5GMOBIX

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

D6.2

Plan and preliminary report on the business models for cross border 5G deployment enabling CCAM

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Control sheet

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Legal disclaimer

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ABBREVIATIONS

Abbreviation	Definition
AV	Autonomous Vehicle
AMQP	Advanced Message Queuing Protocol
BMC	Business Model Canvas
CAV	Connected Autonomous Vehicle
CBA	Cost Benefit Analysis
CBC	Cross-border Corridor
CCAM	Cooperative, Connected and Automated Mobility
CEDR	Cooperative Intelligent Transport System
C-ITS	Conference of European Directors of Roads
C-V2X	Cellular Vehicle to Everything
DoA	Description of Action
E2E	European Commission
EC	Enhanced Mobile Broadband
eMBB	European Union
ETPC	End to End
EU	European Truck Platooning Challenge
GA	Information Communication Technology
ICT	General Assembly
KPI	Key Performance Indicator
MEC	Mobile Edge Computing
mMTC	Massive Machine Type Communications
MNO	Mobile Network Operator
NRA	National Road Operator
NSaaS	Network Slicing as a Service

OEM	Original Equipment Manufacturer
PESTLE	Radio Access Network
QoS	[P]olitical, [E]conomic, [S]ocial, [T]echnological, [L]egal, or [E]nvironmental
RAN	Road Infrastructure Operators
RIO	Small and medium-sized enterprise
SLA	Service Level Agreement
SME	Transport and Road Authorities
TRA	Trial Site
TS	Trial Site Leader
TSL	Use Case
UC	Use Case Category
UCC	Ultra-Reliable Low-Latency Communication
URLLC	User Story
US	Value Network Model
VNM	Work Package
WP	Work Package Leader
WPL	Quality of Service
X-border	Cross-border

EXECUTIVE SUMMARY

This document is the deliverable D6.2 "Foster adoption new business models for 5G & CCAM" and part of "WP6 Deployment Enablers". The main objective of this deliverable is to provide detailed analysis of 5G-CCAM stakeholders, revenue streams between these stakeholders and new business opportunities from 5G-MOBIX use cases perspective. 5G-MOBIX use cases can be found in D2.1 "5G-enabled CCAM use cases specifications".

Currently, many EU funded projects related with 5G and CCAM services exist. According to our project examination and experience, value network model is effective to show business related interactions between stakeholders. Business model canvas method also helped us to define customer segments, value proposition, key partners and possible revenue stream models.

With emerging 5G-CCAM technologies, we also expect new business models where stakeholders could be responsible for several duties. For example, road site operators could be 5G-CCAM service providers and also take part in the 5G deployment, meanwhile automotive OEMs providing vehicles as traditional way, they can also provide 5G-CCAM services.

Motivation of stakeholders are also listed in this deliverable. According to our study, stakeholders are aware that 5G-CCAM services are emerging technologies, but current unclear specifications, regulations, revenue sharing models etc. decrease stakeholder's motivation. Additionally, workers in logistics sector fear losing their job. Lack of trust in automated vehicles, ethical and legal issues in the development of crash algorithms, unclear way of ensuring protection of consumers' rights and difficulty in determining accountability in cases of accidents are also other open points. We use the PESTLE approach to define these business-related gaps to understand what should be completed in the future to enable 5G-CCAM services.

We recommend determining the best use of public funds for 5G infrastructure, upgrade skills & create a highly specialised workforce, fostering job creation and entrepreneurship, defining a clear path by governmental bodies to increase penetration of 5G-CCAM services and creating a data economy to clarify easily revenue sharing, having open discussions about machine ethics.

We will publish a second version of this deliverable (D6.6) at the end of the 5GMOBIX project. In that deliverable, we will update our initial findings presented in D6.2 according to our trial demonstration results and answers to our questionnaires that are prepared in D6.2. Questionnaires will be directed to stakeholders in and out of our consortia.

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 will demonstrate the potential of different 5G features on real European roads and highways and create and use sustainable business models to develop 5G corridors. 5G-MOBIX will also utilize and upgrade 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 will execute 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 will also define deployment scenarios and identify and respond to standardisation and spectrum gaps.

5G-MOBIX will first define 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 will be 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 a result of these evaluations and international consultations with the public and industry stakeholders, 5G-MOBIX will identify new business opportunities for the 5G enabled CCAM and propose recommendations and options for its deployment.

Through its findings on technical requirements and operational conditions 5G-MOBIX is expected to actively contribute to standardisation and spectrum allocation activities.

1.2. Purpose of the deliverable

This deliverable aims to define possible new business opportunities that 5G-CCAM will create. Other projects can take this deliverable as a reference in the future with its full of content. Deliverable contains but not limited to related other current and previous 5G and CCAM projects. Business model canvas is used to show possible business opportunities and value network model also is used to explain relation between stakeholders.

In the Section 3, business model analysis of each cross-border user story examined. In this examination, we defined possible service flows, stakeholders of each user story, value proposition of user story and current market products, projects related with user story.

Other purpose of the document is the definition of the motivation of the stakeholders. We wanted to define why a stakeholder should invest on 5G-CCAM. Even though, most of the stakeholders are aware about emerging 5G technology, but importance of the 5G-CCAM services have not clear for them completely, yet.

To motivate more the stakeholders, current business- related gaps must be closed. Current deliverable also defines these gaps with the help of the PESTLE analysis. With this approach, we look political, economic, sociological, technological, legal and environmental perspective of the gaps.

To close defined gaps, we placed a recommendation section that may help related governmental bodies and other stakeholders to understand possible action points.

1.3. Intended audience

The dissemination level of D6.2 is public (PU) and is meant primarily for (a) all members of the 5G-MOBIX project consortium, and (b) the European Commission (EC) services.

Intended audience is all 5G-CCAM stakeholders that are at least but not limited to automotive industry, telecom industry, policy makers, research organisations, governmental bodies, standard developing organisations and insurance companies.

2. METHODOLOGY

For this deliverable, we use Business Model Canvas (BMC) and Value Network Model (VNM) to define and show interaction between stakeholders. We have also examined other related projects as a benchmark to understand how we can create a solid document. After that with the help and perspective of the BMC and VNM, we focused on each user story in our cross-border s. PESTLE approach is used to define business related gaps in front of the 5G-CCAM service deployment and finally we provide some recommendations to solve defined gaps.

2.1. 5G-MOBIX Business Model Methodology

The Business Model Methodology supports innovators in conveying their complex business functions in a less complex, graphic and easy-to-communicate and easy-to-share way.[1] One of the well-known and widely used business modelling tools were developed by Osterwalder and Pigneur (2010). Their innovative and manageable paper-based tool to draft and communicate a firm's business model strategy is called Business Model Canvas (BMC). [2]

2.1.1. Business Model Canvas:

According to the authors a business model "*describes the rationale of how an organization creates, delivers and captures value*".[3] Building upon the understanding that a business model functions as a firm's building plan for its business operation, the BMC comprises the following nine building blocks [4]:

1. **Customer segments** describe the target audience that a firm intends to address and serve

2. **Communication, Distribution & Sales Channels** describe how and in what way an organization communicates and reaches its target audience

3. **Customer relationships** refer to what kind of relationship a firm establishes with its target audience, in order to reach, sustain and grow its customer base.

4. **Value proposition** refers to the core of the BMC and any business is general. The formulation of the value proposition is the starting point and affects the remaining building blocks. Value proposition is the value that is created for a specific target audience with a firm's product or service

5. **Revenue stream** represents how and the amount of monetary value a firm generates from its customer base in exchange for its products and services.

6. **Cost Structure** describes the expenses inherent to a firm's business model.

7. **Key resources** outline the relevant and needed core assets for a business to operate and fulfil its value proposition

8. **Key activities** describe the essential activities needed to deliver the expected value proposition

9. **Key Partnerships** refer to the partnerships a firm needs in order to deliver the proposed value proposition

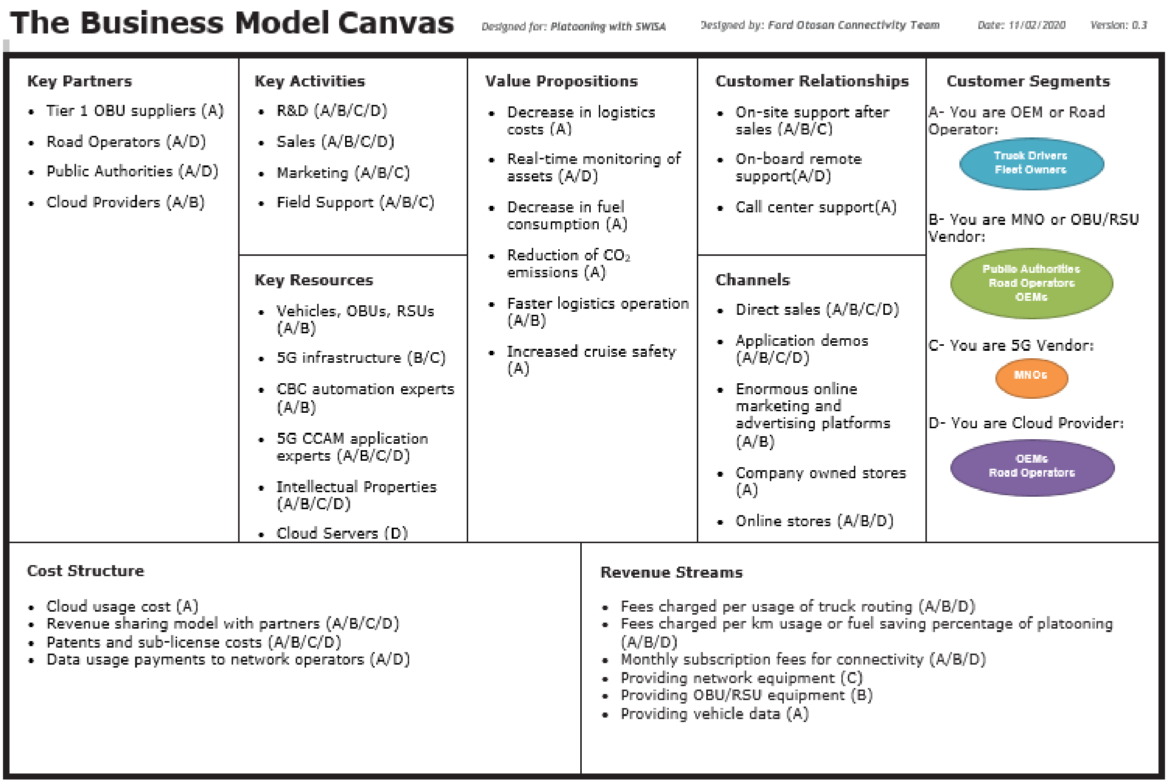

Figure 1: BMC example from 5GMOBIX User Story: Platooning with See What I See

As the nine building blocks highlight, the BMC is particularly characterized by its holistic approach that enables a visual thinking and allows easy to comprehend storytelling [5] of an organization's operational and physical form [6].

Moreover, Osterwalder's motivation to propose the BMC was rooted the impact he saw with the emergence of Information Communication Technologies (ICT) and its effects on the way business would operate. He predicted that ICTs would promote business to "*work in partnerships, offer joint value propositions, build-up multi-channel and multi-owned distribution networks and profit from diversified and shared revenue streams*". [7] Foreseeing the complexity of these value networks, he identified the need to create an innovative and manageable tool to communicate business models, which resulted in the BMC [8].

Against this background and the given context of 5G, BMC was chosen as one of the adequate methodologies to capture the innovative business models each stakeholder within the 5G-CCAM ecosystem intended to pursue with their products, services and innovations.

In order to get first insights into each stakeholder's business' intention and mode of business operation, each user story owners were initially asked to fill out a BMC for their own user stories. As a difference from traditional BMC, we divided all BMC sections according to each stakeholders' perspective and grouped with capital letters A-B-C-D (Please see Figure 1 for details). As an example, if stakeholder is an Automotive OEM, it stated with 'A' and its customer segment, key sources, value proposition etc. are also stated with '(A)'. Building upon these insights, a more detailed questionnaire based upon the nine building blocks of the BMC were prepared and distributed (see appendix).

2.1.2. Questionnaires:

The aim of the questionnaire is to capture and understand each business model and be able to gain further insights into the value exchanges, motivation of stakeholders, understand the gaps, possible new revenue streams in 5G-CCAM complex networks and ecosystem.

Answers of the stakeholders to prepared questionnaires will be analysed in second version of this deliverable, which is D6.6.

2.1.3. Value Network Model:

In addition to BMC, Value Network Model is also prepared for this deliverable to understand connections between organizations interacting with each other to benefit the entire 5G-CCAM. A value network allows stakeholders to buy and sell products as well as share information. Prepared Value Network Model could be seen in Section 2.4.

Last but not least, in Section 2.2 we review other 5G-CCAM and CCAM related projects that could help us to improve this deliverable and D6.6 in the future.

2.2. Other Project Activities

In this section, we made a detailed review of other CCAM related EU funded projects that could help us to create a solid business-related deliverable. Some of the projects are still on going and results of these projects will be followed closely and used in second version of this deliverable, which is D6.6. D6.6 is planned to release at the end of the project.

5G-CroCo**[9]** is a project implementing trials of 5G technologies in the cross-border corridor along France, Germany and Luxembourg. Its natural focus on cross-border technical issues such as QoS predictive mechanisms, E2E QoS control components, localisation, etc., as well as its multi-stakeholder, trans-national integral approach to scenarios definition, use cases implementation and impact analysis make it a natural complement with 5G-MOBIX. Its Working Package n. 5 is dedicated to the identification and validation of business potentials, focussing on its use cases: Tele-Operated Driving, HD Mapping, and Anticipated Cooperative Collision Avoidance. Its deliverable 5.1 "Description of 5GCroCo Business Potentials" [10] illustrates the project's use cases opportunities, stakeholders' involvement, deployment, data and security, and the gap identification from business case perspective. 5G-CroCo has been funded under the call ICT-18 and there is a broader, ongoing cooperation in place with 5G-MOBIX. Its use cases for HD Mapping and

Anticipated Cooperative Collision Avoidance match closely those of 5G-MOBIX, and the business models and potential of the two projects can benefit from each other's findings.

Deliverable 5.1 identifies new business opportunities in the 5GCroCo Ecosystem based on multi-vendor for telco equipment, multi-vehicle OEM, multi-MNO (Mobile Network Operator) and multi-data/content providers in a cross-border 5G setup. There is specific focus on the adaptation of existing business validation canvases to the new automotive ecosystem, including new KPIs and business model building block. This first report includes the following items:

- Identification of drivers in the areas of technology, economics, environment, society, regulation, politics, etc.
- Description of KPIs to validate business opportunities
- Markets in terms of sizes, segments, competition, interrelation

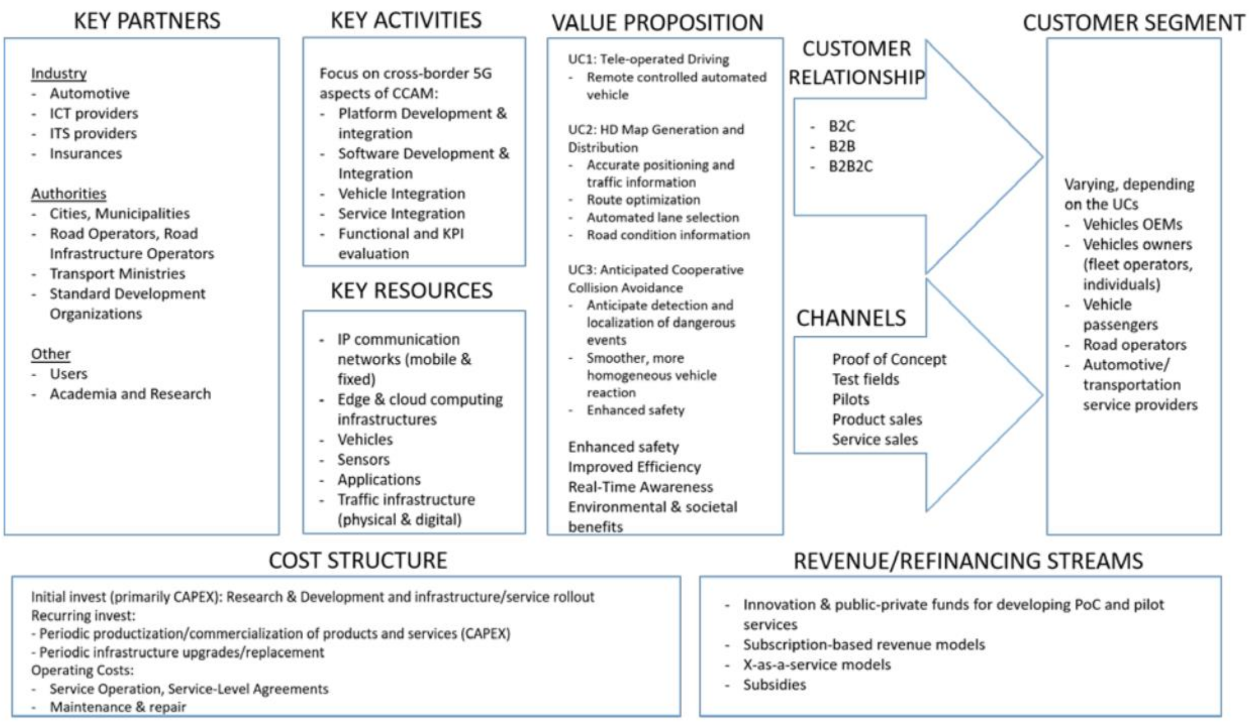

Figure 2: Layout of the business model Canvas for cross-border 5G (source 5gCroCo D5.1, fig. 2.2)

5G-CARMEN **[11]** is focussing on the Bologna-Munich corridor (600 km, over three countries), with use cases on (I)Cooperative Manoeuvring, (II) Situation awareness, (III) Video Streaming, and (IV) Green Driving. 5G-CARMEN has been funded under the call ICT-18 and there is a broader, ongoing cooperation in place with 5G-MOBIX, also working closely for business model study. Its use cases for Cooperative Manoeuvring and Situation Awareness match closely those of 5G-MOBIX, and the business models and potential of the two projects can benefit from each other's findings. No exploitation or business-related deliverable has been made public yet, but from D 6.1 Data management plan, p. 8 [12] we acknowledge that task 6.2 will perform a market analysis of cooperative, connected and automated mobility for the three main stakeholder groups (vehicle manufacturers, MNO-Mobile Network Operators and road infrastructure authorities), and task 6.3 will address the exploitation of results from the demonstration phase for vehicle manufacturers.

5G-GENESIS **[13]** has as its main goal to validate 5G KPIs for various 5G use cases, in both controlled set-ups and large-scale events. As with other ICT-17 call projects, the foundation of 5G-GENESIS is the establishment of a reference flexible architecture that support different verticals over and E2E virtualised network. In the deliverable n. 7.8 "Innovation and exploitation activities", release B, [14] in the "partner-specific exploitation plans" paragraph new business models are set to be identified and established in the future. The final version of the deliverable is expected at the end of the project, in the current version a preliminary exploitable outcome categorization is graphically described as follows:

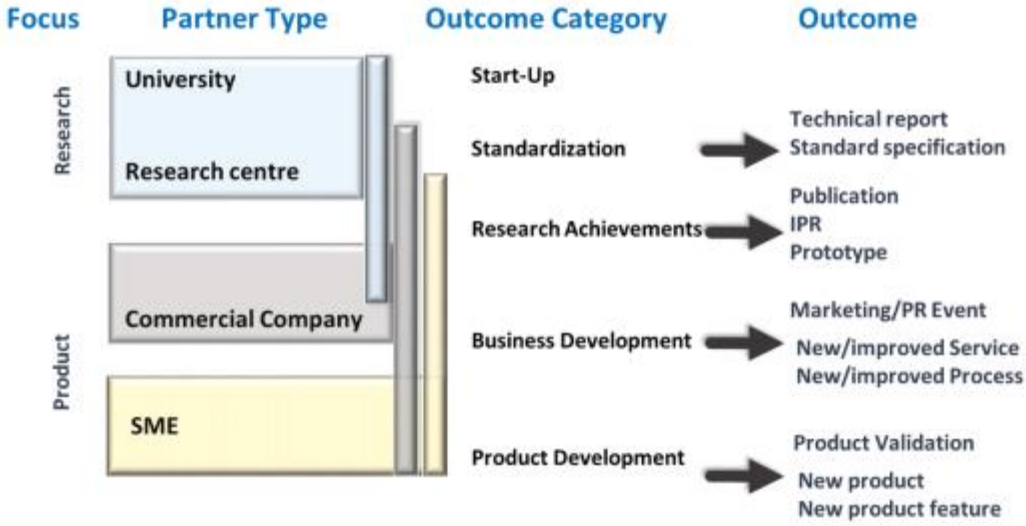

Figure 3: 5G-GENESIS, exploitable outcome categorization (source 5G-GENESIS, D7.8, release B)

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5G-VINNI**[15]**'s concept is to develop an E2E 5G facility that can be used to first demonstrate the practical implementation of infrastructure to support the key 5G KPIs, and then to allow vertical industries to test and validate specific applications that are dependent upon those KPIs. An extensive analysis for 5G and the project's verticals has been carried out in the D 5.1 "Ecosystem analysis and specification of B&E KPIs", [16] and the business layer have been investigated in the D 5.2 "D5.2 Business requirements and fundamentals of the 5G-VINNI Business Layer". [17] The first version of service catalogues has been published (D3.2) [18] and some services, such as network slicing, monitoring entry point and data assurance could be of interest for 5G-MOBIX.

5G-VINNI proposes a general 5G ecosystem model, which captures the ecosystem complexity with regards to the number of actor roles and their relationships. It is suggested that there are three families of business relationships: between operators and other IT firms, between operators, and between the NSaaS (logical networks) which are held between enterprise customers. Additionally, analysis show that interoperability, both technological and business-wise, is an issue in the future 5G ecosystem. 5G-VINNI business approach is based on the concept that to capitalize on the 5G opportunity, existing Business Support Systems need to be upgraded in order to support:

- Massive scaling of devices, customers and end-users;
- New services, products and different requirements for quality of service, coverage or security;
- Services customized to the customers' requirements,
- Zero-touch self-service models that are cost-efficient and ideally suited for short-lived services;
- a broad range of business models that involve a wide set of partners and variety of pricing strategies and Service Level Agreements (SLAs) for attracting customers;
- Interoperability with other business systems.

D5.2 describes the identified requirements and key features of these new 5G backend systems, the 5G-VINNI business layer. This layer should support users from vertical organisations in planning, designing, executing and evaluating experiments with 5G infrastructures, 3rd parties willing to advertise, offer and bill their services via the platform of a facility site/communication service provider, and members of facility sites managing the platform.

The analysis performed reveals the following set of business layer requirements: secure universal login, assisted customer access, global service catalogue, open to external suppliers, pick and choose, experiment, global coverage, homogeneous service end-to-end, automated replicability, flexible cost-revenue sharing agreements, flexible way of SLA definition and billing, real-time resource monitoring, reporting, community, license management, experiment scheduling, user device access control, open documentation, feedback mechanism and slice control

5GCAR **[19]** ended in July 2019 and was one of the 5G PPP Phase 2 projects. 5GCAR was devoted to conduct research in the area of V2X communications for and the automotive vertical sector towards the adoption of 5G technologies. Architectural items addressed by the project, and their implications in terms of the resulting network and multi-tenancy stakeholder architecture included E2E security, network orchestration and management, advanced network procedures, edge computing enhancements, multi-connectivity cooperation (SL, Uu, PC5, multi-RAT, etc.), radio interfaces and positioning. All these aspects have a relation with developments in 5G-MOBIX and can complement the business model vision of the project. Deliverable D2.2 "Intermediate Report on V2X Business Models and Spectrum" [20] and Deliverable D2.3 "Automotive use cases and connectivity challenges, business models and Spectrum related aspects" [21] address the project's business-related output. They address the service definition and how connectivity can affect new services by enhancing or enabling them for deployment, and the business model examples show the evolution from a linear value chain to a multi-linear relationship model.

In 5GCAR D2.2, the service definition and how connectivity can affect new services by enhancing or enabling them for deployment are discussed, as well as practicalities where some of the main risks for the connectivity business model definition are shown. Further, the business model examples, where the evolution from a linear value chain to a multi-linear relationship model is explained focusing on the example of autonomous driving amongst others.

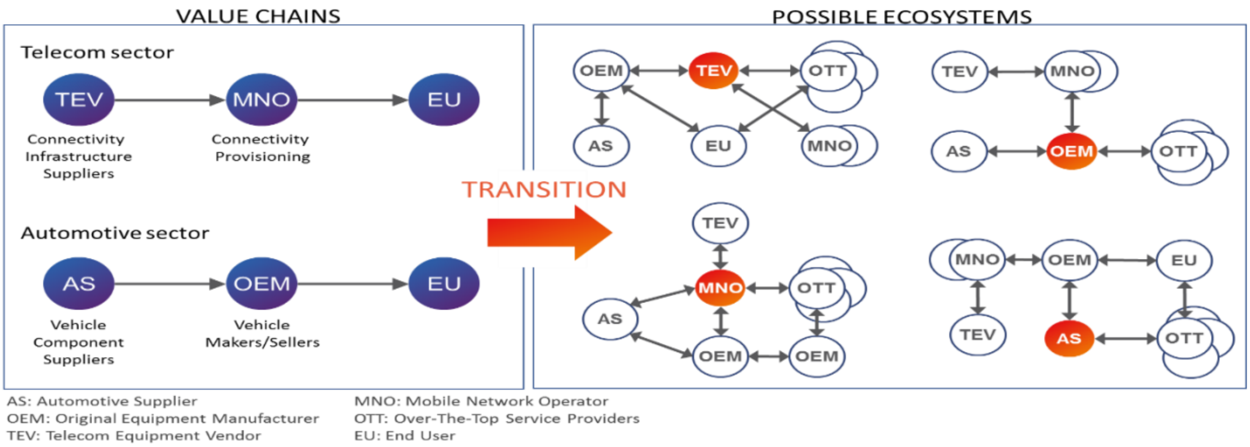


Figure 4: 5GCAR Value Chain Transition

5GCAR D2.3 describes and automotive use case roadmap with the current 4G situation, challenges and 5G advantages, as well as reflections on both 5G performance KPIs and societal KPIs. Business model analysis of 5GCAR technical components as well as business marked opportunities for V2X are presented. The main technical categories around which value and models would be created are positioning, V2X radio design, network procedure, end to end security and edge computing enhancements.

