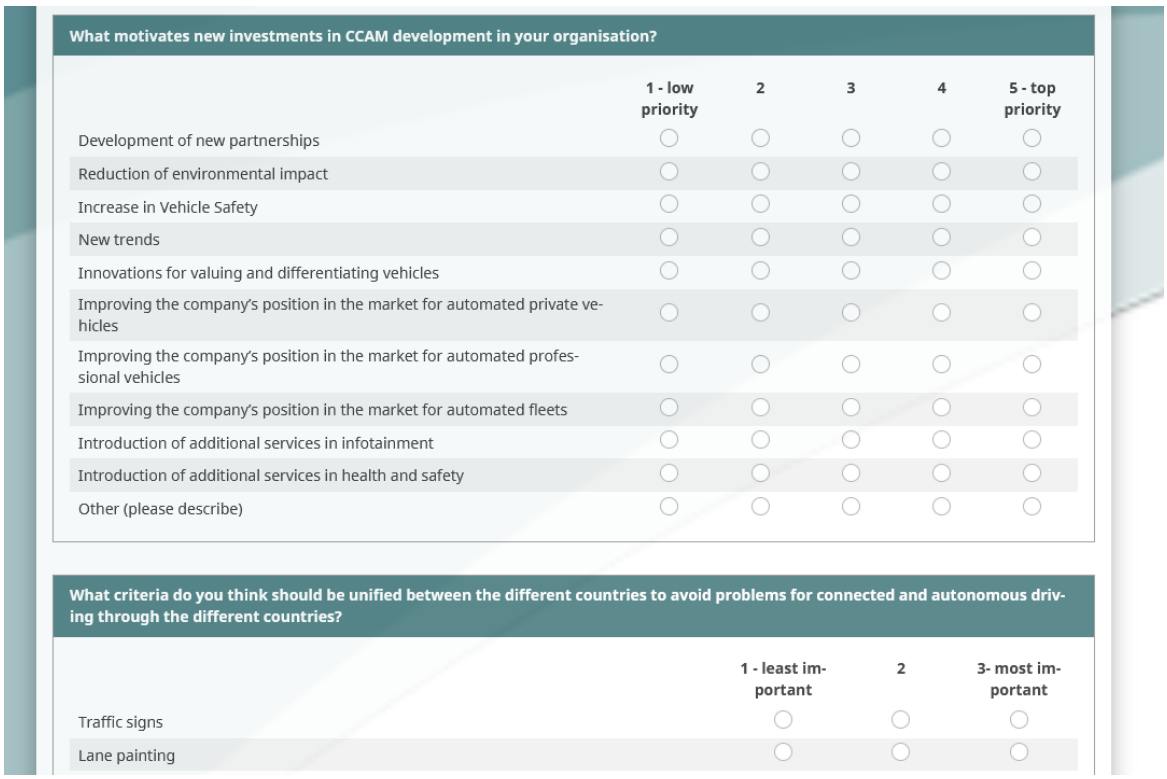
How would you rate the technical priority of the following areas?

	1 - least mature	2	3	4	5 - most mature
Advanced, Automated Driving	○	○	○	○	○
Quality of Service	○	○	○	○	○
Remote Driving	○	○	○	○	○
Platooning	○	○	○	○	○
Continuity of Vehicle-to-Everything (V2X) connectivity	○	○	○	○	○
Cybersecurity, Data protection	○	○	○	○	○
Driving safety	○	○	○	○	○
Issue Traceability & Accountability	○	○	○	○	○
Service continuity	○	○	○	○	○
Automated Fleet Management	○	○	○	○	○
Device Synchronisation	○	○	○	○	○
Other (please indicate below)	○	○	○	○	○

What motivates new investments in CCAM development in your organisation?

	1 - low priority	2	3	4	5 - top priority
Development of new partnerships	○	○	○	○	○

Figure 11.:Online survey: Part 2 of the questions for the "Automotive Industry"



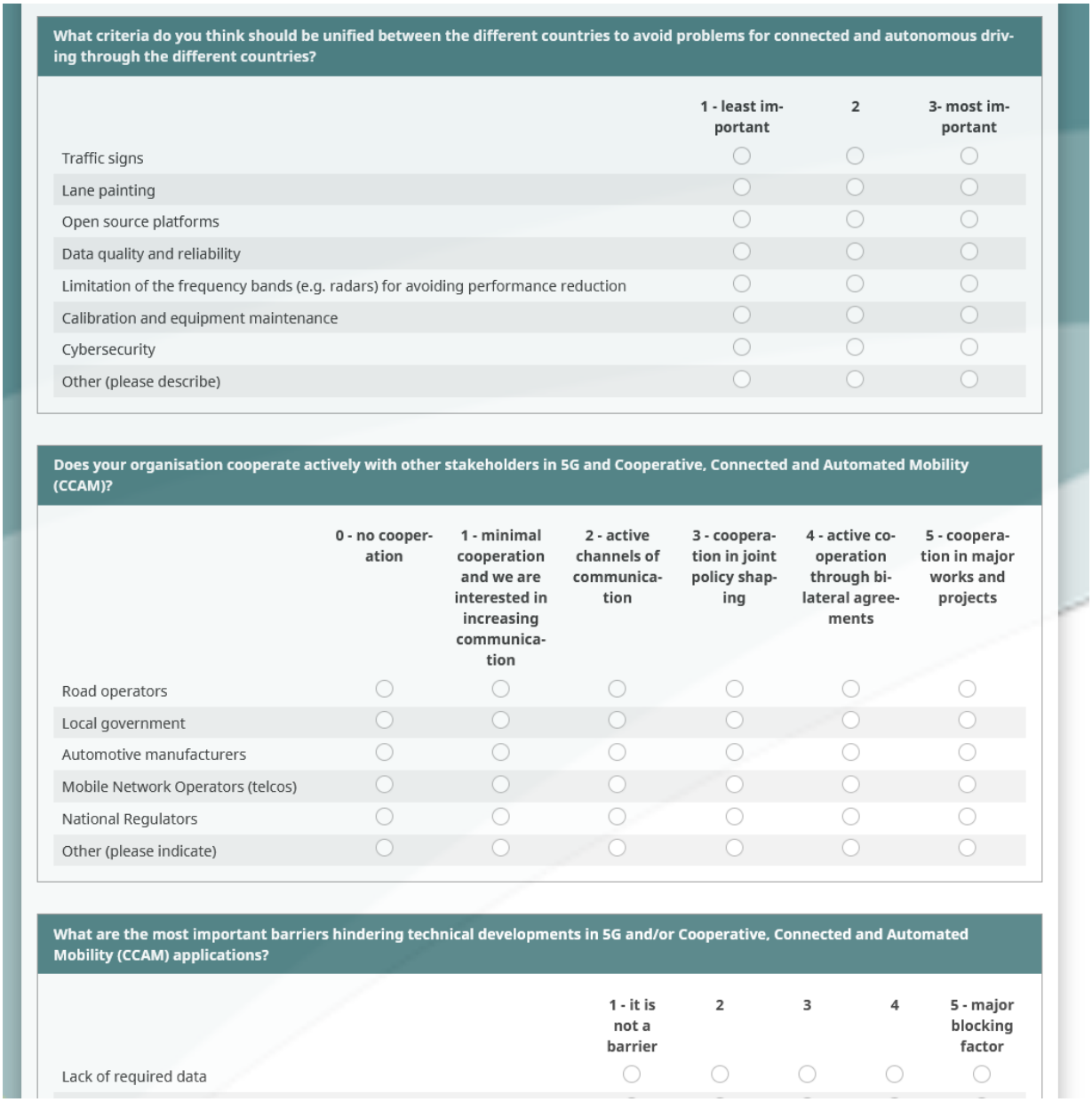
What motivates new investments in CCAM development in your organisation?