DRAGON is a CEDR project investigating the implications of vehicle automation for national Road. DRAGON is supporting the movement towards high and full automation and realising the benefits and savings that come with it. It considers both the general case for NRAs (National Road Authorities) in Europe as a whole, as well as focussing on the particular needs of individual NRAs through three selected case studies.

Vehicle automation technology is developing rapidly with demand for automation systems across passenger cars and goods vehicles, based on existing benefits with current systems and greater anticipated benefits from higher levels of automation in future. The road networks which NRAs manage (mainly motorways and other strategic routes) are likely to be amongst the most suitable networks for automated vehicles, in that they are usually consistent, well-ordered environments in terms of layout, lane markings and signage, with comparatively few interfaces with other transport modes. It is important for NRAs to understand what potential benefits and costs automated vehicles may bring to their network, how they can best support their introduction, and to understand their potential role in influencing implementation, in order to maximise benefits and mitigate potentially negative side-effects. The success of automated vehicles ultimately hinges on how well they meet their users' needs, and this will be influenced by the support of the NRAs. As such the NRAs have the ability to influence directly the impacts of these vehicles on their network. D3.1 Report on the benefits and costs of automation describes the economic benefits that NRAs could derive from the implementation of automated systems as vehicle deployment rates change, around the three case studies identified (automated trucks – UK, truck platooning – NL, Autobahn Chauffeur - DE) and the impacts identified in the project (traditional takes on mobility efficiency, sustainability, costs structures and safety).

Costs identified in DRAGON are categorised in three groups: infrastructure operator point of view (physical, digital, strategic), vehicle/individual (training, additional equipment costs) and mobility industry (Maps, manufacturers compliance procedures with AV devices, services and applications, maintenance increased costs due to the additional complexity of the systems, etc.)

Benefits in the project are identified as the typical in transport CBA studies: travel time, vehicle operating costs, carriers' operating costs, accidents savings, noise and emissions, increases in capacity and efficiency and human facts such as attractiveness of transport and comfort of driving.

While specific in their use cases, given that the project is focusing on automated vehicles, the overall assessment methodology could be useful for application in 5G-MOBIX. Main findings of the project were that in the three UCs, CBA indicators have been interesting:

- Time and productivity savings are a key benefit within all of them –taking into account a high sensitivity of the set of assumptions made for the analysis.
- The division of costs and benefits for the involved stakeholders needs specific attention, as they are usually completely separated amongst stakeholders.
- Costs of technology are still unknown and were proven in the analysis as the most sensitive factor.
- Decision making support is still not completely clear, and the analysis was not solid enough to convince NRAs for investment decisions, even with a clear potential for benefits.

NordicWay. NordicWay 2 and NordicWay 3 are C-ITS pilot projects that enable vehicles, infrastructure and network operators to communicate safety hazards and other information from roads in the Nordic countries between different stakeholders. The projects are a collaboration between public and private partners in Finland, Norway, Sweden and Denmark and build on the achievements from the previous NordicWay project. NordicWay will demonstrate the use and feasibility of Day 1 and Day 1,5 C-ITS services in the challenging Nordic environment. The C-ITS services are defined in terms of use cases with scenarios showing how the different types of actors interact in the NordicWay Environment. The CEF supported NordicWay C-ITS deployment pilot (2015-17) has already shown the feasibility of cellular C-ITS service provision with low latencies. NordicWay has also developed and published the Cloud2Cloud concept with an Interchange network building on standards and open solutions, in particular by combining traffic messages with AMQP server technology. The NordicWay concepts forms a blueprint for a scalable, interoperable C-ITS implementation, with embedded privacy, security and data governance solutions and is coming into operational use. Specific areas addressed by NordicWay projects that could be of relevance for 5G-MOBIX include scaling-up of C-ITS services by supporting cloud to cloud hybrid communication, the analysis of technical solutions with potential to reach high penetration without additional infrastructure investments, contribution to harmonisation through C-Roads, exploration of the feasibility of C-ITS solutions in environments with poor cellular connectivity, infrastructure readiness for CCAM on major freight routes and challenges for higher (>L4) automation levels.

By the end of 2019, the project NordicWay2 carried out an Ecosystem evaluation, in which the aim was to discover the ecosystem actor' perception on viability, feasibility, resiliency and profitability of providing C-ITS services as a group, and did not focus particularly on technological challenges. From the preliminary results, the main focus of this exercise was the data flow (generation, provision, consumption, monetisation), resulting for all the Use Cases in the following short-mid-term future picture which also was an example for our Value Network Study in Section 2.4.

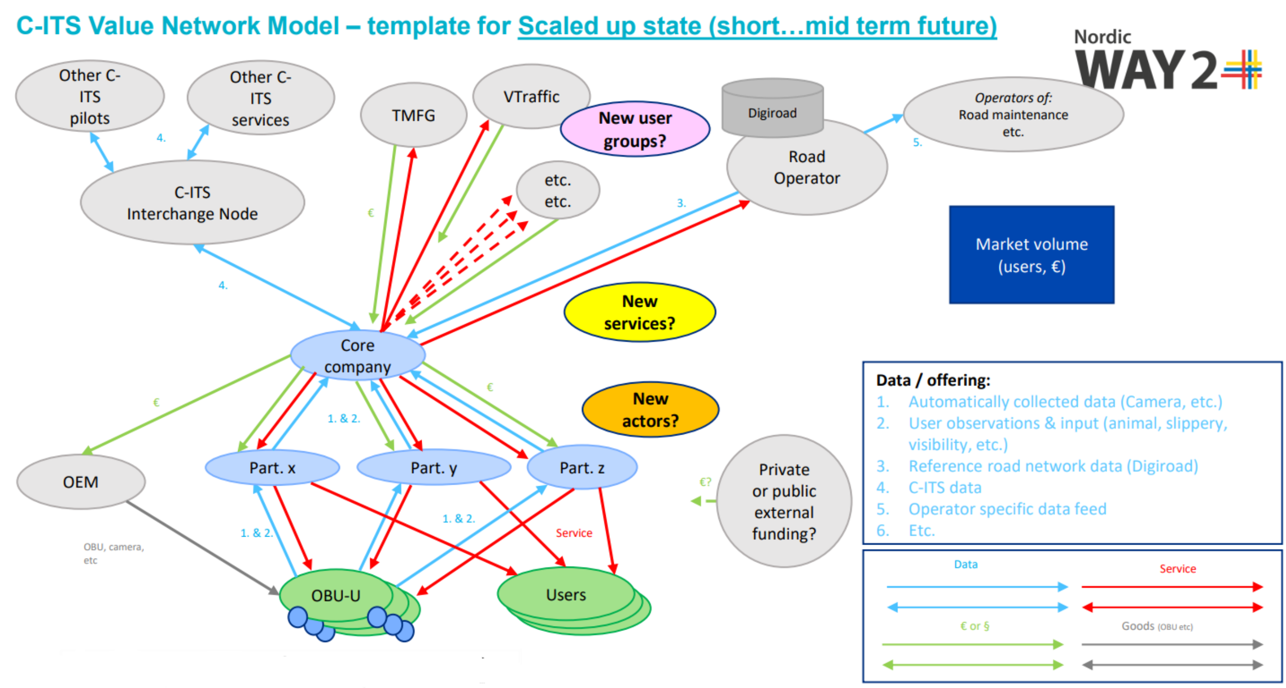


Figure 5: NordicWay2 Ecosystem evaluation

Publicly available information on the findings of the NordicWay2 Business model analysis is limited, and an Interim Evaluation Report has been prepared by the project with the full results of the analysis. 5G-MOBIX will monitor the progress of NordicWay2 as there are several aspects of the whole CCAM ecosystem that could be applicable to the project's outlook.

ENSEMBLE[22]'s main goal is to pave the way for the adoption of multi-brand truck platooning in Europe to improve fuel economy, traffic safety and throughput. Platooning Levels will be defined to guide the design of different platooning functionalities and strategies, reflecting the full diversity of trucks with platooning functionality. Stakeholder are in place to ensure that the pre-standards are taken up by the respective organisations and working groups to form the actual standards, in cooperation with the ETPC platform. The deliverable D4.3 'Analysis of market needs, business models and lifecycle environmental impacts of multi-brand platooning' will be publicly available from M30 (Dec 2020) and it will be followed closely also by 5GMOBIX.

ICT4CART's main objective is to design, implement and test in real-life conditions a versatile ICT infrastructure that will enable the transition towards higher levels of automation (up to L4) addressing existing gaps and working with specific key ICT elements, namely hybrid connectivity, data management, cyber-security, data privacy and accurate localisation. ICT4CART builds on high-value use cases (urban and highway), which will be demonstrated and validated in real-life conditions at the test sites. To enable and accelerate the insertion of such vehicles in our everyday life, ICT and especially connectivity, is a prerequisite. Deliverable 2.2 "Analysis of market needs" [23] captures the underpinning market needs of CAV ICT infrastructure, i.e. what end users need from this infrastructure and the value it could create for them. The report aims to inform those working in the CAV technology space on the potential markets for CAV information services. It is particularly concerned with the transition from Level 2 CAVs to Level 3/4 CAVs (see Section 3.2 for information on SAE automation levels), such that drivers no longer need to be fully attentive, instead vehicles can complete all driving functions in certain environments. At this point, it is anticipated to be a shift from the use of automation purely for driver support and to automation for improving driving experience. The document describes the demand for information services from different groups in the CAV market. This can form the basis for the development of more detailed system requirements of CAV ICT infrastructure along with more extensive service design. It can be used to inform developments of other complimentary technologies within this sector.

The WP8 "Evaluation impact assessment" [24] will instead provide information on technical evaluation, impact assessment and cost analysis. Including tasks on Technical Evaluation, Impact Assessment and Cost Analysis and Market Sustainability, the only published deliverable D8.1 introduces the overall methodology for the assessment and defines the KPIs and impact assessment metrics for the analysis.

In ICT4CART, impact analysis focuses on Quality of Life, Business impacts and Cost Benefit Analysis, and the following metrics are selected: Increase/decrease of traffic flow, Manoeuvre completion time, Decrease of automation level (False positives), Cost of infrastructure deployment, Revenue potential for operators, Business cases maturity and Market sustainability.

Deliverable D2.2 also provides a preliminary market analysis for CCAM, which identifies the relevant aspects to understand the value for the ICT infrastructure. As a result of this analysis, a framework and systematic categorisation of the information service which could make up separate 'markets' were identified:

1. Automated driving. Connectivity to support the automated decision making of road vehicles

2. Informed journeys. Connectivity to improve driving decisions, regardless of how automated the vehicle is.

3. Intelligent management. Connectivity to improve awareness of what is happening on a road network or other driving environment.

4. Coordination of vehicles. Connectivity to instruct automated vehicles in specific scenarios and coordinate their driving.

5. Underpinning services. Connectivity and information service with commercial potential that enable a safe and effective CAV driving environment.

D8.4 Impact assessment and D8.5 Cost analysis, are still under revision by the European Commission according to the ICT4CART website, but their publication will be followed by 5G-MOBIX, as it can provide useful insight for the project.

LEVITATE aims to develop a wide-ranging evaluation framework to assess the impact of Connected and Automated Transport (CAT) on all aspects of transport and individual mobility as well as at societal level. This framework will be used to evaluate the impacts of CAVs on individuals, the mobility system and society using a wide range of indicators. The outcomes of Levitate will include a set of validated methods to measure the impacts of existing technologies and forecast that of future systems. Deliverable 3.1 "A taxonomy of potential impacts of connected and automated vehicles at different levels of implementation" [25] can be considered useful in establishing a framework of potential impacts of connected and automated transport systems (CATS) at different levels of implementation. The provided taxonomy is based on a systematic review of recent studies that have proposed taxonomies of impacts of CATS. There is considerable overlap among the lists of impacts presented by the studies, suggesting a high level of scientific consensus about the potential impacts of CATS. LEVITATE is an ongoing action, expected to continue at least until March 2021. 5G-MOBIX should also keep monitoring this project, as the impact analysis presented in D3.1 addresses a wide range of issues in CCAM, and later developments in impact analysis and business models could be very useful for the project.

MAVEN project aimed at developing infrastructure-assisted platoon organisation and negotiation algorithms. These extend and connect vehicle systems for trajectory and manoeuvre planning and infrastructure systems for adaptive light optimization. Traffic lights adapting their signal timing to facilitate the movement of organised platoons and reversely will yield substantial better utilization of infrastructure capacity, reduction of vehicle delay and reduction of emissions. The MAVEN project built a system prototype for both field tests and extensive modelling for impact assessment, contributing to the development of enabling technologies such as communication standards and high-precision maps, and developing ADAS techniques for the inclusion of vulnerable road users. Additionally, MAVEN intended to include a user assessment and the development of a roadmap for the introduction of vehicle-road automation to support road authorities in understanding changes in their role and the tasks of traffic management systems. D7.2 Impact Assessment describes and discusses the results of the MAVEN use cases (16 use cases, from platooning, to speed and lane changes, through emergency and priority management cases to routing), focusing on the potential impact on the city environment and expectations of the city public. D8.8 Transition Roadmap considers technical, political and organisational aspects related to the transition path to a Cooperative, Connected and Automated Mobility and as it reflects MAVEN encompassing view on deployment and consolidation of CAVs, it is also useful for 5G-MOBIX business models.

MAVEN impact categories were identified as Policy, Infrastructure, Planning, Capacity building and Traffic management, with general expected results along the following lines:

- Improved traffic flow and lower environmental impact.
- Improved safety, lowering societal costs and increasing attractiveness to prospective residents.
- Increased network performance reducing the need for extra physical road infrastructure.
- Improved quality of driving, comfort and fuel saving for drivers.
- Improved safety for drivers and other road users through advances in sensing and cooperation amongst road entities.

Another relevant view on the roadmap is the importance of the awareness and education in the successful deployment of connected and automated vehicles, which has been declared to be highly dependent on the acceptance of the stakeholders at all levels. Policy makers, traffic managers, the police force and the general public should be targeted specifically for relevant information campaigns. Another identified challenge in the deployment of automated vehicles is the importance of standards and regulation in the deployment of CCAM.

The MAVEN project has already finished, so no further BM related deliverables are expected in the future.

SCOOP@F was a C-ITS pilot deployment project that aimed at large scale testing of solutions improving the safety of road users and road operating staff, while also helping improve the traffic management and promoting multimodality. Technical objectives included: testing deployment of Day 1 C-ITS services, preparing related stakeholders for the deployment, providing E2E communication security and security management solutions, enabling hybrid communications (ITS G5 + cellular). To contribute to interoperability of C-ITS in EU, SCOOP@F cross-tested in sites in France, Austria, Spain and Portugal, addressing the activities of the C-ITS platform and the Amsterdam Group towards interoperability in the EU.

The project SCOOP@F identified the complex ecosystem of stakeholder collaborating to produce value in the C-ITS environment, resulting in the following figure which is also helped us to create a Value Network Model in Section 2.4:

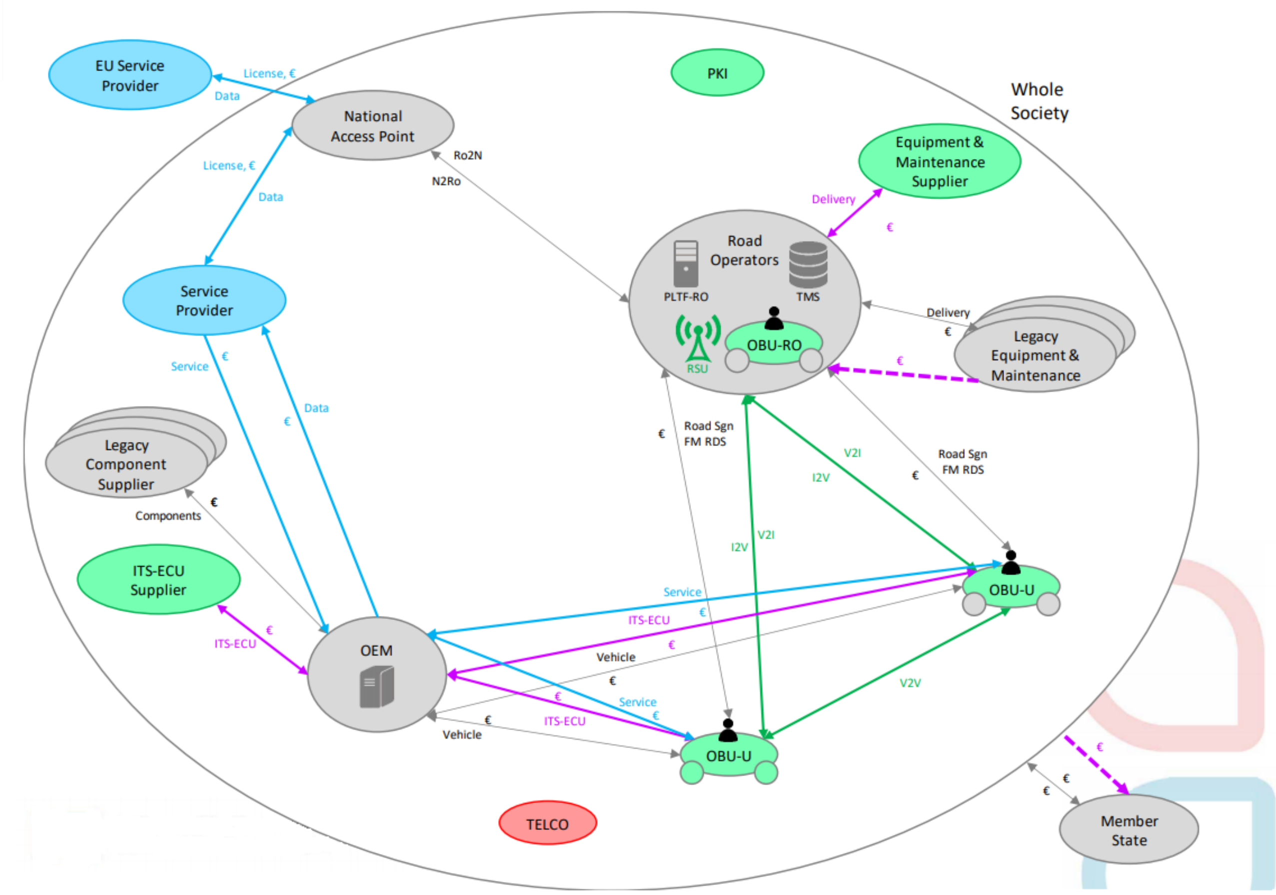


Figure 6: SCOOP@F Project Value Network Model

However, it was noted by the project how this framework describes processes, activities and organisation, but not resources, being therefore useful to address main functionalities (such as Use Cases, divided in their content collection, content processing, service provision and service presentation steps, for example). SCOOP@F worked on a revision of the 'static' network to include resource items and precise following of the processes involved with each stakeholder for each Use Case functionality.

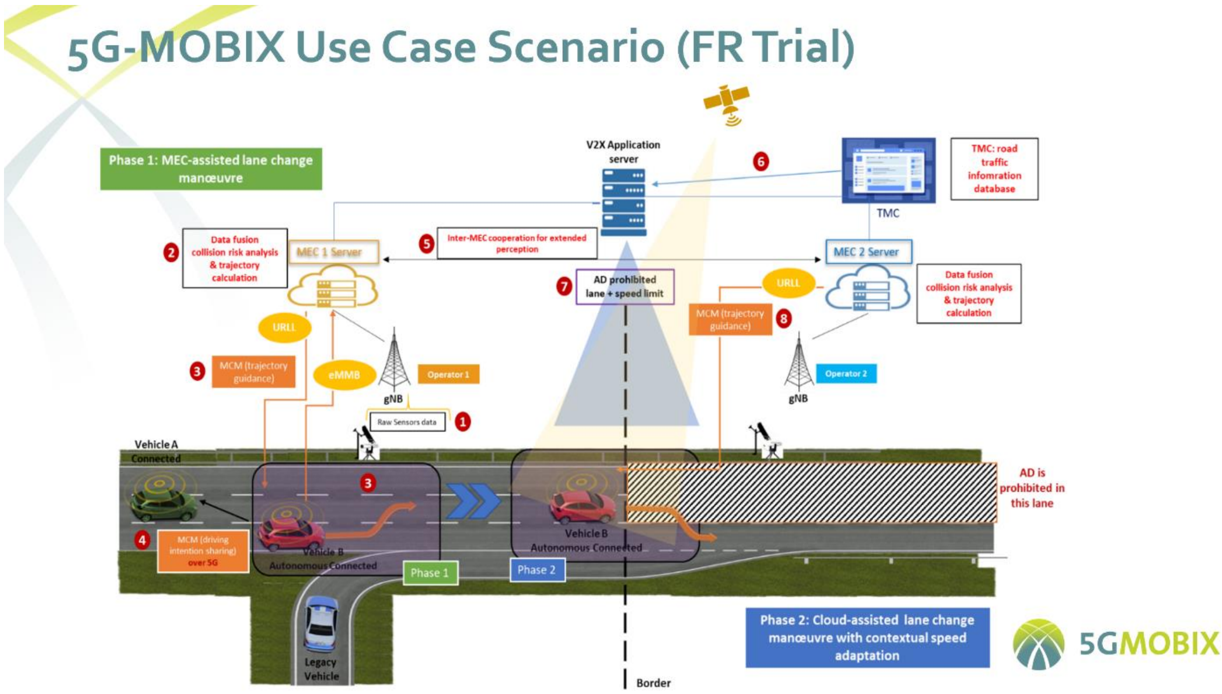
CARAMEL **[26]** addresses artificial intelligence-based cybersecurity for connected and automated vehicles, and its goal is to proactively address modern vehicle cybersecurity challenges applying advanced Artificial Intelligence (AI) and Machine Learning (ML) techniques and also to continuously seek methods to mitigate associated safety risks.

CARAMEL outcomes include advanced technologies and services to manage complex cyber-attacks and reducing the impact of breaches, and robust, transversal and scalable ICT infrastructures resilient and equipped with sustainable mechanisms for cybersecurity, digital privacy and accountability. Deliverables D7.2 'Market Analysis' and D7.5 'Roadmapping and Business Modelling Report' are the documents describing the business approach in the project but are currently not available.

INFRAMIX is preparing the road infrastructure to support the transition period and the coexistence of conventional and automated vehicles. Key aspects considered throughout the project will be to ensure that the proposed adaptations will not jeopardize safety, quality of service, efficiency and will be appreciated by the users. A significant outcome from the project is the proposed Infrastructure Support Levels for Automated Driving (ISAD) framework, which, aggregating the different technical areas considered by the project, consists in a classification similar to the SAE levels for autonomous vehicles. Considering both physical and digital infrastructure elements, it can support harmonisation and advancement of the road infrastructures and road operations towards integration with the autonomous mobility. Its deliverable 6.4 "Roadmap towards fully automated transport systems" [27] will be considered – once published - in the background of the business model for 5G-MOBIX' relevant use cases.

2.3. 5G-MOBIX Partners and Value Network Model

We have established the Value Network for 5G-MOBIX by adapting the generic model in Figure 6: SCOOP@F Project Value Network Model, into ones that fairly and accurately reflect the implementation at one of the shred borders. The example we shall share here is for the France-Spanish Border.

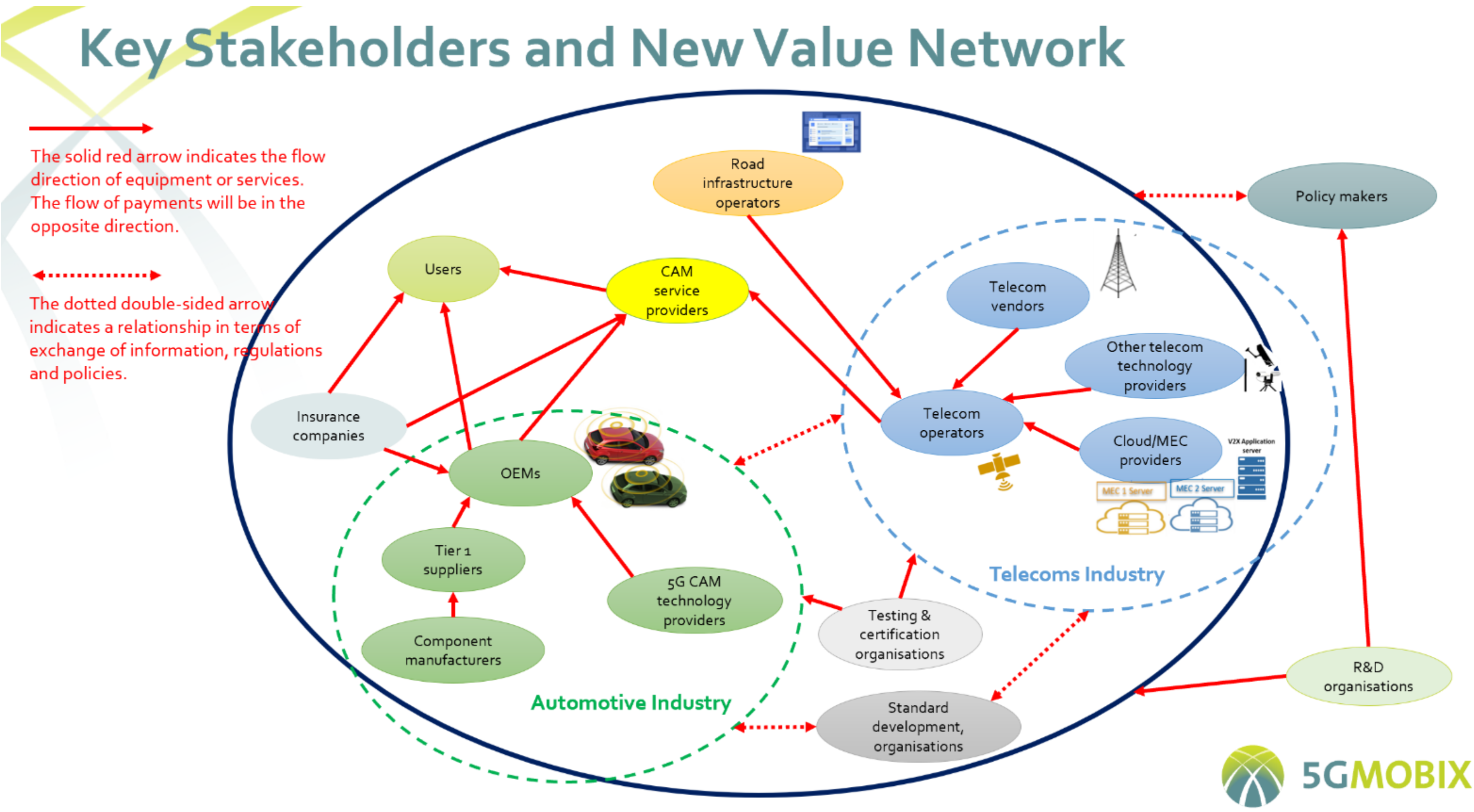


To develop the right Value Network, it is important to understand how the technology plays it part in the transition of the vehicle from one side of the border to the other. This is best described by the diagram below:

Figure 7: FR Trial Site User Story

It is shown how the route of one vehicle entering from a side road affects another already en-route to the border and thus all of the connectivity that is already in place for routine operation well away from the border itself and for as it is approached. We have used the scenario above at the French-Spanish (FR) border to the derive where data/information flows to and from, and this then in turn provides us with a Value Network when we transition that flow into the flow of monetary transactions to facilitate these operations.

Our Value Network looks like this for the specific FR example scenario; it shows the flows of data, be they unidirectional (from one party to another; one gives an one takes) or bi-directional (in both directions between these entities; both give something and received something else from each other). We also distinguish between monetised relationships (solid arrows) – where monetary exchange is associated with the transfer of data/information - and non-monetary exchanges (dotted arrows) – where there is "free" exchange of data/information.



We have then established, of this example, where each partner within 5G-MOBIX sits, and two examples are shown below the generic plot.

Figure 8: 5GMOBIX Value Network Model

2.3.1. Value Network Model – Automotive Industry:

Within the traditional automotive industry, the component manufacturers supply the Tier 1 companies, which in turn integrate these components into higher-level components and supply directly the OEMs (vehicle manufacturers). For Connected and Autonomous Vehicles (CAVs), this chain is extended to include the providers of 5G CAM-related technology to the vehicle OEMs. Examples are the HD map providers, and the providers of on-board sensors and telecom units. This category includes all the hardware and software suppliers, together with all the relevant supply and logistics chains.

The automotive industry collaborates closely with the telecoms industry to design and develop technologies that meet the necessary 5G CAM requirements.

Table 1: Automotive Industry Consortia Partners

Role:	Who:
OEMs	Ford Otosan, CNHTC, SENSIBLE4; NEVS, PSA and Renault (represented by VEDECOM),
5G CAM Technology Providers	TÜBİTAK, A-to-BE, DATANG, HERE, KATECH, SA Catapult, TNO, VALEO, VEDECOM, VICOMTECH, WINGS

2.3.2. Value Network Model – Telecom Industry

The traditional telecoms industry consists of the telecom operators, which include the Mobile Network Operators (MNOs) that deploy and operate the 5G and 4G networks, and the telecom vendors, which provide the necessary physical equipment to the MNOs such as the base-station antennas and the associated hardware (i.e. core network and Radio Access Network (RAN) infrastructure providers).

Here, in the category of telecom operators we also included the Satcoms operators.

For 5G CAM deployments, cloud and MEC infrastructure providers will also be needed to supply the local and central datacentres providing the storage, processing and networking resources.

Other 5G CAM-related telecom technology providers include the providers of any other necessary telecom devices and software (road-side C-V2X and sensor units are also included in this category here).

Due to the high CAPEX and OPEX costs for deploying and operating CAM services, it is likely that MNOs will decide to share infrastructure, spectrum and/or core network resources. In order to ensure seamless CAM service delivery to the end-user, this will require various agreements (at technology as well as policy and regulatory level) between MNOs within the same country and of different countries for cross-border corridors. The automotive industry have embraced the GSMA Embedded SIM (eSIM) cards technology. The eSIM cards are fixed, allow remote provisioning, and can store multiple MNO profiles making it easy to switch between different MNOs.

Table 2: Telecom Industry Consortia Partners

5G-MOBIX Project Partners		Role
Telecom Operators	COSMOTE (Deutsche Telecom), KPN, Telefonica, Turkcell – Associated partners: SES, TELIA, CUSJ	Providers of network
Telecom Vendors	ERICSSON, NOKIA, DATANG	Providers of 5G and 4G core network and RAN infrastructure
Other Telecom Technology Providers	TÜBİTAK, INTRASOFT, SA Catapult, SIEMENS, WINGS, VICOMTECH – Associated partners: NXP, Technovation	Providers of C-V2X and sensor Road-Side Units (RSUs), integration of different technologies.
Cloud/MEC Providers	AKKA, DDET, SNET ICT, VEDECOM	Providers of Cloud/MEC infrastructure and relevant software tools for data storage and processing.

2.3.3. Value Network Model – Road Infrastructure Operators

The Road Infrastructure Operators are national or regional entities in charge of the deployment, operation and maintenance of physical road infrastructure. They can be public entities or private companies. The Road Infrastructure Operators may provide infrastructure to the MNOs for the 5G network deployment (e.g. masts, fibre, cabinets, etc). The road operators provide geo-coded information to facilitate autonomous driving (e.g. traffic management information). Some Road Infrastructure Operators may decide to deploy and/or operate their own 5G networks and, acting as MNOs, directly provide the necessary coverage for CAM services.

Table 3: Road Infrastructure Operators Consortia Partners

5G-MOBIX Project Partners		Role
Road Infrastructure Operators	AENL, INFRAPT	Provide and manage the trial sites

2.3.4. Value Network Model – Policy Makers

The Policy Makers include the International, European or National authorities that define the legal framework and policies for the whole ecosystem of stakeholders. From a 5G CAM perspective, the relevant policy makers can be divided in two broad categories:

- Road and transport authorities
- Telecom regulators (including ITU and national spectrum regulators)

Here, in this category we also include the various city authorities.

Table 4: Policy Makers Consortia Partners

5G-MOBIX Project Partners		Role
Transport authorities	DGT, IMT – Advisory board: FTA, HMIT, LVM, TRAFI	Authorise, regulate and support deployment for trials
Telecom authorities	Advisory board: BTK, LVM, YME, FICORA	
Cities	Helmond, Vigo – Advisory board: Berlin, Espoo	

2.3.5. Value Network Model – Standard Development Organisations

The Standard Development Organisations include International, European and National entities that define the standards that will be adopted by the 5G industry. Example organisations that define the telecoms-related technical standards include: 3GPP, ETSI, IETF/IRTF, IEEE, NGMN, IIC, 5GAA, AECC). For safety-related 5G CAM applications pertinent standards developing organisations such as ISO may also be relevant.

The Standard Development Organisations consider the regulations set by the Policy Makers and work closely with the 5G telecoms and automotive industry, particularly for CAM applications where high levels of safety are imperative.

2.3.6. Value Network Model – Testing & Certification Organisations

The testing & certification organisations offer testing and evaluation services that aim to ensure that equipment and products achieve the necessary quality while complying with the relevant national and international performance, safety and operational standards and regulations. These organisations may have a focus on the automotive industry, the telecoms industry or both (for 5G-CAM related equipment and products).

Table 5: Testing & Certification Organisations Consortia Partners

5G-MOBIX Project Partners		Role
Testing & Certification	DEKRA, TASS	Set requirements, collect and evaluate results of trials

2.3.7. Value Network – CAM Service Providers

The CAM Service Providers might be the MNOs, the car OEMs, the Road Infrastructure Operators or other service providing companies. The CAM service provider receives a fee from the end user for the provision of 5G CAM services and pays a fee to the network operator for the supply of connectivity products and added-value services.

2.3.8. Value Network – End Users

The end users can be the vehicle drivers, owners or passengers who enjoy the 5G CAM services. Here, we also consider as end users not only individual vehicle owners but also national or private road transport operators that own vehicles equipped with 5G CAM technology. The end users buy the vehicle from the OEM, pay the CAM Service Provider following a pay-per-use model, a one-time payment model or a recurring-subscription fee model, possibly at different prices for different levels of CAM Service Level Agreements (SLAs).

Table 6: End User Consortia Partners

5G-MOBIX Project Partners		Role
Users (Transport Operators)	ALSA – Associated partners: AMBER	Provide public transport vehicles

2.3.9. Value Network – Insurance Companies

The insurance companies are now connected not only to the users but also to the CAM service providers and the car OEMs. For Level 4/5 autonomous driving, where the driving of the car relies completely on technology, the user may not have any relationship with the insurance company at all.

2.3.10. Value Network – R&D Organisations

R&D organisations such as academic institutions and private or public research companies and centres work closely with the whole ecosystem during the design, development and deployment phase of current and next generation CAM-related technologies and applications. Here, we have also included consulting companies in this category.

Table 7: R&D Organisations Consortia Partners

5G-MOBIX Project Partners		Role
R&D Organisations	AALTO University, AEVAC, CCG, CTAG, DALIAN, ERTICO, ETRI, Fraunhofer, GTARC, ICCS, ISEL, IT, KATECH, LIST, SA Catapult, SHANDONG, TIS, TNO, TU Berlin, TU Eindhoven, UL, UMU, VICOMTECH, VTT	Develop requirements and methodologies, coordinate tests, establish international collaborations, assess impact, disseminate and roll out development of project results

2.3.11. Value Network Disclaimers and Next Steps

This example value network is based on the 5G-MOBIX use cases, and the 5G-MOBIX partners have been categorised here solely based on their role within the project. It is also perfectly possible for some partners to be part of more categories than those listed here.

We designed this value network assuming that the entity that benefits and is positioned at the centre of the network is the end user of the connected and autonomous vehicle, who pays for and enjoys "CAM as service". Different value networks can be designed assuming other entities (such as the telecom operators or the OEMs) at the centre of the network.

This is only an example value network. The roles and responsibilities of entities such as the Telecom Operators (MNOs), the vehicle OEMs, the Road Infrastructure Operators and the CAM Service Providers are not fully defined and may dynamically change. Hence, different ecosystems and value networks are perfectly viable.

Some associate partners, supporters and advisory board members of those listed in the 5G-MOBIX project proposal have not been included here.

We are now in the process of establishing what each of the data flows involves, so we can identify what transaction is taking place, what its value between the involved parties is to routine operation at the border and thus what monetary exchange may (or may not) be needed to facilitate that to happen. That is the focus of our next stage of the work. The field trial will ensure that we can detail example numbers for a TRL7-based demonstration.

3. 5G-MOBIX USER STORY BUSINESS MODEL ANALYSIS

3.1. Business Models Analysis for US – Complex Maneuvers– Lane Merge

US1, Complex manoeuvres in cross-border settings, explores advanced driving maneuvers in the autonomous mode. This maneuver includes the lane merge and overtaking.

As a requirement, these maneuvers should be performed in a vehicle's and infrastructures' connected context, where vehicles' data are shared through an internal communication unit or radars, placed on the road infrastructure, and detects non connected vehicles. The data is shared through a 5G communication network.

The lane merge maneuver is characterized by the management of a situation where automated vehicles are in a lane merge scenario. Success of maneuvers is defined by the capability of an autonomous vehicle in:

1) Identifying nearby vehicles, including their lane position, acceleration, speed, size, etc.

2) Determining the best merge manoeuvre according to the current situation.

3.1.1. Current Market Situation for US – Complex Maneuvers– Lane Merge

The number of autonomous vehicles (level 5) available on the market is limited. However, the overtaking feature is already provided in vehicles with mid-levels of autonomy (level3).

The Lane merge manoeuvre is a feature that should be incorporated in autonomous vehicles launched on the market. Actually, the lane merge is still a problem that automotive makers are trying to solve. The provided solution is still not safe enough to be used without precaution. Most of these problems could be related to the interaction with non-connected vehicles: the lane merge manoeuvre is performed based on the information provided by vehicle sensors. However, in the near future, this feature will be improved and will be integrated as a default feature in full autonomous vehicles.

3.1.2. Stakeholders of US – Complex Maneuvers– Lane Merge

This section list US stakeholders and relations among them (Figure 9).

- **5G Infrastructures Providers:** These actors include all elements related with the development, implementation and deliverable of 5G communication equipment. This may include Original equipment Manufacturers and Tier 1 suppliers, vendors and other suppliers of technical solutions or products, involved in the deliverability of a 5G communication related infrastructure. This group of stakeholders will develop and provide the equipment needed to assemble the network infrastructures. Nokia-PT and Nokia-SP will be vendors of the equipment to MNOs (RR5), Road operators (RR4) and C-ITS stakeholders (R6).

- **5G Mobile Network Operators (MNOs):** These actors play an important role in the maintenance of the telecommunication infrastructure. This stakeholders group includes Telecommunication Operators and Service operators, Telecom vendors, Cloud providers and other Technology providers such as edge devices providers, software developers, etc. NOS and Telefonica will provide the communication service to Road infrastructures Operators (R8), C-ITS stakeholders (R9), R&D organizations (R14) and Transport Operators or End Users (R15).

- **Automotive Industry:** These actors provide a technological platform, such as vehicles and related components, or services to support autonomous driving or connected vehicles. This category of stakeholder includes car OEMs (car manufacturers), component manufacturers, Tier 1 suppliers, CAM service providers, HD map providers and other automotive-specific technology providers. Automotive actors will provide autonomous mobility solutions to Transportation Operators or End Users (R13).

- **Cooperative Intelligent Transport Systems (C-ITS):** These stakeholders manage the infrastructures and provide the information received and sent by connected vehicles that are on the road. This category includes local or national entities. These stakeholders, that could relate entities that manage the traffic and infrastructure, such as Infrastruturas de Portugal (IP) Direção Geral de Tráfego (DGT), or technologic companies that develop technological solutions, such as A-to-Be, Instituto de Telecomunicações (IT), CTAG or CCG. These actors will manage the traffic, having relation with Infrastructure Operators (R7). This is a bidirectional relation: Road Operators can be clients or data suppliers to a C-ITS centres. These infrastructures can even be managed by the Road Operators. R&D Organizations (R10) will develop, update and maintenance the C-ITS centres. The communication will be by the MNOs (R9). The transport Operators and End Users will be the final clients (R12).

- **Road Infrastructures Operators:** Correspond to entities that are in charge of deployment, operation and maintenance of physical road infrastructure. This includes the agents that are involved in managing road traffic operations, own or operate the toll system, etc. This includes public entities, governmental institutes and departments, and private companies that manage private or public road infrastructures and third-party maintenance companies. In public infrastructures, such as public roads, infrastructures operators can manage the equipment and provide access to the data that are available on the roadside units or ITS Centres. This data can be used by a third-party agent to develop a service (free or paid) for end users. Private road infrastructures operators can provide this service for all their clients (e.g.: Payed roads infrastructures). Road Infrastructure Operators, such as Infrastructures de Portugal (IP) and Direção Geral de Tráfego (DGT) will require equipment from 5G Infrastructures Providers (R4) and the network service from MNOs providers (R9). They will even provide the requirement or the data to C-ITS (R7), as a bidirectional relation.
- **Transport Operators:** This section joins the final transport operators and suppliers of mobility solutions to the end user. Actors such as local, national and European transport companies that manage vehicle's fleets and related service providers. This includes transport of goods and passengers agents. Transport Operators, such as Alsa, public transports, or renting companies, will required network service from 5G NMOs (R11) to access the service provided by C-ITS (R12) o by a R&D Organization (R11). Automotive Manufactures will provide the vehicles operated by these companies (R13).

- **Transport and Road Authorities:** This section includes Local, National and European authorities and regulators that are directly involved in the regulation of traffic and organizations responsible to define and execute legal framework and policies, such as road and transport authorities or telecom regulators. These stakeholders include regulators and policy makers, actors that provide the highest authorities and regulate the relationships within the whole ecosystem. They have the responsibility to manage the access to the technological solution. These stakeholders, such as European Union Organizations, Portuguese and Spanish Government, Autoridade Nacional de Segurança Rodoviária (ANSR) or Director General (da Dirección General de Tráfico) will provide the legal framework to regulate the service, from the infrastructure point of view (R3), C-ITS (R2) and autonomous vehicles through automotive industry (R1).

- **Researches and Developers Companies:** This group of stakeholders include researchers, Research Centres, Universities, Developer centres and other R&D stakeholders related to the automotive industry. These entities can develop the sensors and to be implemented on Road Side Unities (RSU) and radars. These entities will be involved in the exploration of the data that are collected on site and use it to improve the lane merge algorithms for the automotive industry and related stakeholders. Researches and Developers, such as Instituto de Telecomunicações (IT), Centro de Computação Gráfica (CCG), Centro Tecnolóxico de Automoción de Galicia (CTAG), Instituto Superior de Engenharia de Lisboa (ISEL) and A-

To-Be will provide the technological solutions to develop the C-ITS and deployment of the service (R10) or use the data from C-ITS to provide the service directly to end users (R11).

- **End User:** End users could be drivers, vehicle owners and vehicle passengers. This group of stakeholders would benefit from technological advances, using it daily. They represent a key role in the technology acceptance, as owners or passengers of an autonomous vehicle, such as users of autonomous driving related services. Users will benefit from these technologies or provided service, improving safety of a lane merge manoeuvre. The end users will benefit from the mobility solutions provided by Automotive Manufactures (R13) or transport Operators. The service will be provided by the transport operators, R&D organizations (R11) or directly by the C-ITS (R12). The 5G MNOs will provide the communication service (R15).

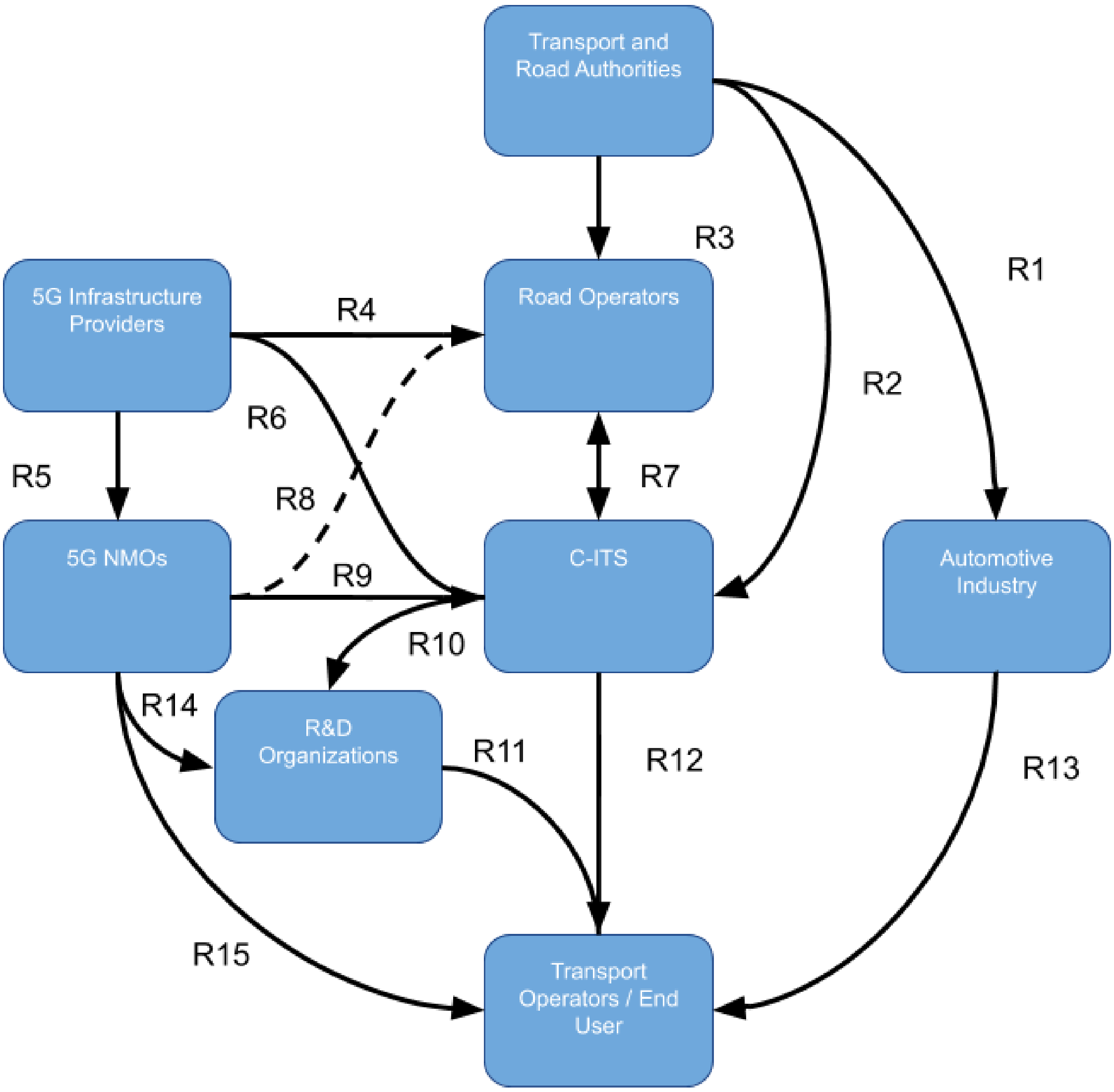


Figure 9: Schematic of Relations between Lane Merge Stakeholders

3.1.3. Value Proposition and Business Impact of US – Complex Maneuvers– Lane Merge

This product will improve safety on lane merge scenarios. These products will extend the capability of a lane merge algorithm provided by automotive manufacturers. The product can extend the sensor data provided by the vehicle's sensor systems, by adding information about other vehicles that are in the region but are not detected by vehicle sensors.

The infrastructure can provide a solution optimized for each acceleration path or road entrance. Compared to generic solutions provided by competitors, an optimized solution can improve performance and safety.

3.1.4. Customer Focus of US – Complex Maneuvers– Lane Merge

Table 8: Customers of Lane Merge

Service and/or Technology Provider	Customers
Transport Operators	Passengers
Road Infrastructure Operators	Automotive OEMs, R&D Organisations, Transport Operators, Drivers, Fleet Owners
Automotive OEM	Transport Operators, Drivers, Fleet Owners
Mobile Network Operators	Road Infrastructure Operators , Other MNOs, R&D Organisations
5G Mobile Infrastructure Providers	Road Infrastructure Operators, C-ITS Centres, MNOs
R&D Organisations	Transport Operators, Road Infrastructure Operators, Drivers, Fleet Owners
C-ITS Centres	Road Infrastructure Operators, Transport Operators, Drivers, Fleet Owners

3.1.5. Financial Analysis of US – Complex Maneuvers– Lane Merge

A lane merge maneuver can be split into three main services. They are described below.

- **Service 1:** Infrastructure Operators provide a lane merge service as an add-on to vehicle lane merge. Road infrastructure operators manage the infrastructure that can support the lane merge manoeuvre, such as sensors, radars and CCAM service. These road infrastructure operators sell a lane merge service, optimized for each entrance. This service is an add-on to the lane merge system provided by the automotive manufacturer. The service can be provided as an extra to all clients of a paid infrastructure (road with tools), or as a standalone service available in infrastructures that support this service. Clients are road users, vehicle owners, private or companies that manage autonomous fleets. The service can be provided as a service with a single sale for a specific entrance, or as a weekly, monthly or annual subscription. The infrastructure cost and service management are supported by the profit of these spellings or subscriptions.

- **Service 2:** Road Operators Provide data required to perform lane merge and a third-party company provides the lane merge manoeuvre as a service. Road infrastructure operators manage the infrastructure that can support the lane merge manoeuvre, such as sensors, radars and CCAM service. These road infrastructure operators sell the data to other stakeholders. The infrastructure cost is supported by the profit of these sales. A second stakeholder, from a technological area or vehicle manufacturers, provides the lane merge manoeuvre as a paid service. This service can be paid by vehicle owners, private or companies that manage autonomous as a weekly, monthly or annual subscription or a paid service only applicable for a location (e.g. highway entrance). The service is available as an alternative to autonomous vehicle lane merge algorithms. The data can even be sold to Research centres related to universities or automotive industries. These data can be used to improve the lane merge algorithms and to develop alternative products. These final products can be sold to infrastructure operators, technology related companies, transport fleet management companies or to automotive manufacturers.

3.2. Business Models Analysis for US – Complex Maneuvers– Overtaking

Complex manoeuvres in cross-border settings, explores advanced driving maneuvers in the autonomous mode. This maneuver includes the lane merge, overtaking and HDMaps.

As a requirement, these maneuvers should be performed in a vehicle's and infrastructures' connected context, where vehicles' data are shared through an internal communication unit or radars, placed on the road infrastructure, and detects non connected vehicles. The data is shared through a 5G communication network.