	1 - low priority	2	3	4	5 - top priority
Development of new partnerships	○	○	○	○	○
Reduction of environmental impact	○	○	○	○	○
Increase in Vehicle Safety	○	○	○	○	○
New trends	○	○	○	○	○
Innovations for valuing and differentiating vehicles	○	○	○	○	○
Improving the company's position in the market for automated private vehicles	○	○	○	○	○
Improving the company's position in the market for automated professional vehicles	○	○	○	○	○
Improving the company's position in the market for automated fleets	○	○	○	○	○
Introduction of additional services in infotainment	○	○	○	○	○
Introduction of additional services in health and safety	○	○	○	○	○
Other (please describe)	○	○	○	○	○

What criteria do you think should be unified between the different countries to avoid problems for connected and autonomous driving through the different countries?

	1 - least important	2	3- most important
Traffic signs	○	○	○
Lane painting	○	○	○

Figure 12.: Online survey: Part 3 of the questions for the "Automotive Industry"



What criteria do you think should be unified between the different countries to avoid problems for connected and autonomous driving through the different countries?

	1 - least important	2	3- most important
Traffic signs	○	○	○
Lane painting	○	○	○
Open source platforms	○	○	○
Data quality and reliability	○	○	○
Limitation of the frequency bands (e.g. radars) for avoiding performance reduction	○	○	○
Calibration and equipment maintenance	○	○	○
Cybersecurity	○	○	○
Other (please describe)	○	○	○

Does your organisation cooperate actively with other stakeholders in 5G and Cooperative, Connected and Automated Mobility (CCAM)?

	0 - no cooperation	1 - minimal cooperation and we are interested in increasing communication	2 - active channels of communication	3 - cooperation in joint policy shaping	4 - active cooperation through bilateral agreements	5 - cooperation in major works and projects
Road operators	○	○	○	○	○	○
Local government	○	○	○	○	○	○
Automotive manufacturers	○	○	○	○	○	○
Mobile Network Operators (telcos)	○	○	○	○	○	○
National Regulators	○	○	○	○	○	○
Other (please indicate)	○	○	○	○	○	○

What are the most important barriers hindering technical developments in 5G and/or Cooperative, Connected and Automated Mobility (CCAM) applications?

	1 - it is not a barrier	2	3	4	5 - major blocking factor
Lack of required data	○	○	○	○	○

Figure 13.: Online survey: Part 4 of the questions for the "Automotive Industry"

What are the most important barriers hindering technical developments in 5G and/or Cooperative, Connected and Automated Mobility (CCAM) applications?

	1 - it is not a barrier	2	3	4	5 - major blocking factor
Lack of required data	○	○	○	○	○
Lack of data interoperability	○	○	○	○	○
Lack of a service/application marketplace	○	○	○	○	○
Deployment complexity	○	○	○	○	○
Management complexity	○	○	○	○	○
Maintenance complexity	○	○	○	○	○
Monitoring complexity	○	○	○	○	○
Fault-tolerance & Reliability	○	○	○	○	○
Scalability	○	○	○	○	○
Safety	○	○	○	○	○
Critical/Real-time nature of applications	○	○	○	○	○
Status of 5G deployment on transport corridors	○	○	○	○	○
Status of 5G deployments in urban areas	○	○	○	○	○
Other (please indicate)	○	○	○	○	○

Does your organisation take into account the effects of cross-border scenarios on the following technologies?

	0 - Does not apply to my organisation	1 - No, we are not taking into account cross-border scenarios	2 - No, but we are aware of the issues	3 - Yes, we are actively developing safeguards for our products	4 - Yes, we already have placed safeguards into our products
Service Continuity	○	○	○	○	○
Data Protection	○	○	○	○	○
Vehicle Homologation	○	○	○	○	○
Service & Data Migration	○	○	○	○	○
Resource allocation	○	○	○	○	○
Spectrum allocation	○	○	○	○	○
Other (please indicate)	○	○	○	○	○

What is the expected role of Artificial Intelligence in the deployment of CCAM technology?