The overtake maneuver is characterized by the integration of data from all road users, shared by other vehicles or infrastructure, and extending the autonomous vehicle perception about the actual situation, improving the safety of overtaking maneuver. Thus, the sensor's range of an autonomous vehicle will be increased by the data shared through the network, especially in occlusion scenarios.

3.2.1. Current Market Situation for US – Complex Maneuvers– Overtaking

The number of autonomous vehicles (level 5) available on the market is limited. However, the overtaking feature is already provided in vehicles with mid-levels of autonomy (level3). This feature will be provided by the automotive manufacturers. The overtaking is supported by the sensors data available on the vehicles. Actually, this feature is still in the development stage. However, some brands reported that are able to perform an overtake in urban scenarios, where the overtaken vehicles are stopped.

3.2.2. Stakeholders of US – Complex Maneuvers– Overtaking

The stakeholders involved on this US Business model are common to stakeholders involved in US – Complex Maneuvers– Lane Merge. Stakeholders and relation between them are listed and described in the section "Stakeholders of US – Complex Maneuvers– Lane Merge". Figure 9 presents the relation between stakeholders.

3.2.3. Value Proposition and Business Impact of US – Complex Maneuvers– Overtaking

This service will improve safety on overtake scenarios. The C-ITS will enable a CCAM platform, being possible to share messages related with vehicle positions. These messages will extend the vehicles sensor systems by adding information about other vehicles that are in the region but not detected by vehicle's sensors. Connected and autonomous vehicles will perform a overtake manoeuvre considering the information about other's vehicles position and actions. These information enables a more reliable and safety manoeuvre, avoiding a possible collision with vehicles that are at front or are coming in the overtake lane.

3.2.4. Customer Focus of US – Complex Maneuvers– Overtaking

Table 9: Customers of Overtaking

Service and/or Technology Provider	Customers
Road Infrastructure Operators	Automotive OEMs, R&D Organisations, Transport Operators
Automotive OEM	Road Infrastructure Operators , Drivers, Fleet Owners
Mobile Network Operators	Road Infrastructure Operators , Other MNOs, Drivers, Fleet Owners
5G Mobile Infrastructure Providers	Road Infrastructure Operators, C-ITS Centres, MNOs
R&D Organisations	Transport Operators, Road Infrastructure Operators, Automotive OEMs
C-ITS Centres	Road Infrastructure Operators, Transport Operators, Drivers, Fleet Owners

3.2.5. Financial Analysis of US – Complex Maneuvers– Overtaking

- **Service 1:** Overtaking Edge computing solution: The infrastructure provides a service that can handle the control of an autonomous vehicle to perform an overtaking manoeuvre. The system can be an SW installed in MECs. The associated costs are the C-ITS service, MEC and HW and SW upgrades and maintenance. The service can be managed by the infrastructure operators. The service is played as a mensal or annual subscription or included as an add-on to paid road clients.

- **Service 2:** Warning assistant: The infrastructure provides the warnings and recommendations that can be used as auxiliary/assistant to an overtaking algorithm. The system can be a SW installed on MECs. The associated costs are the C-ITS service, MEC and HW and SW upgrades and maintenance. The service can be managed by the infrastructure operators. The service can be played as a mensal or annual subscription or included as an add-on to paid road clients.

3.3. Business Models Analysis for US – Complex Maneuvers– HD maps

The third user scenario within Complex manoeuvres in cross-border settings that explores advanced driving manoeuvres in the autonomous mode, is HD Maps.

As a requirement, these manoeuvres should be performed in a vehicle's and infrastructures' connected context, where vehicles' data are shared through an internal communication unit or radars, placed on the road infrastructure, and detects non connected vehicles. The data is shared through a 5G communication network.

The HD Maps US is characterized by the capability of autonomous vehicle and roadside units, to detect changes in the road. Lasers, cameras and traffic radars information can be fused with D-GPS and HD Maps data, in order to determine changes in the stored information. This information can be measured in terms of length of the event, changes in road description (number of lanes, width of the lanes), dangerousness of the situation, etc.

Finally, obtained data is shared with the ITS-Centre in order to be stored and shared with other vehicles, ensuring the information reaches all the relevant vehicles.

3.3.1. Current Market Situation for US – Complex Maneuvers– HD maps

HD map data is used to identify the position of vehicles, road signs and other elements relevant to driving. This capacity has been in the market for more than ten years. Car manufacturers have been selling navigation systems that used roadmaps in DVD format. In the best case, there is a new release of the maps' library once a year. Navigation systems, usually based on a 2D vector database, could be supplemented with local traffic events information transmitted via RDS.

Actually, some technological companies provide the HD maps service. TomTom [28], HERE [29] and Carmera [30] are just a few examples. These companies come from the navigation, GPS providers and computer vision background.

Autonomous driving requires more information and much more updated, ideally in real time, otherwise vehicles should switch to manual driving under certain circumstances.

HD Map companies provide several layers of information: a base map, road signs, traffic information, etc. This information is regularly updated. This update do not include traffic events like traffic jams, road works, lane closings, accidents, hazardous events, etc. that require to be updated in the HD map to maintain its accuracy and to allow autonomous cars operation without reducing its functionality.

Traffic events information could be provided by road operators and/or road authorities or captured by the vehicles using the road. These updates can be large and be very demanding on bandwidth, coverage and availability, especially if they include geometry information. The quality of HD mapping data would increase with the number of sensing vehicles, but this increases the load on the radio network. The updates information should be available across multiple networks and seamlessly beyond national borders.

The HD map information is localized for the surroundings of the road users and made available to vehicles by regular downloads for non-urgent information or pushed to vehicles for major changes, highly urgent or emergency information for a road accident or similar. This localized character makes MEC infrastructure very useful to host HD map information relevant for the area, reducing the demand for large downloads and providing fast, reliable and efficient access to relevant local map data. Cloud providers could host map content less localized and not so frequently updated.

HD Maps change detection and update capability should be integrated in autonomous vehicles but there are some aspects that have to be further developed and standardized like the type of sensors used on vehicles (cameras, LiDAR, radar etc.), the type of data updated, etc. The main HD Maps providers are making great improvements optimizing the information sent back from the vehicles to the ITS centers, reducing the bandwidth requirement while sensors providers are making important price reductions thanks to mass production so we can expect big changes in the near future.

Summarizing, there is a significant number of companies that are providing the technological solution for HD maps. However, the map coverage and data available is still limited and has a standardization problem related with formats.

3.3.2. Stakeholders of US – Complex Maneuvers– HD maps

This section lists US stakeholders and relations among them. Transport and Road Authorities (TRA) and Road Infrastructure Operators (RIO) collect and provide traffic events information including, road conditions, adverse weather, road works, lane closings, traffic jams and accident information among others. They also receive traffic events information they use to update its data, so the flow or information is bidirectional. That information supplements the map data that automotive OEMs acquire from HD Map providers. That communication is done via ITS platforms (C-ITS centers). So, data flows from TRAs (D1) and RIO (D2) to C-ITS centers. Operators will require equipment from 5G Infrastructures Providers and the network service from MNOs providers.

5G Mobile Network Operators (MNOs) provide the connectivity services for all the infrastructure related stakeholders (transport and road authorities -R1-, road infrastructure operators -R2, C-ITS stakeholders -R3, MEC and cloud services providers -R4) and vehicles and their drivers (R5) including transmitting location-based map information. MNOs will use technologies like network slicing and MEC to provide seamless cross-border implementation. In this US, vehicles are connected to MEC (D3) that acts as a gateway to the ITS platform (D4). MEC will be a significant value-added used to keep and provide localized and changing traffic information updated to vehicles crossing national borders and between MNOs coverage regions. Similarly, there will be an opportunity to for Cloud service providers to host less localized map data and less changing map information.

5G Infrastructure providers develop, implement, delivery and maintain 5G communications equipment to MNOs (R6), MEC/Cloud providers (R7), road infrastructure operators (R8) and C-ITS stakeholders (R9).

Automotive OEMs provide an HD maps service to End users/Vehicle owners (R10) as part of an autonomous mobility solution. OEM provides and integrates the on-board equipment required and the connection to the infrastructure. The OEM contracts map information from HD Maps providers (R11) and supplements it with the dynamic information received from TRAs and RIOs (R12).

Cooperative Intelligent Transport Systems (C-ITS) manage this US. C-ITS communicates with:

- Transport and road authorities (D1) and road infrastructure operators (D2): They exchange traffic events information. This data flows are bidirectional, so TRAs and RIOs can either be clients or data suppliers to C-ITS centres.
- Vehicles/end users: C-ITS sends HD Map data and traffic events information and receives on-board sensor data. In this scenario, vehicles do not use V2V communications, so they do not share information directly and they neither access the C-ITS directly but through MEC that acts as a gateway. Vehicles exchange data with MEC (D3) and the MEC provider exchanges data with the C-ITS (D4).
- HD Maps provider: The C-ITS sends to the HD maps source the updated map data obtained after processing the vehicles sensor data and receives the updated HD map updates to distribute them to the other autonomous vehicles (D5).

The ITS platform has two roles:

- Monitoring the vehicles during the use case.
- Processing the data uploaded from the vehicle in order to generate a new map segment that will update the whole map source. Then, this map source will update the vehicles' maps.

End Users in this scenario are drivers and vehicle owners who use or contract the OEM's HD Maps service (R10).

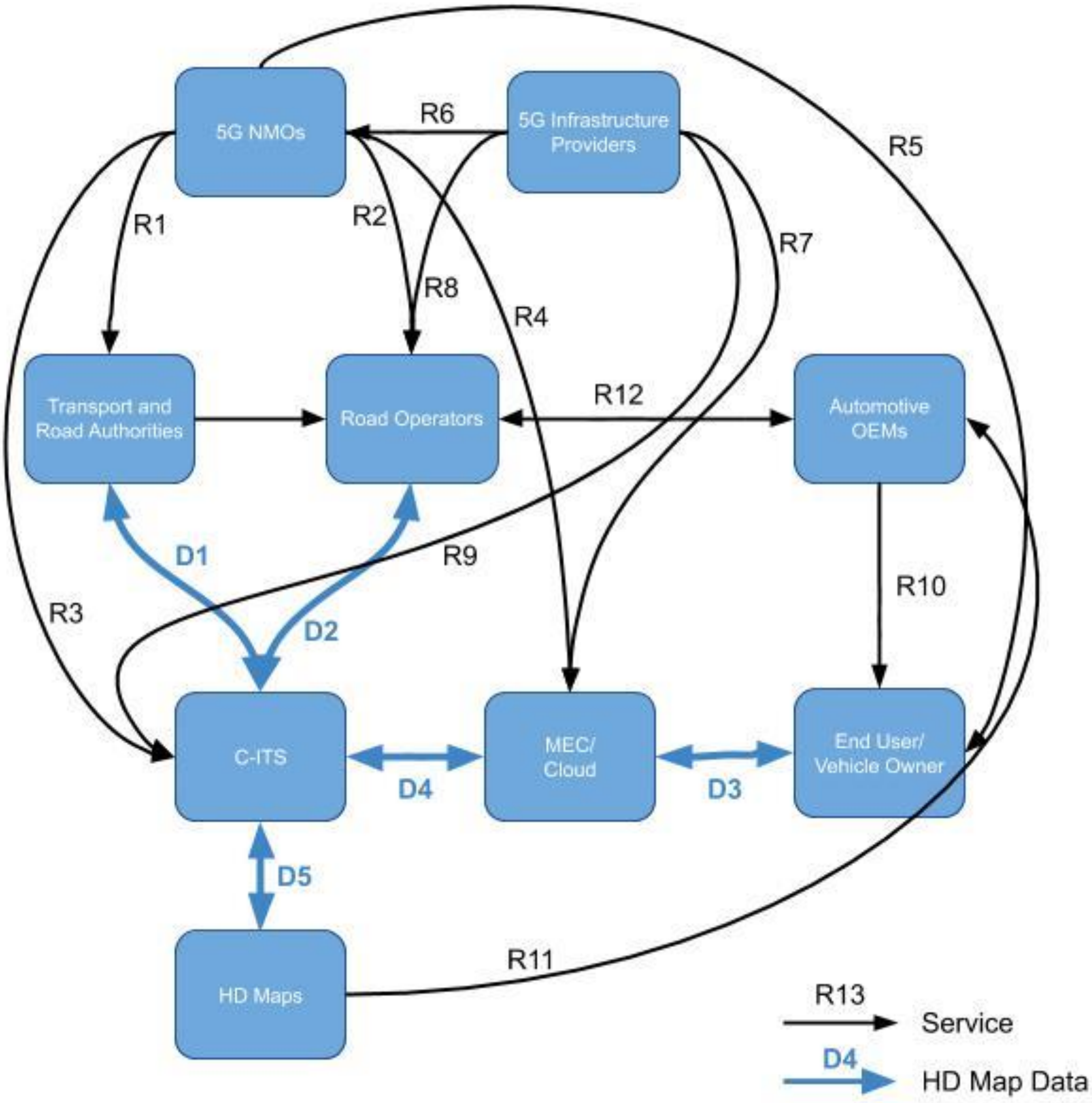


Figure 10: Schematic of Relations between HD maps Stakeholders

3.3.3. Value Proposition and Business Impact of US – Complex Maneuvers– HD maps

- **Reliability:** HD maps are a reliable source of information to use to expand vehicles sensors. Reliable information is critical in autonomous driving scenarios. Merging information from different sources of information (redundancy) will guarantee information reliability.

- **Information updated in real time:** HD maps enables information updated in real-time. The user will have access to the actual conditions of the road, traffic and events.

- **Resource management:** a real time update of information enables a prompt reaction to an event and improves resource management from the infrastructure operators and safety related organizations.

- **Standardization:** A generalization of HD maps usage leads to the development of standards to support HD maps information. Simultaneously, this is a requirement for HD maps implementation. However, the generalization of a tool or a technology highlights the necessity of developing standards to increase the possibility of interoperability between solutions developed by different stakeholders.

- **Safety:** Safety is the main benefit of the usage of HD maps. A HD map updated in real time with reliable information can decrease the risk of accidents and improve the safety.

3.3.4. Customer Focus for US – Complex Maneuvers– HD maps

Table 10: Customers of HD Maps

Service and/or Technology Provider	Customers
Road Infrastructure Operators	Automotive OEMs, R&D Organisations, Vehicle Owners, Drivers
5G Infrastructure Provider	Road Infrastructure Operators, MNOs, C-ITS Centres
Automotive OEM	Drivers, Transport Operators, Fleet Owners
Mobile Network Operators	Road Infrastructure Operators , R&D Organisations, Other MNOs
R&D Organisations	Road Infrastructure Operators, Transport Operators, Vehicle Owners, Drivers
C-ITS Centres	Road Infrastructure Operators, Vehicle Owners, Drivers

3.3.5. Financial Analysis of US – Complex Maneuvers– HD maps

- **Service 1:** Road Operators provide HD maps. The Operator manages the infrastructure, such as radars, roadside units and CCAM service, enabling an updated HD map service. These operators sell the HD maps service for their roads. This service is an add-on to the installed in the vehicle. The service is an extra to all clients of a paid infrastructure, or as a standalone service available in infrastructures that support this service. Clients are road users, vehicle owners, private or companies that manage connected or autonomous fleets. The service has a weekly, monthly or annual subscription. The profit is used to support the costs of the infrastructure.

- **Service 2:** Road Operators supply the data to be used to others third-party organizations that develop the HD maps solutions. The operator manages the infrastructure, such as radars, roadside units and CCAM service, enabling an updated HD map service. A third-party company, involved in the development of a HD Map service, buy the data provided by road operators. These technology organizations can provide HD Map service focus on a specific road, route, limited to a region, or national territory. Vehicle owners and users can use this service as add-on to the regular HD map installed in the vehicle. The clients are road users, vehicle owners, private or companies that manage connected or autonomous fleets. The service is provided against payment of a subscription, weekly, monthly or annual and focuses on geographic area. The infrastructure are supported by profit from the sale of data. The end users pay the development of HD maps service.

- **Service 3:** Vehicle owners provide information to update the HD Map. HD maps can be updated using vehicle data collected by sensors such as radars, LIDAR, cameras and inertial sensors. In this business model, the vehicle owner can select the amount of information provided to the road infrastructure or HD map service provider. The vehicle owner's payment are related with the amount of information that they share to the network. The payment is in function of the amount of data that is shared (e.g. per megabyte) or per type of data (e.g. LIDAR, cameras or other sensor). Services profits can amortize the investment in vehicles or sensors. The road infrastructures and HD maps providers can pay this data to have updated data in routes without roadside units or related infrastructures. Using this model, these stakeholders can guarantee an updated HD Map without fixed expenses related to infrastructure. This third service can be explored as an additional to others previous services.

3.4. Business Models Analysis for US – Public Transport – 4K video surveillance

The objective of this use case is to provide the public transport vehicle that connects the cities of Vigo and Porto with a 4K Camera in order to be able to remotely access the video stream for Control Centre management and monitoring tasks.

Added to this, in vehicle sensor data will be sent to the ITS Centre in order to update the HD maps of other vehicles around, helping to improve the execution of autonomous driving manoeuvres in terms of safety and comfort.

The 4K Front camera will be connected to the communication unit, opening the stream channel from the bus to the ALSA Control Centre and the ITS Centre. ALSA, as the public transport operator, will have the remote connection to the 4k camera stream in order to visualize the image of where the vehicle is passing by.

3.4.1. Current Market Situation for US – Public Transport – 4K video surveillance

Currently, some public transport companies already provide certain internet services in their fleets. However, these services are often limited for users, and have reduced capacities in terms of bandwidth and latency.

In the specific case of bus surveillance, it is common for buses to have surveillance systems. However, these systems are often revised ex-post, as it is not possible to transmit them in real time.

3.4.2. Stakeholders of US – Public Transport – 4K video surveillance

This section lists US stakeholders and relations among them. Transport and Road Authorities (TRA) regulate the solutions provided by CAM technology providers from automotive industry (R1), used by Passenger Transport Operators (R2), Road Infrastructure Operators (R3) and C-ITS (R4).

The main use of the monitoring solution studied in this scenario is internal for the Passenger Transport Operator, but Road Operators might be interested to have access to the monitoring video and that surveillance could be transferred to a C-ITS (R5).

5G Infrastructure providers develop, implement, delivery and maintain 5G communications equipment to road infrastructure operators (R6), MNOs (R7), MEC and C-ITS stakeholders (R8).

5G Mobile Network Operators (MNOs) provide the connectivity services for all the infrastructure related stakeholders (road infrastructure operators -R9-, C-ITS stakeholders -R10-, control center -R11-) and the buses (R12). In this scenario, any communication between the bus and the control center or the C-ITS is done through MEC.

The bus is monitored from the Transport operator Control Center (R15) but there could be other models where other stakeholders undertake that task and it is done in a C-ITS, providing that service to the transport operator (R13) or transferring some tasks or information from the Control Center to the C-ITS (R14).

Automotive Industry provides the on-board equipment: 4K camera and on-board communication units for the bus (R16).

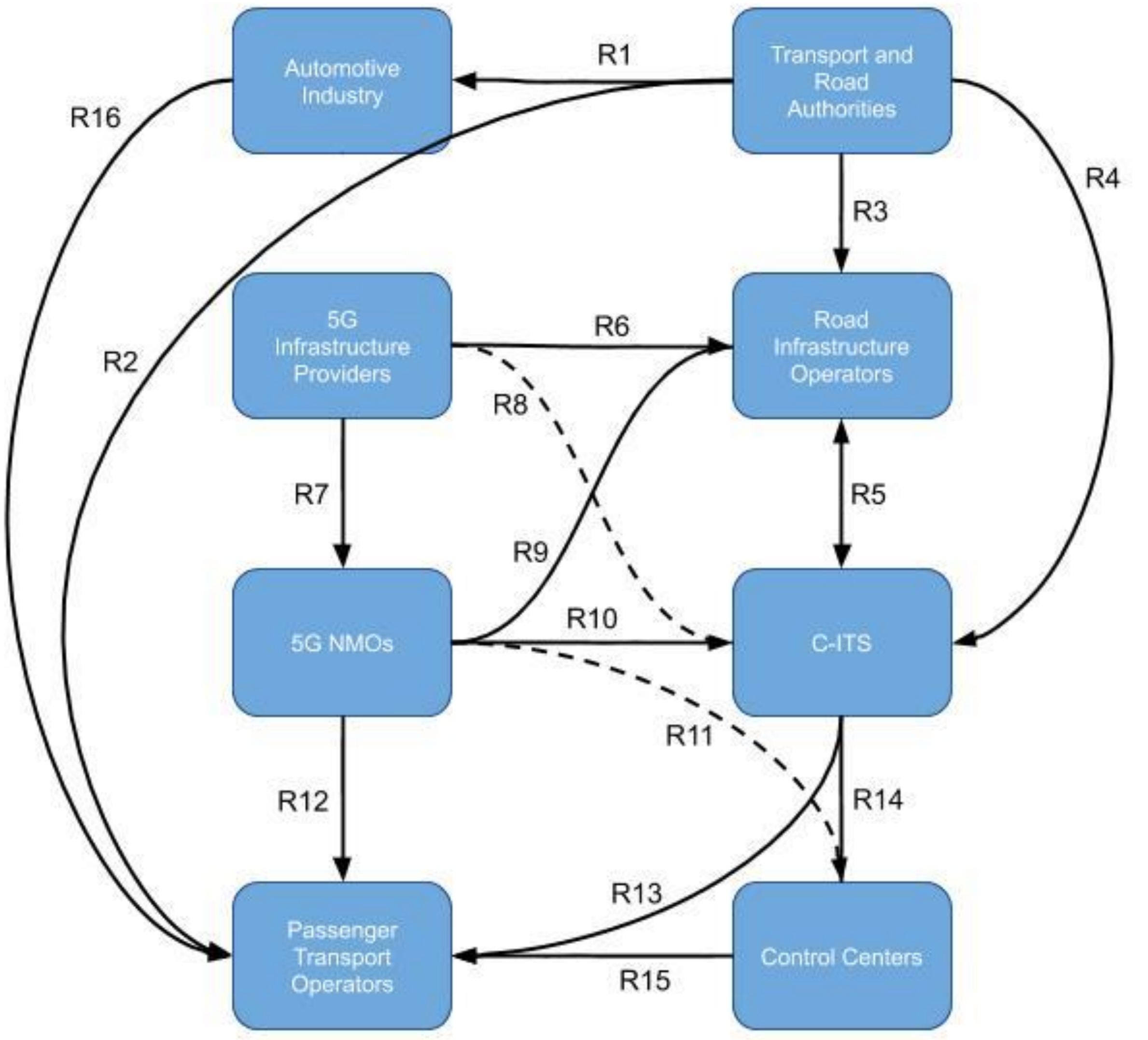


Figure 11: Schematic of Relations between 4K video surveillance Stakeholders

3.4.3. Value Proposition and Business Impact of US – Public Transport – 4K video surveillance

The case of use of 4K video surveillance aims to take advantage of the large capacities of 5G in terms of bandwidth and low latency, to improve the surveillance system of a fleet of buses, so that not only surveillance videos are recorded, but can also be consumed in real time from a location outside the bus itself, as a hypothetical security and comfort department of the bus company.

This use case aims to carry out a pilot test, which establishes the frames on which further improvements can be made, such as the detection in real time of risk situations, or the external action on some component of the vehicle (for example, speakers).

For road operators, additional monitoring capacity could be provided to enhance safety.

3.4.4. Customer Focus of US – Public Transport – 4K video surveillance

Table 11: Customers of 4K video surveillance

Service and/or Technology Provider	Customers
Transport Operators	Passengers
Road Infrastructure Operators	C-ITS Centres
Automotive OEM	Transport Operators
Mobile Network Operators	Road Infrastructure Operators , Transport Operators, C-ITS Centres
5G Mobile Infrastructure Providers	Road Infrastructure Operators, C-ITS Centres, MNOs
R&D Organisations	C-ITS Centres
C-ITS Centres	Road Infrastructure Operators, Transport Operators

3.4.5. Financial Analysis of US – Public Transport – 4K video surveillance

- **Service 1:** In a first approach, the monitoring service is internal for the passenger transport operator, so it is not a source of income, but the service involves acquisitions, connection fees, staff expenses and maintenance. The passenger transport operator (fleet owner) installs a 4Kcamera, a communications OBU and a 5G Wi-Fi router to link the camera and the OBU, paying the acquisition, installation and maintenance to the CAM technology provider. Data communication requires a 5G infrastructure along the bus route. The fleet owner deploys a control center connected to the bus through MEC. This involves setting up the control center, its applications, communications infrastructure and fees, and staff.
- **Service 2:** In case the road operator is interested in the monitoring activity or the information collected, there would be an opportunity for the fleet owner to get some revenue from the developed infrastructure.

3.5. Business Models Analysis for US – Public transport with HD media and video surveillance - HD maps (ALSA)

This user scenario could be considered a specific case of US – Complex Maneuvers– HD maps. In this scenario, mobile sensors are mounted on a public transport road bus (in this case a bus belonging to ALSA, the passengers transport operator partnering in 5G MOBIX). The bus is used as a sensors platform that provides HD maps updates to other users of the road. The bus is driven manually so it is not an autonomous vehicle that could be a target user of the captured data, but it has sensors and a communications unit like an autonomous vehicle.

As a requirement, these manoeuvres should be performed in a vehicle's and infrastructures' connected context, where vehicles' data are shared through an internal communication unit or radars, placed on the road infrastructure, and detects non connected vehicles. The data is shared through a 5G communication network.

The HD Maps (ALSA bus) US is characterized by the capability of the bus and road side units, to detect changes in the road. Lasers, cameras and traffic radars information can be fused with D-GPS and HD Maps data, in order to determine changes in the stored information. This information can be measured in terms of length of the event, changes in road description (number of lanes, width of the lanes), dangerousness of the situation, etc.