Figure 12.: Online survey: Part 5 of the questions for the "Automotive Industry".

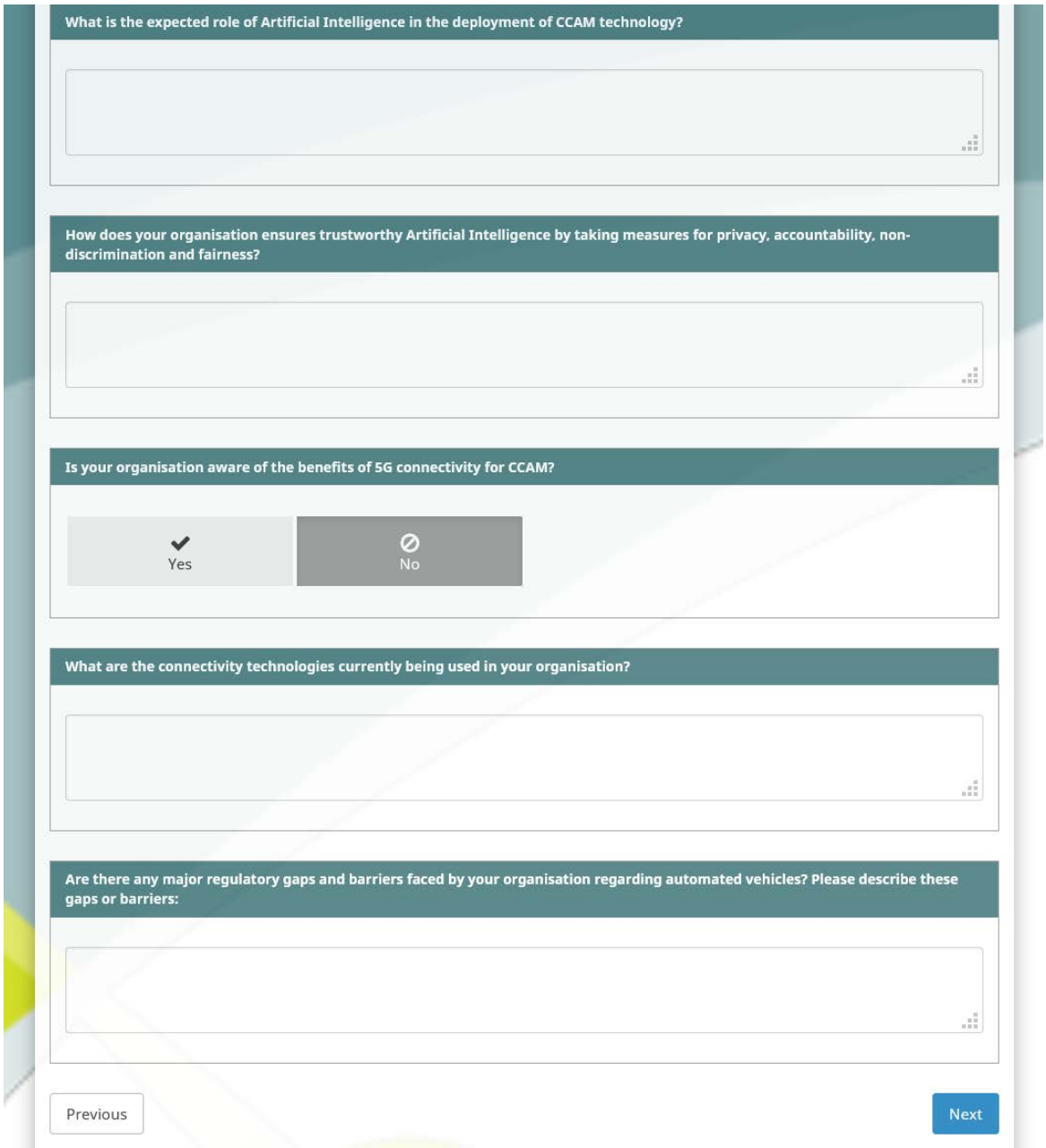


Figure 14.: Online survey: Part 6 of the questions for the "Automotive Industry"

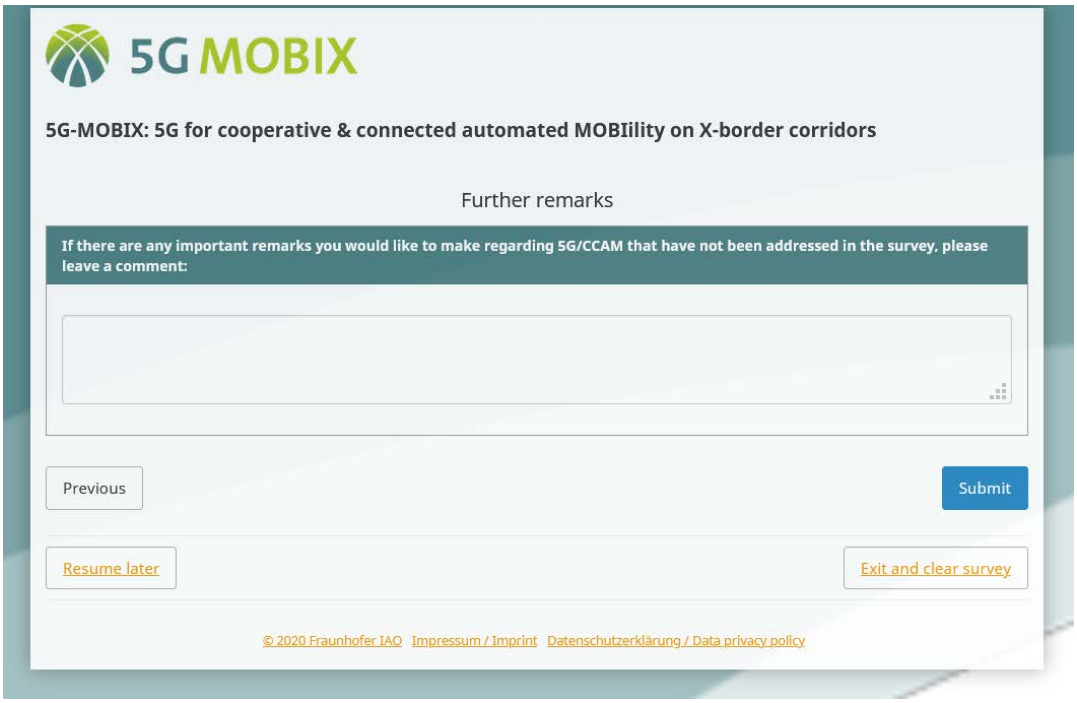


Figure 15:Online survey: End of the questions (similar for all types of stakeholders)

The questionnaire was opened in two phases. The first phase was only for consortium members to get an initial feedback and in a second phase it was disseminated in a wider range of potentially several thousand contributors. At the time of the delivery of this document, the questionnaire was still open for inputs.

The results are:

Table 5: Contribution to the questionnaire per stakeholder.

Type of Stakeholder	Number of contributors
Automotive Industry	8
Telecommunication operator	3
Road Operator	6
Hardware/Software suppliers	5
Regulator or Policy maker	2
Academia/R&D centre	28
Sum	52

Further details concerning the experts answering the questionnaire are related to company size, area of expertise and "working country".

Table 6.: Contribution to the questionnaire per company size

Company size	Number of contributors
Up to 10	2
Up to 50	9

Up to 250	15
Up to 1.000	3
Up to 5.000	9
Up to 10.000	4
More than 10.000	9
Sum	52

Table 7.: Contribution to the questionnaire per area of expertise

Area of expertise	Number of contributors
Technological/Scientific aspects	36
Regulatory & Compliance aspects	5
Infrastructure aspects	4
Security and Privacy aspects	2
Business aspects	5
Sum	52

Table 8.: Contribution to the questionnaire per working country, multiple answers were possible via "other".

Country	Number of contributors
Spain	9
France	8
China	7
Portugal	7
Germany	5
Netherlands	4
Greece	4
Belgium	2
Finland	2
Austria	1
Luxembourg	1
Norway	1
Romania	1
UK	1
Turkey	0
Sum	53

The answers show that 77 % of the experts are located in Europe and 13 % in China.

For a statistical a minimum of 100 participants should have been reached. Taking this into account, only a few responses of stakeholders can be used to derive recommendations for the policy makers and regulatory entities. Future activities will thus need to focus more on policy makers and national regulators.

Nevertheless, some questions for the group of the Academia/R&D centre will be shown in details as this group is that one with the highest representation in the survey.

The first question addressed the main research area of the academia/R&D experts. The main areas are "Cooperative, Connected and Automated Mobility (CCAM) Application developer" and "Next generation Network".

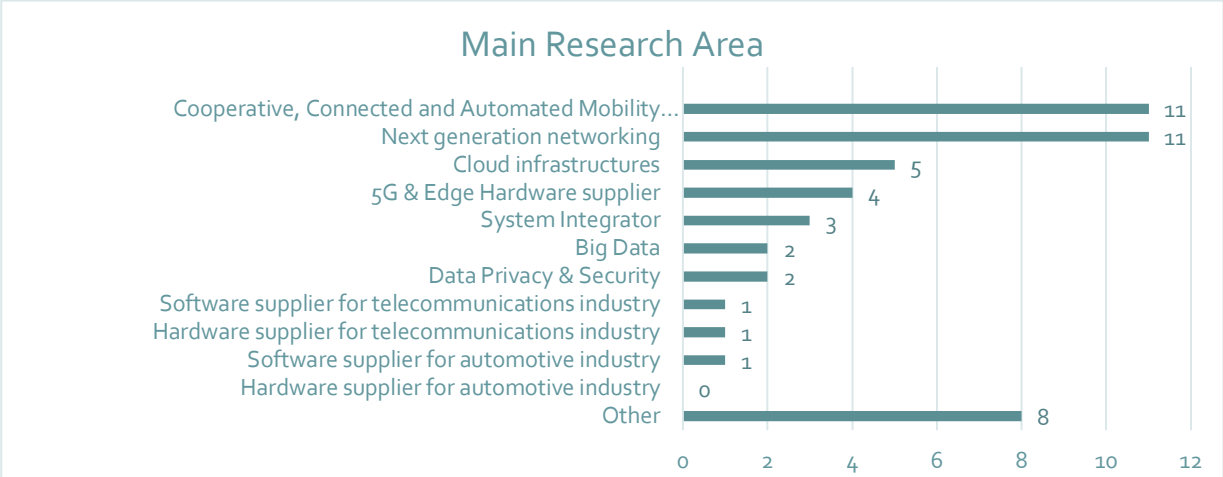


Figure 16.: Main research areas of "Academia and R&D experts", N=28.

The "other" main research areas mentioned from the participants are:

- generic ITS
- Human Factors (2)
- Education
- Testing
- 5G non-terrestrial network convergence
- Intelligent infrastructure for automated vehicles
- Machine Learning

The experts were asked: "What technical/scientific challenges do you foresee for 5G-CCAM?". The following tables shows, that major challenges are seen in Interoperability und Cybersecurity.

Table 9: Technical/scientific challenges foreseen by the "Academia/R&D-experts".

Technical/scientific challenges	**0 - It is not a challenge**	**1**	**2**	**3**	**4**	**5 - It is a major challenge**
Computational complexity	3	1	8	7	6	3
Algorithmic complexity	1	3	7	7	6	4
Hardware complexity	1	3	9	10	3	2
Decision Support	1	2	6	6	8	4
Scalability of the architectures to a massive deployment	0	1	3	5	11	8
Cybersecurity	0	0	2	8	5	12
Interoperability	0	0	2	3	10	12
Standardization	0	2	5	6	6	9
Validation	0	1	3	12	6	6

The experts from the academia and R&D sphere were also asked what kind of funding for research and development in 5G/CCAM they are receiving. The following figure shows, that the main funding resources coming from European and national side.