Finally, obtained data is shared with the ITS-Centre in order to be stored and shared with other vehicles, ensuring the information reaches all the relevant vehicles.

3.5.1. Current Market Situation for US – Public transport with HD media and video surveillance - HD maps (ALSA)

This US has some similarities with US Public Transport – 4K video surveillance where a bus from a passengers' transportation operator was used to capture and transmit 4K video but, in this case, the bus is used to capture HD map data updates.

Streaming data for surveillance there is some use cases already available on the market. First one is centred on the police and authorities [31]. These stakeholders use video cameras installed in their vehicles to stream images. These images are used to spot danger or critical situations. These images are only used for internal and security purposes.

Apart from this use of the bus platform the rest of the market analysis is the same as in US – Complex Maneuvers– HD maps. Please visit that subsection if further information is needed.

3.5.2. Stakeholders of US – Public transport with HD media and video surveillance - HD maps (ALSA)

The stakeholder analysis is the same (same stakeholders, same roles) as in US – Complex Maneuvers– HD maps except by the presence of a new element, the bus, and a new stakeholder, the fleet owner.

There are also three new relationships between the fleet owner and other stakeholders:

- The transport operator sells the map data updates service to the HD Maps provider (R12) or to the C-ITS center (R13).
- The transport operator requires connectivity services from the MNOs (R14).

The bus detects and captures changes in the HD map and sends it to the C-ITS center via MEC (D6). The bus detected changes are processed in the C-ITS and then the localized HD maps are updated just as changes detected by autonomous vehicles in the area or changes detected by the TRA and the RIO.

The differences between the stakeholder "End user/Vehicle driver" and the bus are:

- The bus is not using the HD Maps updated data as it is driven manually, not autonomously.
- The bus is not cooperating with other autonomous vehicles, but it is selling its capacity to capture map updates as a business.
- The connectivity fees charged by the MNOs in US – Complex Maneuvers– HD maps were usually paid by the OEM and included in the subscription fees paid by the end users but in the bus case the MSP pays those fees directly to the MNOs.

The end users are the same as in US – Complex Maneuvers– HD maps, Vehicle owners and drivers who pay for the HD maps update service.

Next figure shows the relationships between the stakeholders in this scenario. Please note that the figure is the same as in US – Complex Maneuvers– HD maps but adding the Passenger transport operator, its data flow with the MEC/Cloud provider (D6) and its relationship with the HD Maps provider (R12).

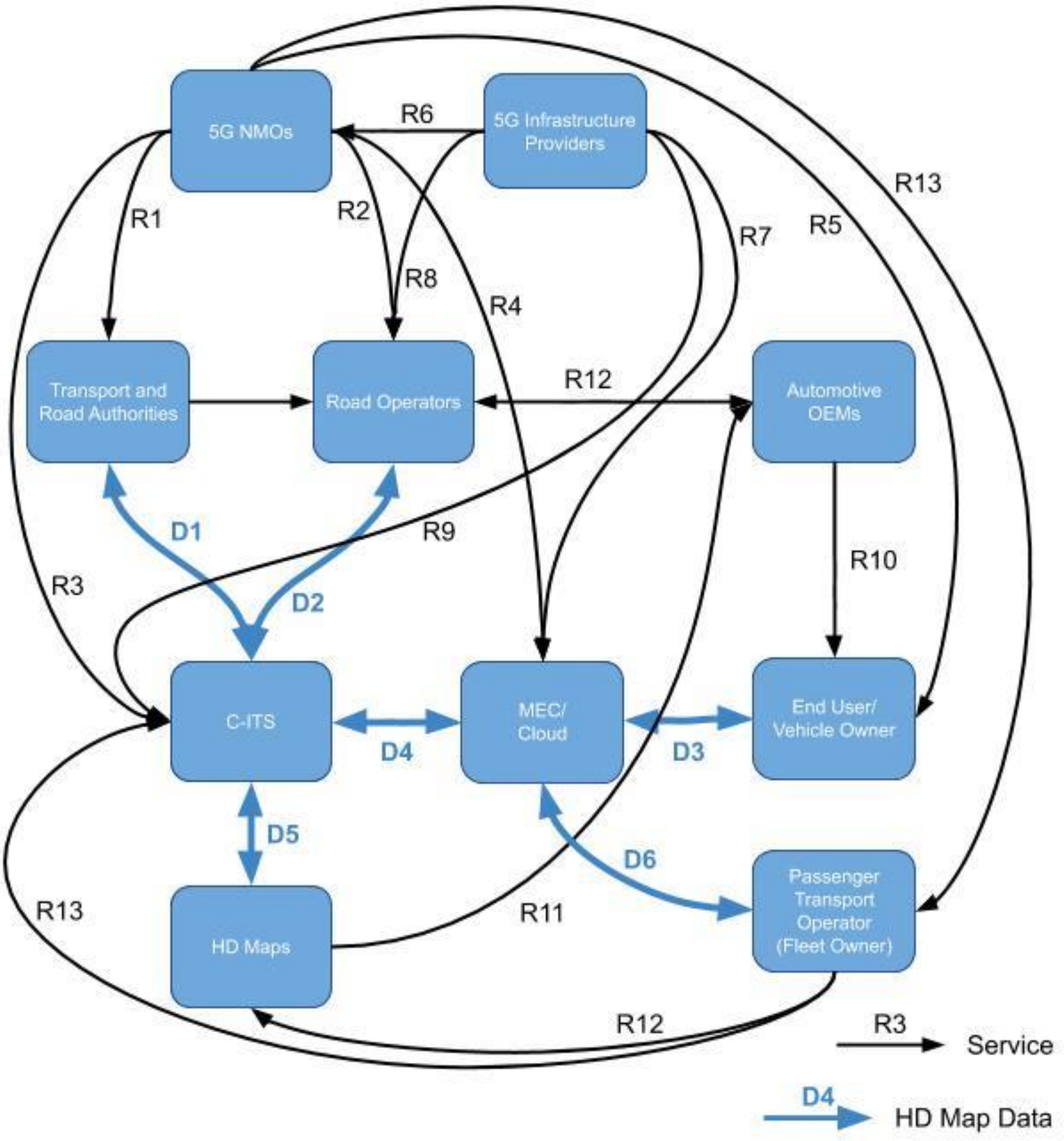


Figure 12: Schematic of Relations between HD maps (ALSA) Stakeholders

3.5.3. Value Proposition and Business Impact of US – Public transport with HD media and video surveillance - HD maps (ALSA)

Apart from the value proposition and business impact already described in US Complex Maneuvers– HD maps Complex Maneuvers– HD maps, it should be added a new offering for service providers.

- **Service provider:** Sensor data from the bus could be sold by the transport operator to HD mapping providers or C-ITS platforms with a subscription-based model. Considering that public road passenger transport usually uses regular routes, using the same roads, there could be some interest from road infrastructure operators to have a regular flow of map data updates.

3.5.4. Customer Focus for US – Public transport with HD media and video surveillance - HD maps (ALSA)

Table 12: Customers of HD maps (ALSA)

Service and/or Technology Provider	Customers
Transport Operators	Passengers
Road Infrastructure Operators	Automotive OEMs, R&D Organisations, Transport Operators
Automotive OEM	Transport Operators
Mobile Network Operators	Road Infrastructure Operators , Other MNOs, R&D Organisations
5G Mobile Infrastructure Providers	Road Infrastructure Operators, C-ITS Centres, MNOs
R&D Organisations	Transport Operators, Road Infrastructure Operators
C-ITS Centres	Road Infrastructure Operators, Transport Operators

3.5.5. Financial Analysis of US – Public transport with HD media and video surveillance - HD maps (ALSA)

The Passenger transport operator sells the bus sensor data to the HD Map data providers or C-ITS centers on a subscription basis.

This service coexists with the other services described in US Complex Maneuvers – HD maps Complex Maneuvers– HD maps, that describes the end users demand of HD maps change detection and update services like that offered by the transport operator.

3.6. Business Models Analysis for US – Public Transport – HD media services for passengers

The objective of this user story is to provide real time connected services to the public transport fleet that connects the cities of Vigo and Porto. According to this approach, users will be able to enjoy different multimedia services while travelling in the public transport, including high bandwidth data consumption applications as well.

The user story can include a multimedia device which will be used as user interface, allowing users to make use of the multimedia application installed on this device.

Another option is to allow users to connect their own devices through a Wi-Fi connection which will be connected to the high capabilities mobile network.

3.6.1. Current Market Situation for US – Public Transport – HD media services for passengers

Currently, some public transport companies already provide certain internet services in their fleets. However, these services are often limited for users, and have reduced capacities in terms of bandwidth and latency.

Specifically speaking of multimedia services, at present most companies opt to consume content hosted locally on the bus itself. While those public transports that give free access to Internet, usually limit the bandwidth that the user can consume.

3.6.2. Stakeholders of US – Public Transport – HD media services for passengers

Transport and Road Authorities and Road Infrastructure Operators may seem not so important in this scenario but if MNOs do not deploy the required radio access network, maybe private road operators should share the investment. In any case, the huge potential offering entertainment services not only to passengers of public transport but in the future to drivers and passengers of autonomous level 4 and 5 cars, and considering that many entertainment platforms are linked to MNOs and those streaming services are one of their main products, it does not look that RAN deployment should be an issue.

5G Infrastructure providers deploy 5G communications equipment for MNOs (R1), MEC providers (R2) and road infrastructure operators (if needed) (R3).

5G Mobile Network Operators (MNOs) provide the connectivity services to MEC providers (R4) and to public transport vehicles (R5). MNOs would service passengers in case they cannot or do not want to access the bus Wi-Fi and want to use their own devices 5G connectivity (R6). MEC acts as a gateway giving access to multimedia services from content providers (R7) to the bus operator (R8).

Multimedia and gaming content providers like Movistar+, provide contents that the transport operator (R9) makes accessible to its passengers. In case passengers were accessing freemium or pay per view content, then content provider would be servicing directly the passengers (R10).

Automotive Industry 5G CAM technology providers supply communication equipment for the bus (R11): A 5G communication unit and a 5G Wi-Fi router.

End Users in this scenario are the passengers of the bus who would benefit from the access to entertainment services via Wi-Fi without consuming 5G data (R12). The initial approach included studying the option of letting passengers connect their own devices to the bus Wi-Fi.

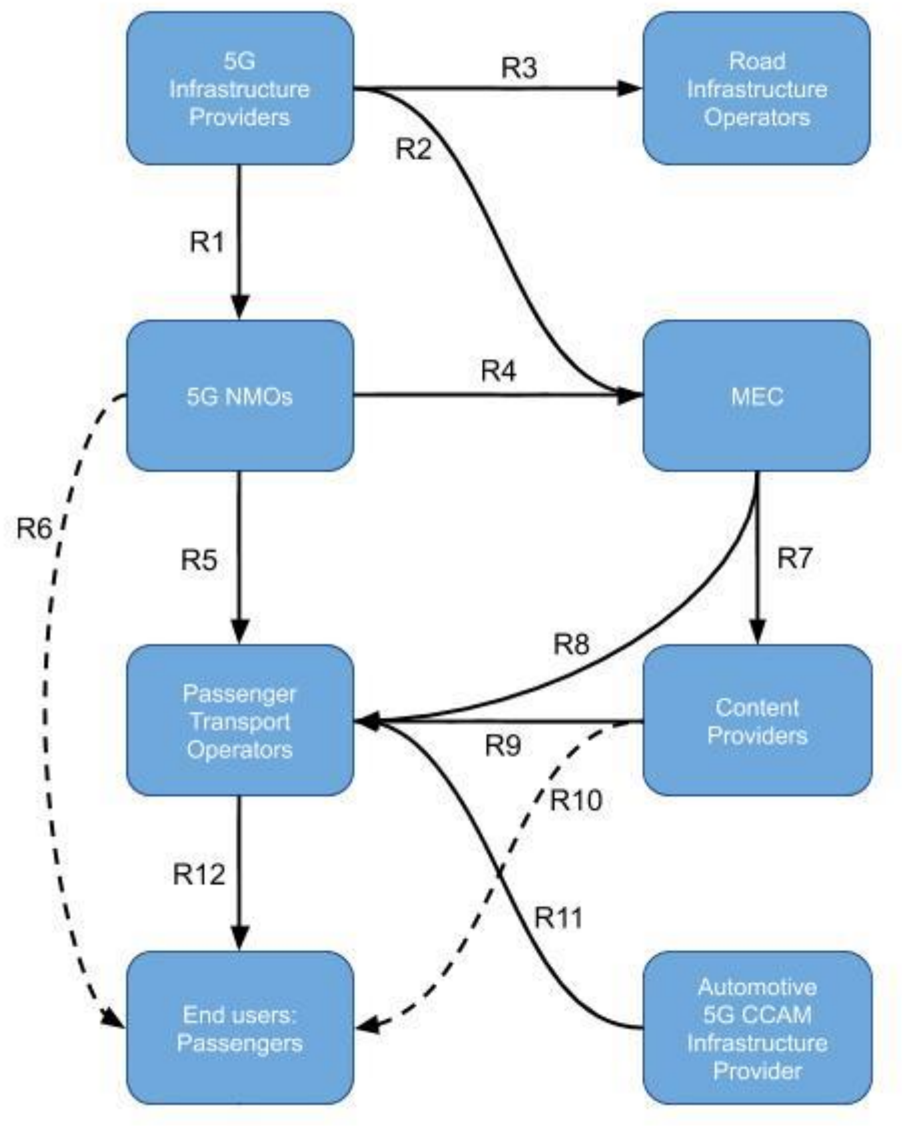


Figure 13: Schematic of Relations between HD media services for passengers Stakeholders

3.6.3. Value Proposition and Business Impact of US – Public Transport – HD media services for passengers

It is expected that passengers of connected cars, either in private or public transport will be able to access their entertainment services seamlessly on the road. This includes films and series from streaming services, that require big bandwidth, and online games from gaming platforms, that require low latency. Users will also expect fast and efficient access to their own contents or those related with their work.

This scenario studies the access to multimedia services from the bus, equipped with multimedia devices like tablets connected to HD multimedia services (like Movistar+) and the access to the passengers' own contents or services with their own devices connected via WIFI.

Entertainment companies see a huge potential for these services not only in public transport but also in level 4 and 5 autonomous vehicles where the driver will expect those services while his intervention is not required.

3.6.4. Customer Focus of US – Public Transport – HD media services for passengers

Table 13: Customers of HD media services for passengers

Service and/or Technology Provider	Customers
Transport Operators	Passengers
Road Infrastructure Operators	C-ITS Centers
Automotive OEM	Transport Operators
Mobile Network Operators	Road Infrastructure Operators , C-ITS Centres, Transport Operators
5G Mobile Infrastructure Providers	Road Infrastructure Operators, C-ITS Centres, MNOs
R&D Organisations	C-ITS Centres
C-ITS Centres	Road Infrastructure Operators, Transport Operators
Multimedia Content Providers	Transport Operators

3.6.5. Financial Analysis of US – Public Transport – HD media services for passengers

The passenger transport operator (fleet owner) installs a 5G communications unit and a 5G wife router to give access to the, paying the acquisition, installation and maintenance to the 5G equipment provider.

Data communication requires a 5G infrastructure along the bus route including MEC, but we can expect that MNOs deploy it expecting return on investment from the access to content services.

The passenger transport operator contracts the multimedia services (films and series streaming, TV live channels, gaming, etc.) with a license for public exhibition and includes a connection fee in the price of bus tickets. There could be options as offering passengers a package closed without options or including most of the content free and some content like film premieres and sports in a pay per view model or in a freemium model.

Transport operators should decide which extent of access would allow to passengers using their own devices, maybe a limited speed connection.

3.7. Business Models Analysis for US – Remote Driving Across borders – Remote Control

In this scenario the EV autonomous vehicle is driving following a predefined route, and suddenly an obstacle appears in its path blocking the original route. In this situation, an operator is alarmed, and he/she is able to remotely take the control of the EV autonomous vehicle or issue a set of new navigation commands in order to handle a new route. The operator is in a control centre, monitoring one or several autonomous vehicles.

3.7.1. Current Market Situation for US – Remote Driving Across borders – Remote Control

The interaction between Cross-border cities has a relevance from the point of socio-economic development of regions. Cross-Border Municipalities developed mobility solutions to improve the mobility between international cross-border s regions.

In the case of SP-PT cross-border municipalities, Valença and Tui, have a touristic bus that crosses the historic centre of these two cities. The service is operated by a driver. The train circulates between the two cities with a defined frequency. The service has a touristic purpose.

In the European context, Tourism is the main reason for people to visit two cities from neighbouring countries. However, shopping for goods or services or work are other reasons to cross a border.

3.7.2. Stakeholders of US – Remote Driving Across borders – Remote Control

This section list US stakeholders and their relations (Figure 14).

- **5G Infrastructures Providers:** These actors include all elements related with the development, implementation and deliverable of 5G communication equipment. This may include Original equipment Manufacturers and Tier 1 suppliers, vendors and other suppliers of technical solutions or products, involved in the deliverability of a 5G communication related infrastructure. This group of stakeholders will develop and provide the equipment needed to assemble the network infrastructures. Nokia-PT and

Nokia-SP will be vendors of the equipment to MNOs (R6), Road operators (R5) and C-ITS stakeholders (R7).

- **5G Mobile Network Operators (MNOs):** These actors play an important role in the maintenance of the telecommunication infrastructure. This stakeholders group includes Telecommunication Operators and Service operators, Telecom vendors, Cloud providers and other Technology providers such as edge devices providers, software developers, etc. NOS and Telefonica will provide the communication service to Road infrastructures Operators (R8), C-ITS stakeholders (R9 and Transport Operators (R11) and Control Centres (R10).
- **Automotive Industry:** These actors provide a technological platform, such as vehicles and related components, or services to support autonomous driving or connected vehicles. This category of stakeholder includes car OEMs (car manufacturers), component manufacturers, Tier 1 suppliers, CAM service providers, HD map providers and other automotive-specific technology providers. Automotive actors will provide autonomous mobility solutions to Transportation Operators (R14).
- **Cooperative Intelligent Transport Systems (C-ITS):** Cooperative Intelligent Transport Systems (C-ITS): These stakeholders manage the infrastructures and provide the information received and sent by connected vehicles that are on the road. This category includes local or national entities. These stakeholders, that could relate entities that manage the traffic and infrastructure, such as Infrastruturas de Portugal (IP) Direção Geral de Tráfego (DGT), or technologic companies that develop technological solutions, such as A-to-Be, Instituto de Telecomunicações (IT), CTAG or CCG. These actors will manage the traffic, having relation with Infrastructure Operators (R4). This is a bidirectional relation: Road Operators can be clients or data suppliers to a C-ITS centres. These infrastructures can even be managed by the Road Operators. R&D Organizations will develop, update and maintenance the C-ITS centres and use the data for Research (R13). The communication will be by the MNOs (R9). The transport Operators (R12) and Control Centres (R19) will be the final clients.
- **Road Infrastructures Operators:** Correspond to entities that are in charge of deployment, operation and maintenance of physical road infrastructure. This includes the agents that are involved in managing road traffic operations, own or operate the toll system, etc. This includes public entities, governmental institutes and departments, and private companies that manage private or public road infrastructures and third-party maintenance companies. These entities, already identified in previous US, require equipment from 5G infrastructure providers (R5), use the network operated by 5G NMOs (R8) and manage or the C-ITS (R4), or contract the service from other stakeholders.
- **Transport and Tour Operators:** This section joins the final transport operators and suppliers of mobility solutions to the end user and Tourism Operators. Actors such as local transport companies that manage vehicle's fleets or local tour operators. Transport Operators, such as Alsa, public transports, or renting companies, will required network service from 5G NMOs (R11) to access the service provided by C-ITS (R12). Automotive Manufactures will provide the vehicles operated by these companies (R13). Municipality institutions will regulate or act as clients of this transportation service (R16). In some cases, the municipality institutions can be the transport operator. The remote and control centres will provide

the service of monitoring and remote controls to transport Operators (R17). In some cases, remote centres will be managed by the transport operators.

- **Transport and Road Authorities:** This section includes Local, National and European authorities and regulators that are directly involved in the regulation of traffic and organizations responsible to define and execute legal framework and policies, such as road and transport authorities or telecom regulators. These stakeholders include regulators and policy makers, actors that provide the highest authorities and regulate the relationships within the whole ecosystem. They have the responsibility to manage the access and the use of the technological solution. These stakeholders, already identify in previous US, will regulate the solutions provide by Automotive Industry (R1), actions of Road Operators (R2) and C-ITS (R3).
- **Municipality Institutions:** This section includes municipality institutions, such as city hall and related companies from the cross-border regions. These institutions are engaged in developing mobility solutions and cross-border cooperation action. These actors can assume a role of facilitators, providers and clients of a remote shuttle service. These stakeholders, that in or special use case can be Valença Municipality and Tui Municipality, will regulate and contract the service to Transport Operators (R16). In some cases, these stakeholders will have the role of transport operators.
- **Control Centres:** These stakeholders have the function of monitoring the vehicle and control it when necessary. These actors, from a technologic background, will provide the service to transport operators (R17). In some cases, transport operators have their own Control centres. R&D Organizations will develop these Remote centres (R18). The Control centres will require data from C-ITS (R19) using the 5G service provide by 5G MNOs (R10).
- **Researches and Developers Companies:** This group of stakeholders include researchers, Research Centres, Universities, Developer centres and other R&D stakeholders related to the automotive industry. These entities can develop the sensors and to be implemented on Road Side Unities (RSU) and radars and other technological solutions. Researches and Developers, such as Instituto de Telecomunicações (IT), Centro de Computação Gráfica (CCG), Centro Tecnolóxico de Automoción de Galicia (CTAG), Instituto Superior de Engenharia de Lisboa (ISEL) and A-To-Be will provide the technological solutions to develop the C-ITS and deployment of the service (R13). These actors will develop the control centres (R18).
- **End User:** End users could be tourists or users of a mobility service between two cross-borders cities. This group of stakeholders would benefit from the provided service, using it daily or punctually. They represent a key role in the technology acceptance, as passengers and users of the service. They will benefit the service provided by transport operators (R15).

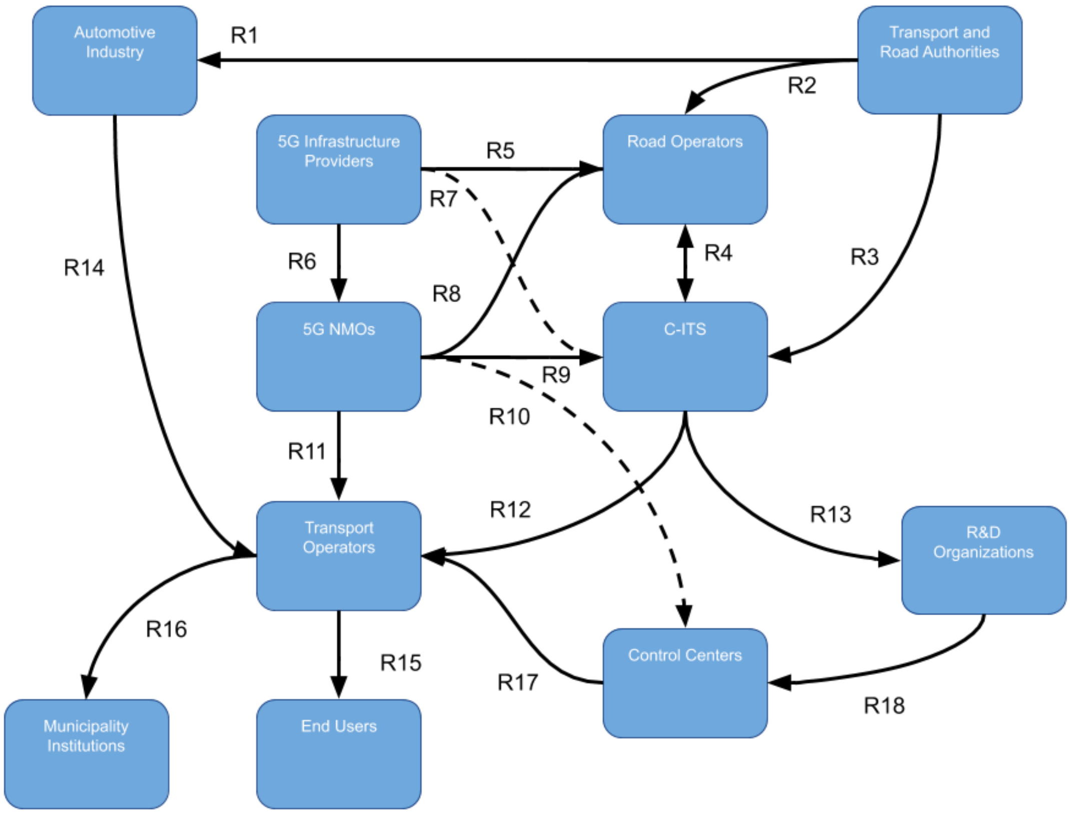


Figure 14: Schematic of relations between Remote Control stakeholders

3.7.3. Value Proposition and Business Impact of US – Remote Driving Across borders – Remote Control

The Costs reduction will be the main impact of this service. A single operator can monitor and control multiple vehicles; Increase the possibility to develop an autonomous fleet in different spots, inside the same cross-border region or in multiple regions.