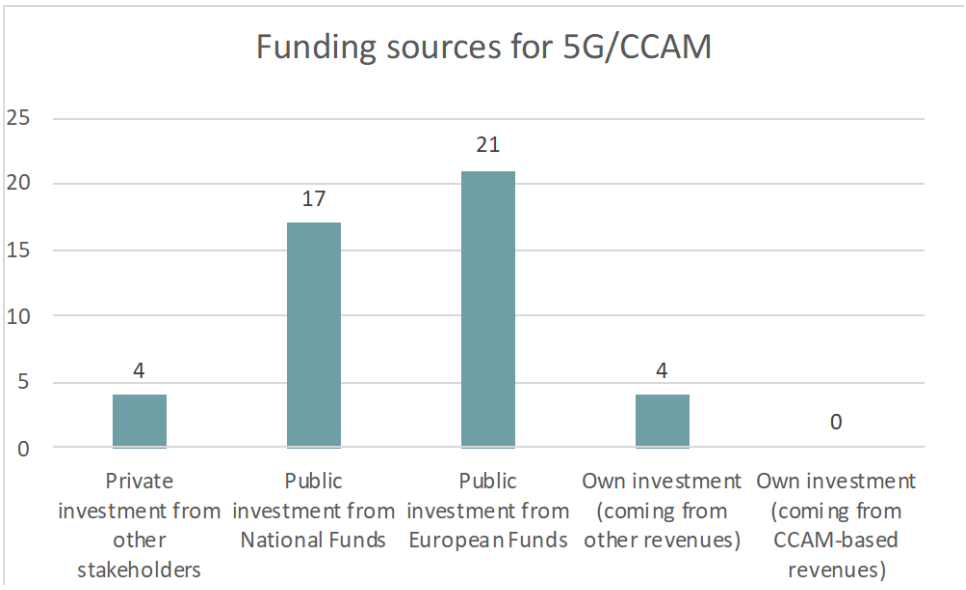


Figure 17.: Funding resources of "Academia and R&D experts", N=28.

Another topic in the survey was concerned to the relation of resources dedicated on the one hand (Question: "What type of resources does your organisation dedicate to research and development in 5G/CCAM?") and lacking on the other hand (Question: "What type of resources are lacking in your organisation regarding research and development in 5G/CCAM?") regarding research and development in 5G/CCAM. The following figure shows the answers:

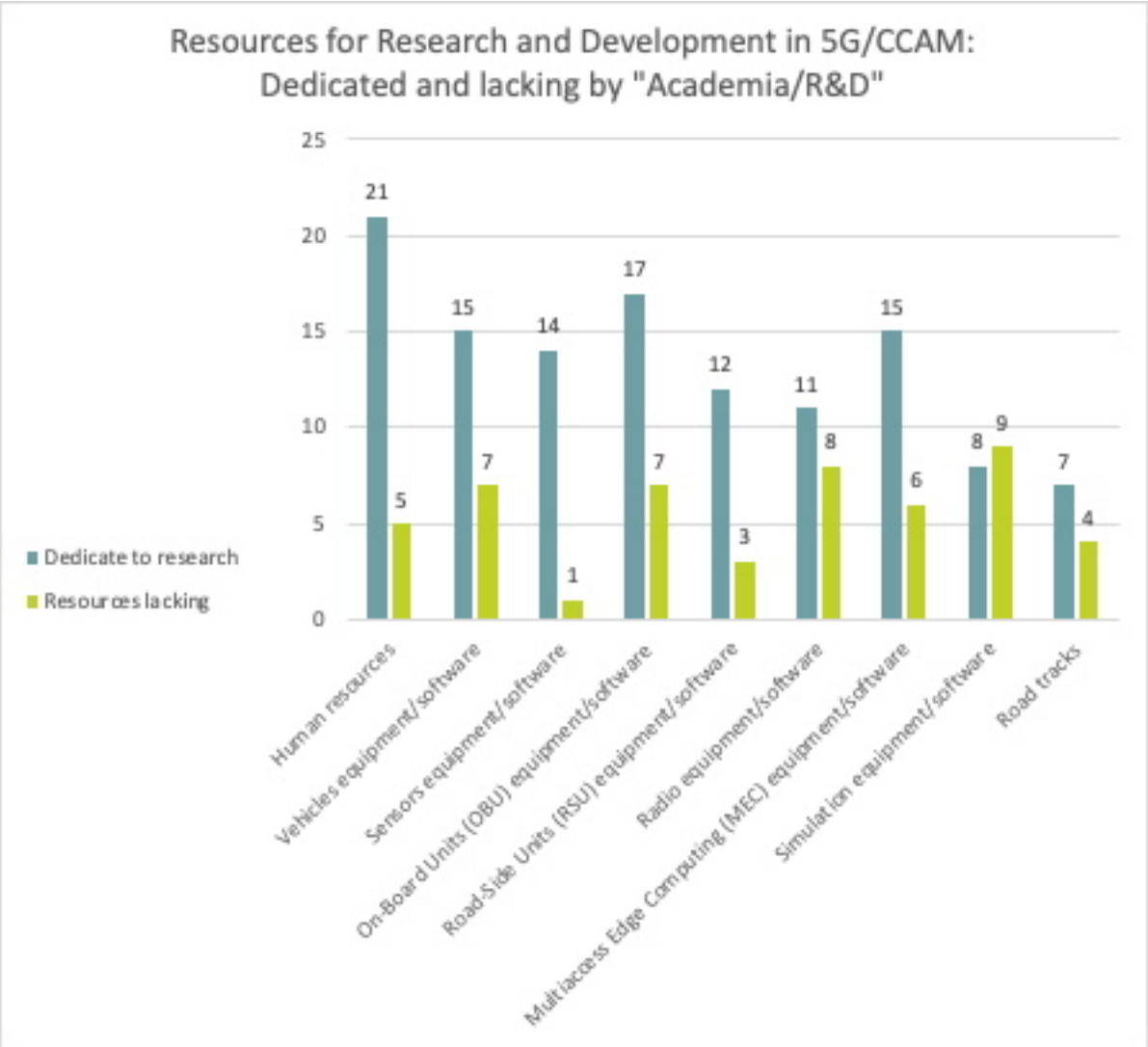


Figure 18.: Dedicated and lacking funding resources of "Academia and R&D experts", N=28.