3.7.4. Customer Focus of US – Remote Driving Across borders – Remote Control

Table 14: Customers of Remote Control

Service and/or Technology Provider	Customers
Transport Operators	Municipalities, Passengers, Tourists
Municipality Institutions	Public Transport Passengers
Automotive OEM	Transport Operators
Mobile Network Operators	Roadside Infrastructure Operator , C-ITS Centres, Transport Operators, Control Centres
Roadside Infrastructure Operators	C-ITS Centres, Municipality Institutions
5G Mobile Infrastructure Provider	Roadside Infrastructure Operators, MNOs, C-ITS Centres
C-ITS Centres	Roadside Infrastructure Operators, Transport Operators, R&D Organisations
Control Centres	Transport Operators
R&D Organisations	Control Centres

3.7.5. Financial Analysis of US – Remote Driving Across borders – Remote Control

- **Service 1:** Transport Operator has autonomous vehicles fleet with remote control option. Transport Operators that manage an autonomous vehicles fleet with the option of having a remote-control option available. The clients will be other transport operators, tours operators or municipality institutions. The service has potential to extend for urban or highway context. The associated costs are the autonomous vehicle, the control room and the communication infrastructure. The service can be paid by an optional subscription to regular autonomous vehicle rent.

- **Service 2:** Autonomous fleet Operator provide the service to Transport Operators. An Operator provides the service to Transport Operators that have autonomous vehicles. The associated costs are the control room and the communication infrastructure. The service can be paid by a mensal subscription. Transport operators, tour Operators or other actors that manage a transport fleet are the main clients. The service has potential to be extended to urban or highway contexts.

3.8. Business Models Analysis for US – Remote Driving Across borders – Coop. Automated Operation

Last mile EV Automated shuttle vehicles will play an important role in the near future of European cities. The cooperation of these vehicles with VRUs (Vulnerable Road User) in order to increase comfortability and safety of these users, as well as the fact of having an alternative solution when the path of these vehicles becomes blocked, suppose a valuable advance in connected cities. 5G technology will enable these developments even in cross-border areas or close to country boundaries.

The capability of sharing information related with position and motion, from the all road users is the key feature of this context. A communication unity, connected to a 5G Network, enables an autonomous shuttle to transmit his position and movement related data as receive information related with pedestrians and vehicles on the surroundings. VRUs connected to the 5G network, also called connected VRUs, use smartphones, wearables or communication units, to share their position and information related to their motion. Pedestrian Radars, installed as Road Side Units, detect non-connected VRUs. The flow of information enables a safer interaction between autonomous vehicles and VRUs in an urban scenario and cross-border scenario.

3.8.1. Current Market Situation for US – Remote Driving Across borders – Coop. Automated Operation

The interaction between Cross-border cities has a relevance from the point of socio-economic development of regions. Cross-Border Municipalities developed mobility solutions to improve the mobility between international cross-border s regions.

In the case of SP-PT cross-border municipals, Valença (Portugal) and Tui (Spanish), have a touristic bus that crosses the historic centre of these two cities. A driver operates the service. The train circulates between the two cities with a defined frequency. The service has a touristic purpose.

These two cities are part of pilgrim route of Caminhos de Santiago. A high number of pilgrims, beyond the local pedestrians, crosses this route daily. The interactions between vehicles and pedestrians are considerable. Apart from conventional traffic signs, there is no other form of signage.

3.8.2. Stakeholders of US – Remote Driving Across borders – Coop. Automated Operation

This section list US stakeholders and their relations (Figure 115).

- **5G Infrastructures Providers:** These actors include all elements related with the development, implementation and deliverable of 5G-communication equipment. This may include Original equipment Manufacturers and Tier 1 suppliers, vendors and other suppliers of technical solutions or products, involved in the deliverability of a 5G communication related infrastructure. This group of stakeholders will develop and provide the equipment needed to assemble the network infrastructures. Nokia-PT and Nokia-SP will be vendors of the equipment to MNOs (R6), Road operators (R5) and C-ITS stakeholders (R7).

- **5G Mobile Network Operators (MNOs):** These actors play an important role in the maintenance of the telecommunication infrastructure. This stakeholders group includes Telecommunication Operators and Service operators, Telecom vendors, Cloud providers and other Technology providers such as edge devices providers, software developers, etc. NOS and Telefonica will provide the communication service to Road infrastructures Operators (R8), C-ITS stakeholders (R9) Transport Operators (R11) and Vulnerable Road User (VRU) (R10).

- **Automotive Industry:** These actors provide a technological platform, such as vehicles and related components, or services to support autonomous driving or connected vehicles. This category of stakeholder includes car OEMs (car manufacturers), component manufacturers, Tier 1 suppliers, CAM service providers, HD map providers and other automotive-specific technology providers. Automotive actors will provide autonomous mobility solutions to Transportation Operators (R19).

- **Cooperative Intelligent Transport Systems (C-ITS):** These stakeholders manage the infrastructures and provide the information received and sent by connected vehicles that are on the road. This category includes local or national entities. These stakeholders, that could relate entities that manage the traffic and infrastructure, such as Infrastruturas de Portugal (IP) Direção Geral de Tráfego (DGT), or technologic companies that develop technological solutions, such as A-to-Be, Instituto de Telecomunicações (IT), CTAG or CCG. These actors will manage the traffic, having relation with Infrastructure Operators (R4). This is a bidirectional relation: Road Operators can be clients or data suppliers to a C-ITS centres. These infrastructures can even be managed by Road Operators. The communication will be by the MNOs (R9). They will share data with transport Operators (R12) and R&D Organizations. The transport Operators and Vulnerable Road Users will be the final clients (R14).

- **Road Infrastructures Operators:** Correspond to entities that are in charge of deployment, operation and maintenance of physical road infrastructure. This includes the agents that are involved in managing road traffic operations, own or operate the toll system, etc. This includes public entities, governmental institutes and departments that manage public road infrastructures and third-party maintenance companies. In public infrastructures, such as public roads, infrastructures operators can manage the equipment and provide access to the data that are available on the roadside units or ITS Centres. Road Infrastructure Operators, such as Infrastructures de Portugal (IP) and Direção Geral de Tráfego (DGT) will require equipment from 5G Infrastructures Providers (R5) and the network service from MNOs providers (R8). They will even provide the requirements to C-ITS (R4), as a bidirectional relation.

- **Transport and Tour Operators:** This section joins the final transport operators and suppliers of mobility solutions to the end user and Tourism Operators. Actors such as local transport companies that manage vehicle's fleets or local tour operators. These stakeholders will buy technological capable vehicles form Automotive Industry (R19) and operate the transportation fleet. Their vehicles will process data provided by the C-ITS (R12) using the 5G service provided by the 5G MNOs (R11).

- **Transport and Road Authorities:** This section includes Local, National and European authorities and regulators that are directly involved in the regulation of traffic and organizations responsible to define and execute legal framework and policies, such as road and transport authorities or telecom regulators. These stakeholders include regulators and policy makers, actors that provide the highest authorities and regulate the relationships within the whole ecosystem. They have the responsibility to manage the access and the use of the technological solution. These entities are represented by European Union and National and local Institutions such as Autoridade Nacional de Segurança Rodoviária (ANSR) or Diretor Geral da Dirección General de Tráfico. These institutions will provide the legal framework to regulate the service, from the infrastructure point of view (R1), C-ITS (R3) and autonomous vehicles through automotive industry (R2).

- **Municipality Institutions:** This section includes municipality institutions, such as city hall and related companies from the cross-border regions. These institutions are engaged in developing mobility solutions and cross-border cooperation action. These actors can assume a role of facilitators, providers and clients of a remote shuttle service and in the design of technological solution for Vulnerable Road User. These actors can be Municipality entities, such as Valença and Tui Municipality. They will require the infrastructure provided by the Road Operators (R16). They will require and guide the implementation of the theological solution, contracting the R&D Organizations (R17). In some cases, the Municipalities entities will share the role of Road Operators.

- **Researches and Developers Companies:** This group of stakeholders include researchers, Research Centres, Universities, Developer centres and other R&D stakeholders related to the automotive industry. These entities can develop the sensors and to be implemented on Road Side Unities (RSU) and radars. Researches and Developers, such as Instituto de Telecomunicações (IT), Centro de Computação Gráfica (CCG), Centro Tecnolóxico de Automoción de Galicia (CTAG), Instituto Superior de Engenharia de Lisboa (ISEL) and A-To-Be will provide the technological solutions to develop the C-ITS and deployment of the service (R13). These actors will provide the technological solution to connect a Road User to the CCAM service (R18). Municipality Institutions will regulate and contract R&D Organizations (R17) to develop the technological solution to Venerable Road User (R18).

- **Vulnerable Road Users:** This section of stakeholder includes all the pedestrians and all users of soft mobility solutions (e.g. bicycle, scooters, wheelchair) that interact with autonomous vehicles in urban and cross-border contexts. These actors will contribute to the acceptance of this technological solution. These actors will use the technological solution provided by R&D Organizations (R18) that make them a connected road user. When connected, will share data with the C-ITS (R14). The interface with the C-ITS will be supported by the 5GMNOs (R10).

- **End User:** End users could be tourists or users of a mobility service between two cross-borders cities. This group of stakeholders would benefit from the provided service, using it daily or punctually. They represent a key role in the technology acceptance, as passengers and users of the service. They will be the client of the Transport Operators (R15).

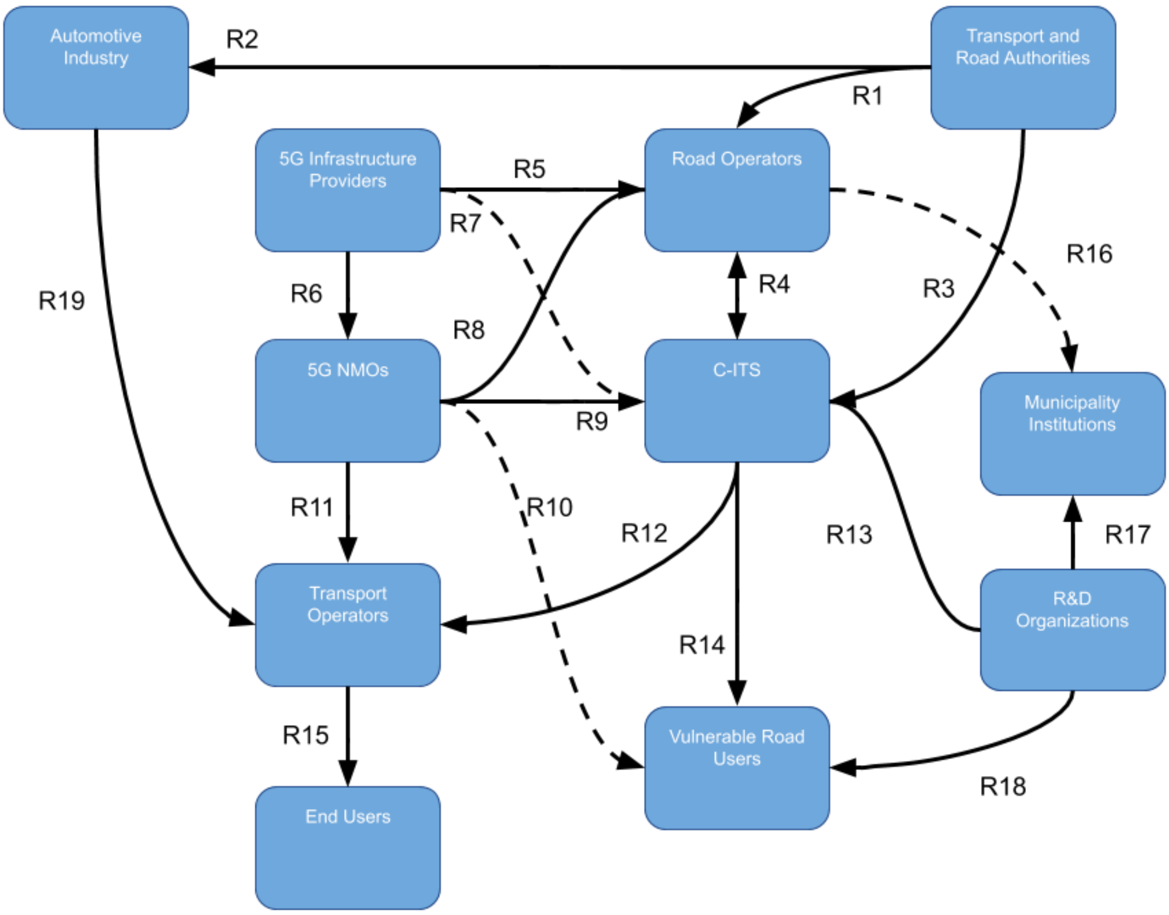


Figure 15 Schematic of relations between Coop. Automated Operation stakeholders

3.8.3. Value Proposition and Business Impact of US – Remote Driving Across borders – Coop. Automated Operation

- **Safety:** This technological solution leads to safer interaction between autonomous vehicles and VRUs in urban scenarios. Connected VRU or VRU detected by sensors extend the autonomous vehicle sensor range having impact on the safety of interaction between vehicles and other road users. A two-way communication channel, based on CCAM communication system, by the implementation of warnings for VRU users, enables the development of more inclusive urban areas.

- **Differentiation factor:** Automated vehicles can attract more tourists and other people such as technological enthusiasts. This technological solution for city centres or for a cross-border context has a

Wow factor that can be used by Municipality authorities as a trigger for the development of tourism, or even as a differentiating element in small cross-border s areas.

- **Environmental impact:** An autonomous vehicle has referred to as having better energy conservation performance and pollution reductions, when compared with manual operated vehicles. The CCAM system can empower the environment impact by anticipating the velocity adjustments or decreasing the breaking behaviour.

- **Costs:** The autonomous vehicles reduced paid driver costs and potentiate an exhaustive operation only limited by the vehicle energy.

3.8.4. Customer Focus of US – Remote Driving Across borders – Coop. Automated Operation

Table 15: Customers of Coop. Automated Operation

Service and/or Technology Provider	Customers
Transport Operators	Passengers, Tourists
Automotive OEM	Transport Operators
Mobile Network Operators	Roadside Infrastructure Operator , C-ITS Centres, Transport Operators, Control Centres
Roadside Infrastructure Operators	C-ITS Centres, Municipality Institutions
5G Mobile Infrastructure Providers	Roadside Infrastructure Operators, MNOs, C-ITS Centres
C-ITS Centres	Roadside Infrastructure Operators, Transport Operators, R&D Organisations
R&D Organisations	Municipality Institutions, Vulnerable Road User

3.8.5. Financial Analysis of US – Remote Driving Across borders – Coop. Automated Operation

- **Service 1:** Autonomous shuttle that is used as public transportation between two cross-borders cities. Implementation of an infrastructure to enable connected VRU or Road side units that can detect them. The system can be developed by road infrastructure operators, network operators or even municipal institutions. Passengers and tourists will be the users of this kind of transportation. The costs can be supported by multiple sources. The service can be paid by ticket sold by the operator. Passengers paid for a ticket, one trip only or a set of it. There is the possibility to integrate the transportation systems with cultural events, where the ticket is part of a cultural ticket or initiatives. For a free service, the costs can be feed by cross-boards municipalities, or from regional or European founding programs related with mobility, cross-border s Corporation or culture.

- **Service 2:** Development of a Warning system based on CCAM communication. An application that is running on the MEC is prepared to anticipate critical events such as a collision or a run over event. These events will trigger a warning that will be received by the shuttle and VRUs involved in the event. The warning service can consider the mobility condition (e.g. without limitations, senior mobility constraints), activity (e.g. walking, running) or disability (e.g. blind, deaf) of the VRU. The warning system can be improved by a historical of critical events, shuttle and VRU profile. This system can be developed by technological companies, telecommunication or infrastructure operators, national or municipal institutions and other actors related with mobility. The VRUs transport operators and other mobility related actors are the potential clients. The service can be paid by transport operators as an additional measure for an autonomous fleet; by municipality institutions as part of an inclusive mobility solution for the cross-border region; or by VRUs as a subscription of the warning service.

3.9. Business Models Analysis for US – Assisted Zero-Touch Border-Crossing

This user story is specifically designed for the borders that exhibit a « hard-border » nature in the sense that there exists actual physical borders between two territories that are governed by different administrations and authorities, which must approve leaving the occupied zone to pass to the other. Depending on the rules of the *from* and *to* territories, certain checks are performed to basically identify the vehicle, the driver and the possible passengers as well as the cargos that are being carried in the vehicle that will do the crossing of the border before any clearance can be granted to the vehicle, which should be considered as a group from the point of view of authorities.

The aim of this user story is to explore mechanisms that will expedite passing from one side of the border to the other by designing a scenario, where the 5G-capable equipment on the vehicle, at the border zone and the customs personnel will feed certain information to the cloud applications that also use data from the authorities to make automatic crossing decisions. The vehicle-based information serves to identify the group, whereas the border zone 5G-enablement is included for enforcing the vehicle to stop in case of a detected possible threat or an additional control deemed necessary by the cloud application. The custom personnel are the vulnerable road users of this user story, who will be protected by sending a *stop* signal to the vehicle if a collision a detected.

3.9.1. Current Market Situation for US – Assisted Zero-Touch Border-Crossing

Within 5G-MOBIX, the user story will be trialled at the GR-TR cross-border corridor, which is situated at the south-eastern region of the European Union constituting a challenging geo-political environment due to the transport of goods essential for the European economy, and is further characterized by rigorous border checks that worsens the already heavy and heterogeneous traffic, especially during the high touristic seasons. According to a recent study [32], a large portion of the time of international transport is wasted at European border crossing in south-east Europe, significantly raising the cost and delivery time of goods and contributing to the segmentation of international logistics. The study has shown that on average most border crossings take between 30 and 60 minutes but can easily surpass 90 minutes depending on traffic conditions and other factors (counting both waiting and procedural times). The largest portion of this delay is attributed to inefficient flow of information regarding the necessary documentation (33.4%), custom agent's inefficiency (21.9%) and lack of necessary infrastructure and equipment (21.3%). Since border control cannot be alleviated due to security and smuggling concerns, improving the average control time by addressing the weak points of the process can significantly benefit the transport and logistics industry, and can greatly reduce both the time and cost of international transportation of goods.

In order to decrease the time spent at the borders and to avoid lines of trucks, which can extend up to a few kilometres, a new system will be deployed at the borders of Turkey as confirmed by the Trade Minister Ruhsar Pekcan [33]. The goal is to equip customs administrations with technological facilities, which will result in uninterrupted and quicker international trade operations at the customs. To serve this purpose, "Transit Vehicle Tracking Program" is designed, which will allow the border gates and customs administration to get quick information on trucks and incoming vehicles beforehand, cutting the times spent at the gates. Through an early effective risk analysis, it will be possible to intervene the vehicles that are likely to be involved in smuggling or have already been involved in other illegal acts much more quickly. This will also ensure an effective usage of the personnel.

Despite the ongoing efforts to solve the issues observed at the border gates as this example demonstrates, there are no measures yet to include automated and connected mobility in the system designs or cooperate with other countries, organisations or authorities to share information about possible suspects that might require closer inspection at the borders by the customs personnel. However, the "Transit Vehicle Tracking Program" of Turkey supports the market need for a service such as the one envisioned in the "Assisted Zero-Touch Border-Crossing" user story.

3.9.2. Stakeholders of US – Assisted Zero-Touch Border-Crossing

The analysis in this subsection builds on the Value Network Model introduced in Section 2.3 to identify the key stakeholders of the user story and subsequently depict their relationships in Figure 16 below.

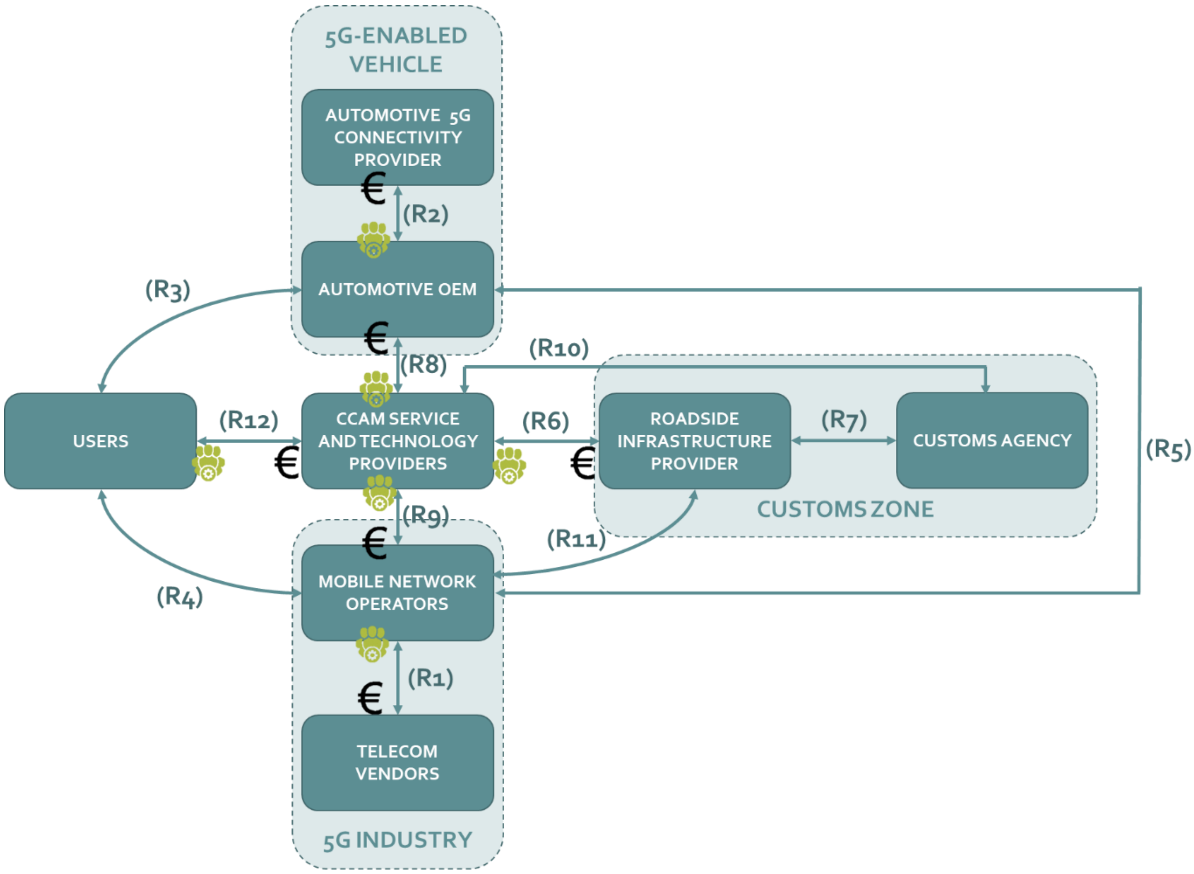


Figure 16: The key stakeholders for the "Assisted Zero-Touch Border-Crossing" user story

- **Mobile Network Operators:** Receive services from *Telecom Vendors* (R1) for deployment of the telecommunications infrastructure, and with the network they operate, give services to *Users* (R4), *5G-enabled Vehicles* (R5) and *CCAM service and technology providers* (R9).

- **Telecom Vendors:** Sell telecom infrastructure to *mobile network operators* (R1).

- **Automotive OEMs:** Benefit from the technology of the *automotive 5G connectivity providers* (R2) to sell connected vehicles to *Users* (R3) and possibly share information with the *CCAM service and technology providers* (R8).

- **Automotive 5G connectivity provider:** Develop the necessary technology to offer connectivity to *automotive OEMs* (R2).

- **CCAM Service and Technology Providers:** Receive services from (possibly) *automotive OEMs* (R8) and *mobile network operators* (R9) as well as *roadside infrastructure providers* (R6) to offer the assisted zero-touch border-crossing application to users (R12). Need an approval procedure or agreement with the *Customs Agency* (R10).

- **Roadside Infrastructure Provider:** In cooperation with the *customs agency* deploy roadside infrastructure within the customs zone (R7) and use *mobile network operator* services (R11) to *CCAM service and technology providers* (R6).

- **Customs Agency:** Allow *roadside infrastructure providers* access to the customs zone (R7) and the *CCAM service and technology providers* the right to offer the assisted zero-touch border-crossing service to users (R10).

- **Users:** Buy *5G-enabled vehicles* (R3) and 5G services from *mobile network operators* (R4). Receive assisted zero-touch border-crossing service from the *CCAM service and technology providers* (R12).

3.9.3. Value Proposition and Business Impact of US – Assisted Zero-Touch Border-Crossing

- **Cost reduction:** The decreased waiting times at the border gates, together with the extra level of efficiency and security added to the whole operation will have profound effects on the transport and logistics sector. First of all, the costs associated with waiting will decrease, and also the duration of the transportation will be more predictable. The time saving will likely translate to indirect reduction of transportation costs, as well, which will eliminate the need to exercise extra protective measures on the goods being transported because of the undesirable situations that excessively extend the time spent during the transport.

- **Better driver experience:** The drivers employed by the logistics industry will suffer less at the gates, and thus taken from the point of view of an end-to-end driving experience, they will be more comfortable on their duty.

- **Customs personnel and pedestrian safety:** The risky driving behaviour that is caused by extensive waiting at the gates will be overseen by the cloud system, which will automatically stop the dangerous vehicles. This ensures the safety of the customs personnel as well as the other pedestrians in the customs zone.

3.9.4. Customer Focus of US – Assisted Zero-Touch Border-Crossing

Table 16: Customers of Assisted Zero-Touch Border-Crossing

Service and/or Technology Provider	Customers
Telecom Vendors	Mobile Network and Road Operators
Automotive 5G Connectivity Provider	Automotive OEM
Automotive OEM	End Users, CCAM Service and Technology Providers

Mobile Network Operators	End Users, CCAM Service and Technology Providers
Roadside Infrastructure Provider	CCAM Service and Technology Providers, Road Operators
CCAM Service and Technology Provider	End Users

3.9.5. Financial Analysis of US – Assisted Zero-Touch Border-Crossing

- **Service 1 – CCAM Service and Technology Providers to End Users:** The drivers will be able to seamlessly pass from one side of the border to the other, with the condition that they are not involved in any illegal affairs. This service will be provided by the CCAM service and technology providers to the end users that agree to deploy the sensors and modules required in the user story to transmit the necessary information about the vehicle and the cargo it carries. The end users will be charged each time they pass the border.

- **Service 2 – Automotive OEMs to CCAM Service and Technology Providers:** The devices and modules to be positioned on the vehicle are manufactured by the automotive industry. The CCAM service and technology providers will be bundling this equipment to the service they offer to the end users. The devices can be sold or rented for a fixed term.

- **Service 3 – 5G Industry to CCAM Service and Technology Providers:** The 5G connectivity is the main enabler for the zero-touch service to the end users. The 5G Industry powers all types of connections, which includes those of the roadside infrastructure and the ones generated by the vehicle and its devices. The 5G services will require regular subscription. It is likely that the CCAM service and technology providers will be compensating for the 5G data consumed by the roadside infrastructure and the vehicles for this particular service (i.e., users, automotive OEMs and roadside infrastructure providers do not appear as receivers of 5G services).

- **Sales:** Three types of sales are shown in Figure 16:
  (1) Telecom Vendors → Mobile Network Operators
  (2) Automotive 5G Connectivity Provider → Automotive OEM
  (3) Roadside Infrastructure Provider → CCAM Service and Technology Provider

The analysis made above assume that the CCAM service and technology provider will be taking on the market risk of the assisted zero-touch border-crossing service, where it is liable towards the automotive OEMs, the mobile network operators and the roadside infrastructure providers. In another scenario, the associated risk of introducing the service to the market might be shared by one or more of the actors shown in Figure 16.

3.10. Business Models Analysis for US – Platooning with "See What I See" Functionality in Cross-Border Settings

This use story contains three different application. First one is platooning application through hybrid 5G connected cloud and PC5, as second, See What I See application to stream video of 4K camera at the leader vehicle to follower vehicle to reduce anxiety and increase safety and as third, autonomous truck routing application in hard border customs area to complete autonomy of a L4 vehicle when there are lots of checkpoints and paperwork exist.

Main focus of the user story is the showing 5G capable platooning, real-time high-quality video streaming with 5G while moving and showing that with the help of the 5G connected RSUs and Cloud, routing a connected but not autonomous vehicle in complex fenced environment like a L4 vehicle. With the help of the selected scenarios, 5G limits such as service continuity, roaming, handover, throughput, latency will be also tested.

During trials, platoon that has See-What-I-See application will reach to Turkish border gate and then platoon will be dissolved. After that point, Autonomous truck routing application will be enabled. With the help of the sensors (CCTVs, LIDARs) located on the border, truck will move through checkpoints autonomously without need of a human intervention.

3.10.1. Current Market Situation for US – Platooning with "See What I See" Functionality in Cross-Border Settings

Today, the most of the known truck OEMs tried their own platooning cases. Additional to this individual trials, seven big truck OEMs (DAF, Daimler, Iveco, MAN, Scania and Volvo Group) join the ENSEMBLE project that is also referred in Section 2.1. Main communication protocol of all these projects is DSRC, and there isn't any video stream or such advanced autonomous maneuvers for hard borders.

About patents, AGVERDICT, INC., San Francisco, CA (US) has a patent [34] namely, "Systems and Methods for Cloud-Based Agricultural Data Processing and Management". This patent is received for agricultural industry but similar to our autonomous truck routing architecture, sensor data and GPS data is fused in cloud and then, this fused information is sent back to a control centre to check status of agricultural fields, when to harvest, which equipment will harvest etc.

Additionally, Scania CV AB, Södertälje (SE), hold another patent [35] and name of it is "Device and Method for Increasing Road Safety in Vehicle Platoons".

Daimler in 2016 demonstrate the platooning with see through capability [36], but video quality was limited, frame rate was low, and latency was high.

These patents and studies cover some bases of Platooning with See What I See Application user story, but none of them commercialized and neither fully capable of what 5GMOBIX user story promised about connectivity continuity, border crossing, video quality, latency etc.

3.10.2. Stakeholders of US – Platooning with "See What I See" Functionality in Cross-Border Settings

Interaction between stakeholders is quite similar with other GR-TR user story, Assisted Zero-Touch Border-Crossing. For stakeholder relation please see Figure 16 that is also shown in section 3.7.2.

- **Mobile Network Operators:** Receive services from *Telecom Vendors* (R1) for deployment of the telecommunications infrastructure, and with the network they operate, give services to *Users* (R4), *5G-enabled Vehicles* (R5) and *CCAM service and technology providers* (R9).

- **Telecom Vendors:** Sell telecom infrastructure to *mobile network operators* (R1). In the future, this might be extended by selling telecom infrastructure directly to Road Operators or Custom Agencies.

- **Automotive OEMs:** Benefit from the technology of the *automotive 5G connectivity providers* (R2) to sell connected vehicles to *Users* (R3) and possibly share information with the *CCAM service and technology providers* (R8). Additionally, MNOs provide network connectivity to vehicles (R5).

- **Automotive 5G connectivity provider:** Develop the necessary technology to offer connectivity to *automotive OEMs* (R2). They are Tier-1 supplier of OEMs.

- **CCAM Service and Technology Providers:** Receive required data from *automotive OEMs* (R8) and *mobile network operators* (R9) as well as *roadside infrastructure providers* (R6) to offer the Platooning with See What I See and Autonomous Truck Routing applications to users (R12). Need an approval procedure or agreement with the *Customs Agency* for Autonomous Truck Routing application (R10).

- **Roadside Infrastructure Provider:** In cooperation with the *customs agency* deploy roadside infrastructure within the customs zone (R7) and use *mobile network operator* services (R11) to *CCAM service and technology providers* (R6).

- **Customs Agency:** Allow *roadside infrastructure providers* access to the customs zone (R7) and the *CCAM service and technology providers* the right to offer the autonomous truck routing service to users (R10).

- **Users:** Buy *5G-enabled vehicles* (R3) and 5G services from *mobile network operators* (R4). Receive Platooning with See What I See and Autonomous Truck Routing services from the *CCAM service and technology providers* (R12).

3.10.3. Value Proposition and Business Impact of US – Platooning with "See What I See" Functionality in Cross-Border Settings

As in BMC document of this user story stated, main value propositions are listed below:

- **Cost reduction at logistic operations:** Platooning is a cost saving function. According to literature researches platooning provides up to 24% fuel consumption reduction depending on position of platoon, distance between vehicles, platoon speed, vehicle load, total trip distance and road topology [37]. Fuel consumption is the second largest operational cost of ownership after personnel cost. Hence, reducing fuel consumption is a quite important value proposition especially for truck drivers and logistic fleet owners.

- **Decreasing environmental effects:** If we talk about reduction on the fuel consumption, it is obvious that CO_2 emission will be also reduced and this will affect environment positively. According to Schroten's "Marginal abatement cost curves for Heavy Duty Vehicles, Background Reports" study [38], vehicles account for 20% of the total carbon emission of which a quarter comes from heavy duty vehicles. Platooning can help this CO_2 emission reduction.

- **Increasing safety and reducing stress:** In a platoon, if an emergency brake situation occurs, follower vehicles can react and brake faster than a human brake. With the help of the V2x connectivity, information could flow faster than human brain decision mechanism. In addition to this, with the help of the See What I See application, follower drivers will be more aware about environment. As an example just before leaving the platoon on highway exit, follower vehicle driver will be able to know whether it is safe to take that highway exit or not. Since platoon vehicles follow each other quite close distances, follower drivers see only a big trailer in front of them. Seeing through also helps to reduce stress level of follower drivers.

- **Faster logistic operations:** With the help of the Autonomous Truck Routing application, while drivers doing their paperwork, truck moves autonomously from one checkpoint to another. Addition to this, X-ray checks will be done with an AI based application and there will not need a human to check X-ray images. These two features will reduce border crossing time per truck.

3.10.4. Customer Focus of US – Platooning with "See What I See" Functionality in Cross-Border Settings

Customer focus of each stakeholder can be seen on the table below:

Table 17: Customers of Platooning with "See What I See" Functionality in Cross-Border Settings

Service and/or Technology Provider	Customers
Telecom Vendors	Mobile Network and Road Operators
Automotive 5G Connectivity Provider	Automotive OEM

Automotive OEM	End Users, CCAM Service and Technology Providers
Mobile Network Operators	End Users, CCAM Service and Technology Providers
Roadside Infrastructure Provider	CCAM Service and Technology Providers, Road Operators
CCAM Service and Technology Provider	End Users

3.10.5. Financial Analysis of US – Platooning with "See What I See" Functionality in Cross-Border Settings

- **Service 1:** For Platooning application and See What I See application scenario, end user pays an extra money when purchase the vehicle to have 5G-CCAM services, because vehicle OEM pays to its Tier-1 suppliers (5G connectivity and see through camera supplier). End user connects Platooning and/or See What I See servers to get advantage of the 5G-CCAM services. For this connectivity, end user pays subscription money periodically (e.g. monthly, yearly etc.) or per usage (e.g. per km) to CCAM service and technology providers. Data usage cost may be covered in subscription or may be paid by end user to MNOs.

- **Service 2:** For Autonomous Truck Routing scenario, as first option, truck driver pays money to CCAM service and technology provider according to his/her subscription method. This could be per usage, if driver use the same road so often, then it could be a periodical subscription. CCAM service and tech provider share this paid money with road operators. Service pays MNOs to get network connectivity. As second option, truck driver pays to road operator at the entrance of the autonomous truck routing capable road and this money is shared between road operator and CCAM service provider. Required data cost should be covered by truck driver or road operator and paid to MNOs in this case. As third option, truck driver pays both CCAM service provider according to his/her subscription method and road operator at the tollgate once or if used so often then an advantage package could be created by road operator. Required data cost should be covered by CCAM service provider and road operator and paid to MNOs. For all options, revenue sharing percentage between road operators and service providers would be decided according to a contract that is signed at the beginning.

For all services, drivers will get 5G-CCAM advantages such as relaxing while driving and have time for secondary tasks like phone call, eating, reading emails etc. Advantages and their cost should be balanced.

4. MOTIVATION OF STAKEHOLDERS

In this section, we look for answers why stakeholders should invest on 5G-CCAM.

The analysis of the motivations of the various stakeholders within the 5G/CCAM ecosystem should begin by investigating first what is of value for the customers that would incite them to pay for connected and autonomous driving products and services. In this context customers are considered to be either individual vehicle drivers, owners or passengers, or national and private road transport operators. Research evidence so far has demonstrated that those end users of 5G/CCAM technology firmly believe that the cost for such services is worth the benefits of [39]:

- *Safety.* The potential of 5G/CCAM technology to dramatically reduce the frequency of road accidents has been one of the most important driving forces for the development and adoption of connected and autonomous vehicles. Assistive driving features such as forward collision and lane departure warning systems, sideview assistance, and adaptive headlights have already started to have an impact in reducing the number of crashes and fatalities on the road. Given the fact that the vast majority of accidents are a result of the drivers' fault, wide adoption of fully autonomous vehicles (levels 4 and 5) are expected to reduce accident statistics even further.

- *Comfort.* Drivers and passengers of fully autonomous vehicles will be able to engage in altenative, more beneficial, work or entertainment related activities whilst travelling. This factor might also make people willing to commute longer distances to and from work, and hence locate further from densely over-populated urban areas improving their quality of life. Although this might result in an increase in the total time and distance of travel, even leading to more congestion in some cases, the quality of time spent inside a vehicle will be increased significantly.

- *Mobililty for those unable to drive.* Level 4 and level 5 autonomous and connected vehicles that do not require a human driver would enable mobility for people who are disabled, too young, too old, or unwilling to drive. The benefits for those people with regards to independence, reduction in social and physical isolation, and access to healthcare, shopping and other essential services will be significant.

- *Environmental sustainability*. Fully autonomous and connected vehicles will be able to optimise travel speeds, distances and times, thus improving significantly road capacity and reducing fuel consumption. This increased efficiency will not only be beneficial for reducing harmful for the environment emissions, but will also result in lower fuel costs for the consumers. Furthermore, the ability of fully autonomous vehichles to drive and recharge themselves when not in use would enable the wider use of electricity as an alternative fuel, and therefore will play an important role in reducing pollution.

Many governments, public authorities and policy makers have also realised how revolutionary those potential benefits of wide adoption of connected and autonomous vehicles are for the economy, the society and the environment in the long-term, and therefore are determined to facilitate, support and promote the development and deployment of 5G/CCAM technology.

Questionnaires that are prepared for this deliverable (See Annex) will guide us to understand stakeholders' motivations in more detailed perspective. Answer to these questionnaires will be analyzed second version of this deliverable, D6.6, which will be published at the end of project.

4.1. Motivation of MNOs

5G CCAM services are important for MNOs for a host of reasons (the order of importance may vary from operator to operator):

1) The "critical 5G CCAM services" respresent one of the most prominent drivers for the investment in a 5G-URLLC infrastructure (this is the incremental investment needed to make a 5G-eMBB network ready for URLLC services), because this market segment has some unique characteristics:

- The total addressable market in the long run is large
- The value created per subscriber is substantial which should help MNOs to recoup the investments made for such services.
- There is no technical alternative / substitution for the connectivity necssasary for such services, which further reduces the risk of malinvestment.
- It is not a question of "if", but more a question of "when" the demand for such services start to appear.

Although the last point (timing / adoption curve) is a positive in the sense that it is easier to decide to invest in a market that surely will exist, the "when" question is still relevant. Even with a low cost of capital (by historical standards), it is still important for MNOs to get the timing of investment right: investing too early leads to significant opportunity costs whereas investing too late can lead to long lasting loss of market share.

2) The "non-critical 5G CCAM services" (eg. In car entertainment) provide a space into which MNOs can extend their existing consumer services in a seamless manner (eg. Premium Cartoon TV subscription). Whereas initially such services are mainly focused at passengers (eg. Kids), in time (as AD moves to Level 5) they will soon also target the former driver, representing a long term growth opportunity. Such services will require 5G-eMBB connectivity and are the closest to "business as usual" from the perspective of the MNO.

3) Business customers are expected to use the data from their connected fleets in their mandatory quests for efficiency (eg. Digital Transformation initiatives). MNOs can add value to such customers providing reliable and secure connectivity within private networks. Connecting fleets directly to Corporate backends without traversing the public internet greatly reduces security risks. From a pure network perspective, these services will mostly require 5G-eMBB networks, though there may

be some usecases for 5G-mMTC as well. However, the main question for MNOs is not on the network side. The main question is until what extents MNOs have the ambition and ability to orchestrate end-to-end services. For this MNOs need to be part of ecossystems together with OEMs, device suppliers, platform providers and integrators.

Arguably, the value above listed opportunities is still subject to many unknowns (notably regarding business models, adoption curves, and regulation). But even for a more cautious MNO, it is probably clear that ignoring the potential of 5G CCAM services would be a significant business risk. Securing the option to participate in the 5G CCAM services market partially explains why MNOs are willing to bid significant amounts in 5G spectrum auctions, especially when it comes to the lower bands.

4.2. Motivation of Automotive OEMs

The autonomous driving market is expected to reach a sheer size in the near future, with estimates of generating $560 billion in revenues by 2035 representing 17% of the global automotive market[40]. The main products that will contribute to these revenues can, in general, be grouped in the following categories:

- *Fully autonomous and connected vehicles*. Several types of self driving vehicles are expected to be designed including, for example, large vehicles for transporting goods or people; simpler vehicles and taxis for commuting and short trips; luxurious vehicles for premium travel experience; and drones for improved road capacity and speed. These self driving vehicles will be able to connect to each other and form platoons with fixed distances and speeds, or swarms giving control to a real-time automated traffic flow management system.

- *Special equipment for high/full driving automation*. This category would include all on-board accessories especially a on-board connectivity modem that enable high level of driving automation, such as assisted driving, auto pilot, navigation, automatic parking, etc. Both hardware and software aspects of those accessories are included in this category.

- *Mobile apps*. It is forecasted that by 2035 autonomous driving systems will free up 5 trillion minutes of idle time for vehicle passengers, most of whom will be in possession of a smart phone or tablet. Smart phone and tablet apps will enable drivers and passengers to enojy access to multimedia and information for entertainment or work purposes while travelling without the risk of causing an accident. Apps will also allow consumers to control various features of their cars remotely, as well as integrate their vehicle with their smart home and program their home from the car and vice versa. Apps can also be utilised to improve insurance policies and offer better legal protection.

- *Infrastructure*. New road-side infrastructure that enables seamless and ubiquotous connectivity for autonomous vehicles needs to be deployed in motorways and cities and complement existing infrastructure. This would include, for example, 5G core network and RAN for wireless connectivity, cloud and MEC datacentres for data storage and processing, road-side C-V2X and sensor units, platforms for automated traffic control, and more.

Undoubtedly, connected and autonomous vehicles will disrupt the existing automotive industry in an unprecedentent way. Today, the value for an average vehilce is 90% hardware and 10% software. In future, it is expected that the value of the hardware will fall to 40% and most of the vehicle's value will be dominated by software (40%) and content (20%). The concept of connected mobility will blur the distinction between connectivity and mobility creating new forms of competition, while generating opportunities for the provision of new services. The current value chain in the automotive industry, which has traditionally been formed as an one-way pyramid with the OEMs sitting at the top and the various component suppliers and integrators at the lower levels, will be replaced by new value network models with complex interdependencies between previously unrelated stakeholders, as discussed in detail in Section 2.3. This is because the various stakeholders, from multi-billion giants in the automotive, telecoms and online technology industries to specialst hardware and software SMEs and startups, have realised that if they want to play a leading role in this rapidly evolving autonomous driving market they will need to join forces and establish powerful partnerships and ecosystems.

4.3. Motivaton of Third-party SW/HW suppliers

Based on the point of view of SW/HW suppliers the main motivation for new investments in 5G/CCAM lies on the development of new business opportunities such as, development of new partnerships, reaching out to new segments/verticals, improvement of existing products and services or development of new ones, the motivation can be affected by many internal and external factors. Internal factors refer to the company's strategic goals, available infrastructures and resources, the company growth, marketing intensity or even the capacity of decision makers to make informed decisions when novel technologies such as 5G CCAM are concerned. External factors include the market dynamics such as market size, growth, competition intensity, restricing regulations and policies or existing standards and patents. This subsection details some enablers that can further motivate investment from SW/HW suppliers.

Creating a data economy around CCAM can be a significant motivator to increase investment in 5G CCAM deployments. In general, Big Data as-a-Service is estimated [41] to grow from USD11.3 billion in 2019 to USD 42.7 billion by 2024, at a Compound Annual Growth Rate (CAGR) of 30.5% during this period, according to recent analyses. This is an indication of the growing demand in industries to gain actionable insights from growing data. The wealth of data in 5G-enabled CCAM makes it possible to offer Big Data as-a-Service as long as compliance with GDPR is maintained. This would enable third parties to create products and services on these data, to improve logistics, route planning, demand responsive transport, traffic management, environmental monitoring and many more. The existence of Secure and Ethical BDaaS can thus spur significant economical growth.

Simplifying decisions related to IPR and favouring standardisation over patenting: Decisions related to IPR can have significant impact on a product's success. Given a novel technology such as CCAM, companies are faced with multiple possible options, e.g. keeping the technology proprietary, patenting the technology, standardising or a mix of those strategies. Significant benefits and drawbacks are also present in both cases as illustrated in Table 18

Table 18: Pros and cons of patenting versus standardization

	Patenting	Standardisation
Pros	Capitalising on IP through royalty fees Temporary exclusive rights Increases trust in investors and clients IP protections	A company can establish a dominant design as a de-facto industry standard and request royalty fees. Community standardisation and specifications such as the German DIN or European PAN are low cost alternatives.
Cons	High up-front cost Incurs additional litigation costs (e.g. to defend against infringments) Imitation of patents is hard to detect Difficult to create a patent that cannot be by-passed Duration of 1.5-3 years disadvantageous in rapidly growing markets	Competing companies pushing their designs can instigate a "standardisation war" (e.g. BluRay against HD DVD, Firewire vs USB etc.) and affect the sector significantly.

ETSI has provided a tool [42] to help companies make an informed decision on whether a new and innovative development should be patented or standardised (Figure 117). However, formal standardisation by large communities of experts or even open specifications could lessen the barriers for market entry to new companies and lead to new products with higher degree of interoperability, leading to a more sustainable market.

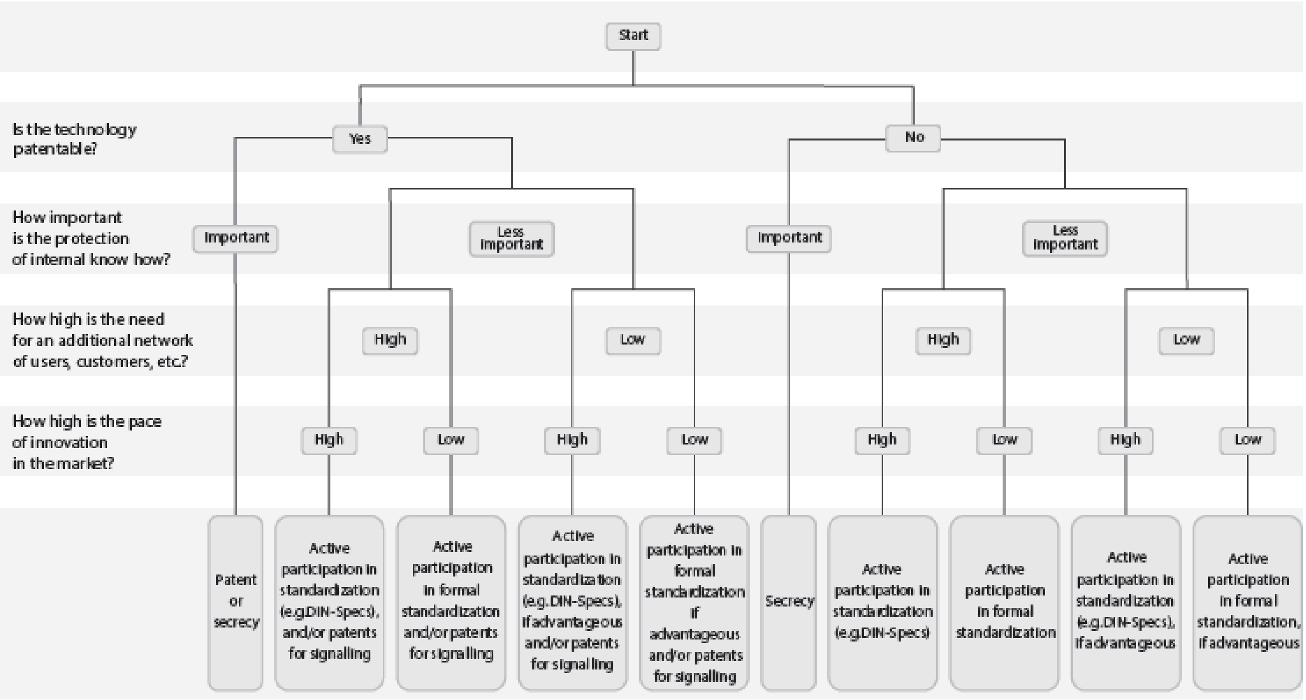


Figure 17: Decision tree provided by ETSI

5. IDENTIFICATION OF BUSINESS-RELATED GAPS

5G-MOBIX explores the barriers that hinder the development of new business models and deccelerate investment in 5G and CCAM. For the purpose of this work, the **PESTLE** approach is adopted, where barriers are discussed in the [P]olitical, [E]conomic, [S]ocial, [T]echnological, [L]egal, or [E]nvironmental sense.

Table 19: PESTLE Approach

Barrier Type	Description
Political	**Difficulty in harmosing and coordinating policies and standardisation between different companies and countries:** Governments and major companies involved in the development and deployment of 5G/CCAM technology have found it difficult to establish common protocols, with some supporting that strict regulations hinder progress while others claim regulations are not strict enough. The differences usually lie behind issues related to road safety (of drivers, passengers and pedestrians); environmental sustainability (e.g. seamless travelling between a country that allows exclusively electric cars and another that allows also biofuels will be significantly affected); cybersecurity (e.g. see the different approach of various countries towards the use of 5G telecom equipment from Huawei); data protection and privacy (e.g. GDPR rules in EU frequently prohibit the effective and efficient development of crucial data-dependent algorithms for CCAM).
Economic	**Lack of motivation for investment in innovative research and development:** The development of a new product can incur high costs in CAPEX/OPEX especially when hardware manufacturing is concerned. Meanwhile, trust in innovative new products can be difficult to build, especially if long-standing contracts among major telcos/vendors etc. are in place. Additionally, there has been a lot of debate about whether the Governments should be paying for it (using tax-payers' money), the vehicle manufacturers, the telecom vendors and mobile network providers, or other stakeholders. As a result of the high CAPEX/OPEX costs, it is also likely that road infrastructure, spectrum and/or core network resources will need to be shared between competitive stakeholders, which will require various agreements at technological as well as policy, regulatory and political level. This breaks the momentum in the creation of new products and in investment in innovative R&D. **Lack of investment from sectors that might benefit greatly from 5G-enabled CCAM:** CCAM is poised to achieve great reduction in congestion and accidents

	in European roads. Multiple industries such as logistics/freight transport, ridesharing and Demand-Responsive Transport etc. stand to gain from 5G/CCAM as costs incurred due to traffic collisions and delays will be minimised. However, there amount of direct investment in 5G/CCAM from these industries is very low due to lack of motivation and trust of the near future.
Social	**Public's lack of trust to automated vehicles:** Although automated vehicles are seen as key disruptors and part of the next "technology revolution", public distrust is still a barrier towards their adoption. Consumers find the idea of relinquishing control as unnerving and news of semi-AVs [43] that have crashed exacerbate this problem. A recent survey by AAA [44] discovered that 88% of respondents felt unsafe to ride in an AV. A poll by AIG discovered that 41% didn't want to share the road with driverless cars. **Concern around security of jobs dependent on driving as a profession:** Although CCAM technology is expected to create economic growth and many new jobs in several sectors of the 5G/CCAM ecosystem, many people such as taxi drivers, bus drivers, HGV drivers, delivery drivers, and others whose profession has traditionally been relying on the physical driving of vehicles, fear that fully autonomous vehicles will replace workers in these sectors. Many petitions and protests have been organised globally by trade unions and organised workforces. These are also sometimes joined by people who see driving as a passion and not as necessity, and fear that their joy in non-autonomous driving will be affected significantly.
Technological	**Disparities in the capabilities of EU Member States:** EU Member States do not share the same adoption rate when it comes to technical innovations. Other disparities such as in the level of automation in ITS centres across the EU, local road infrastructure and GDP per capita can affect the adoption of 5G-CCAM. **Ethical and legal issues in the development of crash algorithms:** Autonomous vehicles of level 4 and level 5 will inevitably need to make ethically difficult decisions in the event of an accident. For example, the majority of people wouldn't choose to buy a vehicle that doesn't prioritise the safety of the driver/passenger, but a crash algorithm that prioritises the safety of the driver or passenger may opt to crash the vehicle into pedestrians or bicycles instead of a wall. Developing ethical and legal crash algorithms that are widely accepted by the society is a complex task and is still unclear what the recommended approach is.