The experts were asked "How can the Academia/R&D Centres better provide their contribution to 5G-CCAM?". As the following figure shows, participating in projects is the most mentioned option. One expert mentioned an "other" idea which is "Development of Standards".

Three more questions addressing motivation, expectations and barriers of 5G/CCAM research in the sphere of academia and R&D.

The top rated motivation factors are "Scentific interest" followed by "Part of my organisation's research" as the following table shows.

Table 10.: Main motivation by the "Academia/R&D-experts".

What is the main motivation for being part of 5G/CCAM research?	**1 - low motivation**	**2**	**3**	**4**	**5 - high motivation**
Profit (N= 25)	10	8	4	3	0
Department/Lab mission statement (N= 26)	1	2	10	8	5
Scientific interest (N= 27)	1	0	2	**11**	**13**
National Mandate (N= 25)	6	7	8	4	0
Part of my organisation's Research Strategy (N= 27)	0	1	2	**13**	**11**
Networking (N= 26)	0	5	11	5	5

Under the expected gains of 5G/CCAM research Demonstrations get the highest values:

Table 11.: Main gains expected from research in 5G/CCAM by the "Academia/R&D-experts".

What do you expect to gain from participating in 5G/CCAM research?	**1 - not likely**	**2**	**3**	**4**	**5 - very likely**
Scientific publications (N= 28)	0	5	9	6	8
Demonstrations (N= 28)	0	1	5	11	11
Dissemination events (N= 26)	0	4	6	8	8
Creation of IP (N= 27)	3	7	9	5	3
Profits resulting from IP, Patents or any other knowledge-based asset (N= 25)	4	9	9	3	0
Creation of spin-off companies (N= 25)	7	9	6	3	0
Attracting more researchers (N= 27)	0	5	12	4	6

Asked about main barriers in the field of 5g/CCAM research, procurement costs are mentioned with the highest rate, followed by access to experimentation facilities.

Table 12: Main barriers in 5G/CCAM research by the "Academia/R&D-experts".

What are the important barriers hindering 5G/CCAM research?	**1 - not a factor**	**2**	**3**	**4**	**5 - major barrier**
Cooperation with other stakeholders (N= 26)	1	10	7	6	2
Access to experimentation data (N= 27)	4	5	6	11	1
Access to experimentation facilities (vehicle testing sites, etc) (N= 27)	2	6	4	11	4
Access to experimentation infrastructures (5G, Cloud, High Performance Computing etc.) (N= 28)	3	5	7	8	5
High costs for vehicle/hardware/software procurement (N= 26)	1	1	6	8	10
End-to-end experimentation requires varied skills (N= 26)	1	1	12	8	4
Skills/Knowledge not present in my organisation (N= 25)	5	10	8	2	0
Acquiring licenses (spectrum, use of road etc.) (N= 27)	2	9	8	3	5

Also the intensity of cooperation of the academic/R&D organisations was part of the survey. The six answer options of the question were single choice, so that "cooperation in major work and projects" had to been understood as the highest form of cooperation, including the other forms. The answers show that the cooperation with the National Regulators has the lowest intensity.

Table 13.: Cooperation with other stakeholders by the "Academia/R&D-experts".

Does your organisation cooperate actively with other stakeholders in 5G and/or Cooperative, Connected and Automated Mobility (CCAM)?	**0 - no cooperation**	**1 - minimal cooperation and we are interested in increasing communication**	**2 - active channels of communication**	**3 - cooperation in joint policy shaping**	**4 - active cooperation through bilateral agreements**	**5 - cooperation in major works and projects**

Other road operators (N= 27)	3	5	6	2	4	7
Local government (N= 26)	0	6	7	3	4	6
Automotive manufacturers (N= 27)	2	4	6	8	1	6
Mobile Network Operators (telcos) (N= 27)	0	3	5	7	4	8
National Regulators (N= 27)	0	10	6	6	3	2

The question if and how the organisations of the academia and R&D take into account the effects of cross-border scenarios in your research was the last specific question for this stakeholder type. The answers are listed below and show that the status of cross-border scenarios are mainly on second highest level.

Table 14: Status of cross-border scenarios in research by the "Academia/R&D-experts".

Does your organisation take into account the effects of cross-border scenarios in your research?	**0 - Does not apply to my organisation**	**1 - No, we are not taking into account cross-border scenarios**	**2 - No, but we are aware of the issues**	**3 - Yes, we are actively researching safeguards for our products**	**4 - Yes, we already have presented research results**
Service Continuity	1	1	7	**11**	7
Data Protection	4	3	10	**4**	5
Management and Orchestration	2	1	7	**11**	4
Service and Data Migration	2	4	6	**9**	4
Ressource allocation	3	2	8	**11**	2
Spectrum allocation	6	4	9	**5**	2
Vehicle development	5	6	9	**5**	1

The eight experts from the automotive industry answering the survey are the second largest stakeholder group. Far away from statistical representativeness a few spotlights to their answers are listed below:

- Asked about the **technical maturity** of eleven areas, "Remote driving" was the item with the highest rating of "least mature". All other areas (Advanced, Automated Driving, Quality of Service, Platooning, Continuity of Vehicle-to-Everything (V2X) connectivity, Cybersecurity & Data protection, Driving Safety, Issue Traceability & Accountability, Service continuity, Automated Fleet

Management, Device Synchronisation) were rated less clear. The areas with the highest rated maturity were "Automated Fleet Management" and "Continuity of Vehicle-to-Everything (V2X) connectivity".

- Concerning the **technical priority** of these areas, "Driving safety" get the highest rating, followed by "Cyber Security, DataProtection" and Issue Traceability & Accountability.
- The top **motivation factor** for new investments in CCAM development are "New Trends" and "Improving the company's position in the market for automated professional vehicles".
- When asked "What criteria do you think should be **unified between the different countries** to avoid problems for connected and autonomous driving through the different countries?" "Cybersecurity" and "Data Quality and reliability" were highest rated.
- As the most important barriers hindering technical developments in 5G and CCAM "Critical/Real-time nature of applications" followed by "Safety" were mentioned.
- To the question "What is the expected role of Artificial Intelligence in the deployment of CCAM technology?" the following answers were given by the Automotive Industry experts:
    - Autonomous driving technology
    - Object recognition is key
    - AI may have an influence on the quality and on the efficiency of realization and deployment.
    - Provides safe options for decisions to driver and vehicles, liberates driver full attention to driving tasks, eliminates human accident factors
    - AI will be the primary technology in finding solutions and making decisions, but will always need to be backed up by sanity checks based on "classical" algorithms.
- The experts were also asked how their organisations ensure trustworthy Artificial Intelligence by taking measures for privacy, accountability, non-discrimination and fairness. The answers wer:
    - No clue yet
    - We ensure these aspects by incorporating them in the projects and proposals.
    - Through a global certification program
    - We are actively involved in several research projects to render AI trustworthy and ensure privacy.

- The last questions was about major regulatory gaps and barriers regarding automated vehicles. These are the answers:
    - The main gap we see it the diversity between countries. Bridging this gap means getting regulatory bodies from several countries in one single line which takes time.
    - implementation of 5G in all geographical areas, today is up to the operator to deploy…needs for automotive is just one, not necessarily the 1st priority for them

At the end of the survey, all the experts of all stakeholder types were asked to give free comments (Question: "If there are any important remarks you would like to make regarding 5G/CCAM that have not been addressed in the survey, please leave a comment:"). Six of the 52 experts gave the following answers:

- Great survey, was a pleasure to fill it.
- We see that interoperability is a major issue currently in Europe. As an example, we see that the current C-ITS PKI is limited to short range connectivity, that message types are not properly standardised (e.g. not backward compatible or versioned), no proper standardisation going on for long range message exchange. With the current implementation rate it will take a long time before we come to a suitable CCAM infrastructure.
- We consider very important to establish a permanent mechanism for the dissemination of best practices, implementations, lessons learned in Europe and internationally.
- The survey does not account for technology companies who are not in the 'regular' CCAM eco-system but who are driving a lot of innovation who are driving innovation in CCAM as well as the deployment of 5G system. Equally the survey does not address the aspect of 'digital connectivity provider' (as per 5G-PPP vision) that would orchestrate the 5G connectivity through the use of MNO, 5GSA owned by road infrastructure, infrastructure hosted by cities, other non-terrestrial networks. It comes across that MNOs are considered to be the connectivity provider - which is not the case for CCAM to scale, resilience and reach.
- Regulation shall apply on data but also on services for sharing, requesting, searching this data.
- I'm concerning about compatibility between ITS-G5 and the 5G-C2X standards. Standardization bodies are spending too much time for articulating a satisfactory solution for both technologies.

6. CONCLUSIONS

The objectives of the deliverable D6.4 were to:

- Monitor activities related to deployment and Cross-Border issues to identify challenges
- Analyse the issues and challenges detected and put them into an effective discussion procedure resulting in actions to mitigate and address those challenges for the relevant bodies and organizations

Use the 5G-MOBIX experiences to provide concrete results and recommendations in support of the issues identified, and use the project as an effective platform for the dissemination of these results, by liaising with relevant organisations and regulation platforms in support of regulatory, legislative, operative and industry processes.

The methodology adopted in T6.4 underpins these objectives in a work plan consisting of 4 phases, in which different tools will be used to advance on the identification, analysis, target groups addressing and synthesis and knowledge sharing on the challenges on cross-border 5G-CCAM solutions and recommendations on how to address the challenges.

The main instrument for monitoring ongoing activities on cross-border deployment issues was a questionnaire designed to facilitate the communication between experts and professionals in the areas of infrastructure, telecommunications, automotive industry and road operations. It has provided with an overall view of the technology, infrastructure, regulatory framework and business potential for the CCAM and 5G technology, thanks to the contributions from consortium members, related 5G projects and project partners' own networks. T6.4 partners also provided their inputs through a participatory process, where they could relate policies and concerns based on their expertise.

Short analysis of the answers to the questionnaire, as well as additional input and analysis from ongoing and recent initiatives have resulted in the identification of the following challenges, and mainly the lack of a regulatory framework for CCAM solutions and vehicles, involving a common European understanding on necessary digital infrastructure, a joint telecom/vehicle industry approach on supporting CAD, awareness on interoperability issues and cross-border items, a common European Security & Safety validation, and the need for a progressive adaptation of road traffic rules in Member States. This lack of regulation is identified as being addressed by different initiatives (ARCADE, CCAM platform, HEADSTART, CARTRE, and more), focusing on addressing different aspects that could support the transition towards that missing regulatory framework.

The major technical aspects being addressed include V2X communication technologies and performance items, service and application requirements (coming from C-ITS specifications after Day 1, Day 2 and Day 3 services), and most importantly, Cybersecurity, Privacy and Digital infrastructure aspects for CCAM.

A specific analysis on different regulatory items and their potential relation to 5G-MOBIX is carried out as well in the document:

- GDPR, and the implications for cross-border operations
- Non-discriminatory practices
- Vehicle safety, or rather the lack-thereof of regulation on this aspect for highly automated and connected vehicles
- European electronics Communications Code, and specifically, the IoT/M2M services needs
- Roaming, and the obvious implication for Cross Border 5G CCAM applications and scenarios
- Open Internet, and the implications for Cross Border CCAM solutions providers
- Critical Infrastructures and Law enforcement and the relation with 5G CCAM cybersecurity operations and liability
- Radio Equipment and conformity in wide-spread 5G CCAM scenarios
- Certification as the step following up regulation and one of the basic mechanisms to ensure interoperability, of particular relevance in Cross Border CCAM scenarios
    - CE RED compliance and associated harmonized standards applicable (Electrical Safety, Health, EMC, Radio spectrum)
    - Privacy certifications (PrivacyTrust, HITRUST)

Once the major issues and action areas were identified, the entities and frameworks with potential to address these areas were also identified. The EC is supporting in general the deployment of CAM with the development of policies, initiatives and roadmaps; supporting the development of European standards, co-funding research and innovation projects and pilots and introducing relevant legislation and regulation.

The specific initiatives by which these actions are articulated are, amongst others, the following:

- The '5G for Europe Action Plan' defining the roadmap for connectivity strategies. It involves all stakeholder, private and public, in all Member States of the EU, to meet the challenge of making 5G a reality by the end of 2020. The areas of actuation of the plan included:
    - Align of actions in EU Member States for Europe-wide deployment of 5G
    - Spectrum allocation provisions and recommendations
    - Promotion of early adoption in urban areas/nodes and transport trunks
    - Promotion of large-scale trials and push-to-market initiatives
    - Facilitate funding mechanisms for 5G-based innovation actions
    - Promotion of the adoption of global standards
- The 'Europe on the Move' for mobility strategies
- The European 5G Observatory for monitorisation on the implementation of the 5 Action Plan
- 5G Cybersecurity toolbox
- 5G Cross-Border corridors for CCAM initiatives
- 5G Strategic Deployment Agenda for Connected & Automated Mobility
- 5GPPP as a major R&D framework for 5G initiatives
- CEF/CEF2 as funding instruments for infrastructure investments in Europe

- C-ITS platform, focused in its day in an integral view of the Cooperative ITS environment and solutions, from technologies to business and societal impact, and several of the results are being carried on to current standardization activities and certification procedures.
- Other relevant initiatives identified include:
    - European Automotive – Telecom Alliance (EATA)
    - 5G Automotive Alliance (5GAA)
    - Car2Car Consortium (C2CC)
    - C-ROADS platform

Finally, as the feedback from the final survey has been collected, some preliminary findings on the challenges and way to address them via the identified mechanisms and frameworks has been developed as guidance on discussion topics and necessary guidelines for future regulation and policy for 5G CCAM.

Selected recommendations from OEMs & Software suppliers are considered of relevance in the sense that information and data exchanges and therefore their access and interoperability become increasingly important, and can be seen as valuable by themselves.

Selected recommendations from the road operators are of relevance in the sense that the introduction of automated vehicles in public road networks is a challenge for the operators in the relation between infrastructure and road users. Amongst others, the feedback focused on aspects such as better definition and specification of infrastructure (physical and digital) autonomous-readiness-level -involving also infrastructure based information and support for AV manoeuvres, support for traffic law compliance dynamic mapping and data exchanges for vehicles-, traffic management and safety concerns in different scenarios -platooning, remote driving, human failure, higher AV levels- security and privacy issues in an increasingly monitored environment, and support for backwards compatibility of higher level AV functions.

Selected recommendations from car industry. Of relevance in relation to the requirements of automated vehicles for Cross-Border operation. Amongst others, the feedback focused on aspects such as the cross-border issues from multiple angles, from harmonization of application messages and information exchanges, to regulation and homologation processes, to traffic law compliance for cross-border applications, to support for monitoring goods to facilitate border security control. These topics, as well as in-vehicle data access, as well as other sensitive information exchanges are long-standing discussion issues from the car industry.

Other highlighted results involve selected recommendations from network operators, recommendations related to remote driving, and recommendations related to QoS for the users.

As these recommendations can be seen as requirements and needs from operative entities in the 5G CCAM environment, these can be interpreted in the other hand as recommendations for the sanctioning bodies (policy makers and regulation authorities). As per the requirements identified during the task, it is possible to categorize the recommendations for these bodies in the categories of:

- Telecommunications (e.g. roaming, continuity in mixed coverage scenarios and cross-border interoperability issues)
- Applications (e.g. stability of communications performance, data structures consistency across logical entities, scalability issues, positioning accuracy issues)
- Security and data privacy (e.g. Trusted entities and certification of elements related to information processes)
- Regulation (e.g. AV regulation compliance and neutrality in remote driving, law enforcement for AVs)

Deliverable D6.4 presents a complete cycle of requirements gathering, analysis, target group and framework identification, and finally a synthesis exercise. This has resulted in a first step in a comprehensive overall view on the major issues that are of concern to the relevant stakeholders in deployment of 5G CCAM solutions. In the second step, the main result has been the identification of all those entities that could address in a relevant way these issues and the mechanisms and initiatives by which these are being currently addressed, and the production of recommendations and guidelines that should serve as support for the further development of these mechanisms and initiatives. This would ensure that the needs and requirements of the stakeholders are met, and all within the proper regulatory and policy frameworks.

As future steps, T6.4 will first harmonise its outputs with the rest of WP6 tasks and plan further stakeholder engagement activities, to first refine and validate its results and finally to compose a single coherent set of policy recommendations, based on WP6 analysis and on the project's Trial Site and Cross-Border Corridor results. Results will then be communicated to the related stakeholders, through all available dissemination and communication channels.

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