	Stifling of Consumer Choice with Different Techonology: Currently most participants active in the 5G CCAM ecosystem seem to expect that vehicles will have one OBU connected to one physical 5G cellular infrastructure. However, it is unlikely that all operators active in the "5G infrastructure layer" in a geography will invest in the same areas, at the same pace and using the same type of infrastructure and frequency bands. The resulting differences between the 5G infrastructure networks will have different impacts on each 5G CCAM service. Infrastructure A may be superior for one use case (eg. Vehicle Guidance) while for another use case (ex. In car infotainment) Infrastructure B may the best choice. Even if Infrastructure A is equally well suited for the other use case (In car infotainment), there may be differences in the service layer. For example, MNO/MVNO B, which exclusively uses infrastructure B, may offer a premium content (eg. Premium Sports channel) at an exclusive basis or at a beneficial price. In both situations, the customer needs to make a choice (eg. Between "The Best Vehicle Guidance" and "The best in car infotainment").
Legal	**Unclear how to ensure protection of Consumer Rights:** it is highly important to protect Consumer Rights with specific guidelines and legislation. Many issues could arise, not only creating the potential for unfair business practices, but also creating liabilities for companies in the 5G/CCAM supply chain. The introduction of M2M communications and its implications on cross-border scenarios requires clarifications or even possibly new legislation to ensure fair roaming charges for drivers, fair use policies, clarification on taxation policies, portability of data to avoid customer lock-in conditions, potential portability of numbering resources etc. **Difficulty in determining accountability in cases of accidents:** There is lack of a cohesive approach about how insurance companies will deal with accidents and define culpability for the different levels of accountability. This issue becomes particularly complex when one considers the various levels of vehicle automation, the different laws and legal approaches between countries, and the different policies between insurance companies. As a result, some OEMs have been slow, or even reluctant, to roll out connected and automated vehicles with level of automation above 3, so that they don't take full responsibility and the accountability remains with the driver.
Environmental	**Development of environmentally-sustainable but also economically-affordable vehicles:** Low emissions of connected and autonomous vehicles is a requirement of particular importance as it is likely that total travel distances and times will increase as a result of improved comfort for commuters.

	Manufacturers of connected and autonomous vehicles are oblidged, by increasingly strict Government regulations and societal trends worldwide, to keep the environmental polution footprint of their vehicles to as low levels as possible. On the other hand, the costs need to be kept low too in order to ensure that the autonomous vehicles are affordable for the mass market and are not only a luxurious product for the rich and priviledged consumers. Car-sharing and ride-hailing will undoubtedly assist significantly in reducing the polution generated by cars when level 4 and level 5 autonomous vehicles are widely available, but this will require the society to alter their mindset with regards to car ownership.

6. RECOMMENDATIONS

Based on the barrier analysis already provided within Section 5, it is important to identify technologies, policies, and cooperation enablers that can help alleviate their negative impacts and act as business catalysts that boost 5G and CCAM. The purpose of these recommendations is to increase EU competitiveness in CCAM. In order to bridge the technological disparities among Member States, it is important to attract innovation and investment to increase the adoption rate of new technologies. The shaping of common policies in the EU as well as the shaping of policies on Member State level is a crucial factor to enable the creation of 5G CCAM innovation hubs.

Upgrade skills & create a highly specialised workforce: Although there is a large number of professionals active in the 5G, CCAM, big data, cloud computing, computer vision, embedded devices, artificial intelligence and automotive markets, and EU academic and research institutes heavily invest in their education, the realization of the 5G-enabled CCAM vision requires continuous education of young professionals with additional focus on the specificities of 5G and CCAM. In order to alleviate the impact of the technical disparities among member states, there needs to be invested effort to improved education. Another important aspect is the upgrade of current skills in the existing workforce. For example, the increased automation in ITS centers requires personnel re-training. It is important to note that at the level of publicly funded projects, dissemination and communication activities are instrumental and should be intensified. The inclusion of academic and research partners in 5G CCAM projects ensures that these activities will reach a large audience, with additional focus on students, early stage researchers and young professionals in the beginning of their careers. Commercial partners need to ensure that their knowledge reaches their employees and clients. The road-mapping activities, research papers, evidence-based best practices and recommendations to be published by many projects, can be considered a further step towards the effective dissemination of specialized knowledge.

Fostering job creation and entrepreneurship: At the Member State level, a strong connection among high-tier research and academic establishments and the workforce should be established. Legislation could foster the creation of start-ups by ensuring tax breaks and protecting licensed or patented intellectual property. The Digital Single Market policies of the EU are a stepping stone for the creation of a viable ecosystem of highly innovative start-ups, however there are blocking factors when it comes to 5G/CCAM. The creation of a data-driven economy where third parties can create added-value services on big data in the area of transport can greatly benefit from 5G CCAM assuming that a level of protection personal data can always be enforced.

Creating a data economy: 5G-enabled CCAM in conjunction with smart infrastructures has the capacity to transform the economy by enabling third parties to create new data-driven services. The main challenge is to create ethical data proxies that can provide sanitised data to any interested third-party, in order to minimise risks to citizens' digital rights and ensure GDPR compliance. This would be a key step to enable a data economy. The creation of industry-standard data formats is necessary as it would contribute to data interoperability as well as the creation of anonymization and sanitisation services.

Legislating for the future and creating clear liability borders: 5G for CCAM creates a complex ecosystem of actors, creating a web of B2B and B2C relations. There need to be clear definition of fair use policies, penalisation procedures, liability borders, consumer rights protections, as well as a clear understanding on the effects of such policies to billing, fees and taxation.

Investment on better infrastructure can improve EU and regional competitiveness: Road infrastructure needs to be upgraded to meet the demands of the future, to ensure efficient and sustainable mobility and logistics, to enable digital services and to remain resilient to the effects of climate change and resource scarcity. Increasing EU Competitiveness needs to include investment, cost, price, and innovation in road infrastructure and traffic management and must satisfy industry and public authorities, as well as consumers/drivers in order to be sustainable. On regional level, investments in transport infrastructure have been shown to correlate with competitiveness, through enhanced accessibility of services and transport endowment, lower office rental prices, reduction in emissions and noise level, increased labour supply and productivity, increased new business density, increased number of enterprises in certain sectors, growth of FDI inflows, increased export of goods and services, etc. [ref]. Many CCAM-related services are also at the core of smart cities operational concepts which also correlate with regional competitiveness.

Aligning with the EU Digital Single Market: The Digital Single Market Strategy is built on three main pillars:

- **Pillar 1 - Access:** In the context of 5G-enabled CCAM, this means better access for consumers and businesses to 5G, Automated Vehicles and CCAM services across Europe. Novel services are usually adopted by larger organisations, working their way down to smaller organisations. SMEs/MEs have much the same transportation and supply chain needs and will be considerably assisted by the new services.
- **Pillar 2 - Environment:** The EU needs to create the right conditions and a level playing field for digital networks and innovative services to flourish. 5G and Edge computing will ease the communication and data path for CCAM services. Seeing it in a wider context, an entirely new "data value chain" can evolve, comprising firms that support data collection, the production of insights from data, data storage, analysis and modelling.
- **Pillar 3 - Economy & Society:** In order to maximize the growth potential of the digital economy, CCAM need to evolve into network solutions where you are trying to connect all actors on the network to improve collaboration and to get more access to data. For example, logistics companies want to give real time load/order information to customers because customers increasingly have an Amazon-type mindset whereby if they order a book online, they can track where it is. Data from multiple CCAM services can be aggregated and actors can start to provide analytics and operational insight on top of that data. Access to data can have a positive impact in multiple industries and can help them improve their provided services and support their efficiency. Businesses that build digital

platforms on CCAM-related data have a major advantage in the data-driven economy and could be motivated to invest in 5G/CCAM.

Determine the best use of public funds for 5G infrastructure: When it comes to private (unaided) investment in the 5G infrastructure necessary for 5G CCAM services, roads can be divided (albeit somewhat artificially, as reality is more a continuum) into three categories:

1) In many roads (eg. Urban areas) serving existing eMBB customers is a sufficient reason to heavily invest in 5G infrastructure (in extremis: even without expected revenue from 5G CCAM services, the investment would still be made).

2) In other roads (eg. Highways trough sparsely populated areas) investments in 5G infrastructure will be made, but at least initially there may be limits to some 5G CCAM services:

- 5G coverage may not be continuous in some road segments
- 5G coverage may be continuous, but some segments not have the capacity for the CCAM services that require most bandwidth (eg. when a part of the road only has 5G coverage in a lower band, such as the 700MHz band)
- 5G capacity for all 5G CCAM services may exist in normal traffic conditions, but may not be sufficient for more intense traffic scenarios, which incidentally may be when such services would provide most value (eg. "Black Saturday" when many people travel to a vacaction destination on the same day)

3) Finally, for some roads (eg. in remote rural areas) the business case for investment in 5G infrastructure is unclear and such investments may be delayed until more data has become available.

Undoubtedly aware of this reality, the EU has already signaled its intention to stimulate the development of 5G infrastructure covering some roads / corridors. Arguably, this was the most important step, but in order to implement such a plan a CBA should be made in order to decide where the benefits for the public good justify the usage of public funds to stimulate additional investment in 5G infrastructure. In order to make such CBA some inputs are necessary. Some of these inputs are somewhat objective (e.g. a table with the % of vehicles capable of using a certain CCAM service per year). Other inputs represent implicit policy decisions (e.g. Is it acceptable that there is not enough capacity to provide all 5G CCAM services when there is a rare traffic jam on a highway in a rural area? If it is not acceptable, this will greatly raise the necessary funds for 5G infrastructure. If it is acceptable, a selection of the most critical 5G CCAM must be made.)
This leads to a circular situation which could become a barrier:

- As the number of scenarios is nearly unlimited and only a limited number of CBA scenarios can be calculated with the necessary detail. Therefore, policy makers need to first define the inputs.
- In order to define sensible inputs, policy makers need to have some visibility on the respective cost implications. Therefore, participants of the 5G CCAM ecosystem should first provide a CBA.

Create a CBA for the critical corridors (in order to jumpstart 5G CCAM service adoption): In order to execute on the existing plans regarding the first critical corridors where 5G CCAM services can be used, some public investment is necessary for those locations where private investment alone is not sufficient (or not soon enough). In order to create a CBA for such public investment, policy makers need to define inputs. For this to happen, ecosystem participants must provide policy makers with guidance on how certain parameters of policy requirements affect the necessary investment. This is an iterative process which requires investment of time and resources from all participants.

Guaranteeing consumer choice: It is one thing when a consumer buys a particular vehicle which uses a cellular service from a particular MNO in order to provide services that are integral to the usage of the vehicle. It is another thing when the cellular service from this particular MNO limits the choice of which additional services can be used in the vehicle. Consumers should be free to choose which MNO/MVNO they want to use for such services (e.g. Infotainment)

Having open discussions about Machine Ethics: There are cases where a driver is required to make a moral choice, e.g. swerve and risk damage to the vehicle instead of injuring a pedestrian. A recent survey from MIT [45] showed that moral choices when driving are not universal. Although the EU has provided guidelines for Trustworthy and Ethical AI, there needs to be a comprehensive framework for the ethical programming of automated vehicles, and a close inspection of the moral choices involved in driving. Having moral safeguards can increase the public's trust in connected, cooperative and automated mobility and may influence the uptake of a novel and disruptive technology [46].

7. CONCLUSION

This document describes in detail possible new business models that could come with 5G-CCAM services. Document examines other global projects that are also contains business related deliverables. Some of them have not publish the related deliverables, yet, but for second version of this deliverable, D6.6, we will follow closely to check what are the ideas of other projects and try to find the most suitable business model strategy.

As methodology, after reviewing other projects, we determined to use both business model canvas and value network model. Business model canvas provides us key pillars in a business model i.e. key resources, key partners, key activities, customer segments, customer relationship and channels, value propositions, customer relations, revenue streams and cost structure of a business. On the other hand, value network model provides us business related connection between all stakeholders i.e. money and/or service sharing.

For detail business model analysis for every cross-border user story, we exploit these two tools and explained user story specific possible business scenarios and relationships. It is obvious that there is not only one method to share revenue or deploy 5G-CCAM service on a border road. Contracts between stakeholders will determine revenue and service deployment.

According to our study, stakeholder motivation points are listed and they are mainly around increasing market share and providing more elite services. Besides, stakeholders will face many struggles to develop, deploy 5G-CCAM services and that could hold them back at the beginning of the technology readiness day.

Business related gaps would be the main showstopper for 5G-CCAM services, and they are listed in detail with the help of the PESTLE approach. We see that governmental bodies need to take action as soon as possible to solve main business gaps that are listed in section 5. After solving main gaps, motivation of the stakeholders could be increase. Possible solution to defined gaps also listed in recommendations section.

According to prepared questionnaires in D6.2, we will gather answers from various stakeholders in and out of our consortia. After that, we will compere these answers with our initial study in D6.2 update required sections in D6.6. Additionally, we plan to organize various workshops with other ICT-18 and 53 projects to increase common understanding about new possible business model opportunities and how to foster them. These workshops could be enlarged with public attendance to increase awareness more. Results of these workshops will be also reflected in D6.6.

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ANNEXES

Annex 1 – QUESTIONNAIRES

Questionnaires cover page and OEM related questionnaire are listed in sections below. We created questionnaires for also end customers, road operators, cloud and MEC providers, MNOs, network equipment providers and RSU providers. But, since other questionnaires of stakeholders are similar to OEM questionnaire, we placed only OEM questionnaire.

1) Cover Page of Questionnaries:

About 5G-MOBIX

5G-MOBIX aims to showcase the added value of 5G technology for advanced Cooperative, Connected and Automated Mobility (CCAM) use case categories and validate the viability of the technology to bring automated driving to the next level of vehicle automation (defined by the Society of Automotive Engineers (SAE) as Level 4 and above). To do this, 5G-MOBIX plans to demonstrate the potential of different 5G features on real European roads and highways and create and use sustainable business models to develop 5G corridors. 5G-MOBIX also utilizes and upgrades existing key assets (infrastructure, vehicles, components), and ensures the smooth operation 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 local corridors using 5G core technological innovations to qualify the 5G infrastructure and evaluate its benefits in the CCAM context. The project also defines deployment scenarios and serves to identify and respond to standardisation and spectrum gaps. 5G-MOBIX consists of 55 partners from 10 countries from the EU and Turkey representing European ICT industry and cooperates closely with South Korea and China to bring forward advances in 5G for CCAM. It is coordinated by ERTICO-ITS Europe.

Funding

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 825496.

Scope and intended audience

Task 6.2 is about the analysis business model analysis of current market and future new business opportunities. We are defining business models for a significant group of 5G-CCAM services use cases, to develop and evaluate new business opportunities for CCAM and 5G, financing schemes, revenue allocation and procurement models. The following questionnaire is a research instrument and it will help to know what current stakeholders think about those services. The questionnaire explores the different areas and elements defining the use cases' business models. The results will provide feedback to refine the business models already outlined by 5G MOBIX project partners. The potential stakeholders have been grouped in several categories including road operators, OEMs, MNOs, network equipment providers, RSU providers, cloud/MEC providers and end users/customers.

The results will be used internally in the elaboration of the deliverable D6.2 of 5GMOBIX which will be made publicly available in the project website, www.5g-mobix.com.

Benefits for participation

The results of this questionnaire will be provided to you via email if you leave your e-mail address at the end of the survey. In this case your address will be stored and used separated from your answers. The results will also be published in on the 5G-MOBIX website.
Your name or your organization name will not be shared in deliverable or in any other public area.

Contact

For more information about the project, you may contact the Project Coordinator Coen Bresser via email: c.bresser@mail.ertico.com
For more information on the questionnaire and your rights as a data subject, you may contact via email: Tahir Sari (Task Leader) tsari1@ford.com.tr, Luxshiya Ariyanayagam luxshiya.ariyanayagam@iis.fraunhofer.de or Maija Federley maija.federley@vtt.fi

2) OEM Questionnaire:

The emergence and rise of connected automated vehicle refers to both technological and industrial developments; in progressive yet rapid stages, it will become possible to safely confer more and more driving responsibilities to automated systems in road transport. These innovations involve personal vehicles, but also public transport and logistics/freight vehicles.
The objective is to take full advantage of technology's potential to deliver a renewed transport and mobility system with the following 5G-CCAM service use case categories:

- **Platooning**
  Vehicle Platooning is a method for efficiently driving several vehicles together, which is enabled by autonomous driving technologies. In a platoon, vehicles are autonomously driven, forming a convoy and moving much closer together than what would be possible if driven by human drivers, like carriages in a train. The reduced distance between vehicles results in greater fuel efficiency and reduced use of road space. To achieve this, vehicles on a platoon continuously share information through air between them regarding location, speed, heading and their intentions such as braking, acceleration etc.

- **Infrastructure/Cloud Assisted Autonomous Driving**
  Infrastructure/cloud collects information from various sensors (such as cameras, LIDARs) or road side signatures and delivers collected information to the automated vehicle in time, and vehicle can start its autonomous maneuvers according to this information. Autonomous maneuvers can be lane change, lane merge, speed up, speed down, change the route according to traffic information etc. Such a communication should be rapid and reliable enough to guarantee the safety of vehicles. Some example use cases: Emergency vehicle approaching warning, slow vehicle warning, vulnerable road user warning, stationary vehicle warning, traffic condition warning, roadwork warning etc.

- **Cooperative Collision Avoidance (CoCA)**
  CoCA aims to prevent collisions especially blind spots on the highways such as lane merge, intersection points. As an example vehicle 'A' that is approaching the intersection must be able to clear itself safely across the highway lanes to join the main traffic flow. When deemed necessary, vehicle 'A' needs to safely stop autonomously before crossing the motorway/highway and start driving only when its calculated trajectory path by a cloud application is safe and clear for autonomous manoeuvring. For this purpose, vehicle 'A' must be able to utilize both its own trajectory and timing data and information from the road side sensors as well as precise location, intended direction and speed information of the vehicle 'B' that can cause a collision, to avoid collision.

- **Remote Driving**
  Remote driving is a concept in which a vehicle is controlled remotely by either a human operator or cloud computing. While autonomous driving needs a lot of sensors and sophisticated algorithm like object identification, remote driving with human operators can be realized using less of them. For example, if on-board camera of the vehicle feeds the live video to remote human operator, human operator can easily understand the potential hazard of the vehicle without assistance of any sophisticated computing. Based on this video, the remote operator sends commands to the vehicle. Also, when cloud computing replaces human operators, coordination between vehicles can be achieved. For example, if all the vehicles feed their schedule and destination, the cloud can coordinate which route each vehicle will take. This coordination will reduce potential traffic congestion, overall travel time, leading to better fuel efficiency.

- **Video Streaming Apps. (e.g. See Through, HD Media Streaming)**
  The visual range of the driver is in some road traffic situations obstructed, for instance by trucks driving in front. Video data sent from one vehicle to the other can support drivers in these safety-critical situations. Video data may also be collected and sent through a capable road side unit. Sharing high resolution video data better supports drivers to make the manoeuvre decision according to their safety preferences. However, sharing low resolution video data is not sufficient, as obstacles are not visible and might get overlooked. Additionally, imagine you sit in a bus and this bus connected to 5G network and also has screens that can play 4K videos. With the help of 5G, you can enjoy watching 4K videos while travelling.

The entire mobility and transport ecosystem will need to adapt to these upcoming changes, therefore we are interested in how each member of the potential 5G-CCAM ecosystem operates.

PROPOSED QUESTIONS

1. Value Propositions

1.1. Please rate the value propositions for each CCAM service category in regard to their relevance for your company, giving the most important value proposition grade 1, for the second grade 2, for the third grade 3 etc. (grades 1…8)

Platooning

Increased market shares	______	Improved safety of the vehicles	______
Innovative image	______	Enhanced data collection	______
Increased turnover	______	Closer customer relationships	______
New sales opportunities	______	Improved environmental performance	______

Infrastructure/ cloud assisted autonomous driving

Increased market shares	______	Improved safety of the vehicles	______
Innovative image	______	Enhanced data collection	______
Increased turnover	______	Closer customer relationships	______
New sales opportunities	______	Improved environmental performance	______

Cooperative collision avoidance

Increased market shares	______	Improved safety of the vehicles	______
Innovative image	______	Enhanced data collection	______
Increased turnover	______	Closer customer relationships	______
New sales opportunities	______	Improved environmental performance	______

Remote driving

Increased market shares	______	Improved safety of the vehicles	______
Innovative image	______	Enhanced data collection	______
Increased turnover	______	Closer customer relationships	______
New sales opportunities	______	Improved environmental performance	______

Video streaming apps (e.g. See through, HD media streaming)

Increased market shares	______	Improved safety of the vehicles	______
Innovative image	______	Enhanced data collection	______

Increased turnover ______ Closer customer relationships ______
New sales opportunities ______ Improved environmental performance ______

1.2. Please list further values that you expect in return to offering 5G-CCAM services like autonomous driving or platooning and rate them

Other kind of values:	Neutral		Somewhat important		Very important
______________________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐

2. Key Resources

2.1. Where are the key resources for your 5G-CCAM products?
(E.g. trucks, buses, cars, labour, patents, supply network …)

2.2. Please mark whether your organisation is currently developing or offering the following 5G-CCAM services for your customers:

	In development	On offer	No such activities at this point
Platooning	☐	☐	☐
Infrastructure/cloud assisted autonomous driving	☐	☐	☐
Cooperative collision avoidance	☐	☐	☐
Remote driving	☐	☐	☐
	☐	☐	☐

Video streaming apps
(e.g. See through, HD media streaming)

2.3. How would you rate the efforts in regard to the implementation of the following 5G-CCAM services in your production?

	Very high				Very low
Platooning	☐	☐	☐	☐	☐
Infrastructure/cloud assisted autonomous driving	☐	☐	☐	☐	☐
Cooperative collision avoidance	☐	☐	☐	☐	☐
Remote driving	☐	☐	☐	☐	☐
Video streaming apps (e.g. See through, HD media streaming)	☐	☐	☐	☐	☐

2.4. In what areas is further expertise and/or substantial progress necessary for your organization to be able to offer the following 5G-CCAM services?
(Please tick the crucial areas)

	Technology	Legislation	Procurement	Revenue share	Other, please specify
Platooning	☐	☐	☐	☐	______
Infrastructure/cloud assisted autonomous driving	☐	☐	☐	☐	______
Cooperative collision avoidance	☐	☐	☐	☐	______
Remote driving	☐	☐	☐	☐	______
Video streaming apps (e.g. See through, HD media streaming)	☐	☐	☐	☐	______

Not important		Somewhat important		Very important
☐	☐	☐	☐	☐

2.5. How important is the implementation or integration of 5G-CCAM services to your organisation?

3. Customer Segments

3.1. Please specify the respective target groups for the 5G-CCAM services.

	Vehicle drivers	Passengers	Fleet owners	Transport operators	Road operators	Other, please specify
Platooning	☐	☐	☐	☐	☐	________
Infrastructure/cloud assisted autonomous driving	☐	☐	☐	☐	☐	________
Cooperative collision avoidance	☐	☐	☐	☐	☐	________
Remote driving	☐	☐	☐	☐	☐	________
Video streaming apps (e.g. See through, HD media streaming)	☐	☐	☐	☐	☐	________

4. Customer Relationships

4.1. Please rate the changes that the mentioned 5G-CCAM services will bring to your relationship with your customers:

	Completely change				No changes at all
Platooning	☐	☐	☐	☐	☐
Infrastructure/cloud assisted autonomous driving	☐	☐	☐	☐	☐
Cooperative collision avoidance	☐	☐	☐	☐	☐
Remote driving	☐	☐	☐	☐	☐
Video streaming apps (e.g. See through, HD media streaming)	☐	☐	☐	☐	☐

5. Key Partners

5.1 What partnerships are essential for you as an OEM to provide or offer 5G-CCAM services? Please tick the required partners and give an order of priority from 1 (the most important partner) to the number of your total needed partners (the least important partner).

Partnerships	This partner is needed	Ranking (1 to x)

Government		
Fleet Owner		
OBU Provider		
Cloud/ MEC Provider		
Network Operator		
Network Equipment Provider		
Road Operator		
RSU Provider		
Software solution/ CAM service provider		

5.2 What steps are needed to form the cooperation between the above-mentioned partners?

	Technology	Legislation	Procurement	Revenue share	Other, please specify
Government	☐	☐	☐	☐	______
Fleet Owner	☐	☐	☐	☐	______
OBU provider	☐	☐	☐	☐	______
Cloud/ MEC Provider	☐	☐	☐	☐	______
Network Operator	☐	☐	☐	☐	______
Network Equipment Provider	☐	☐	☐	☐	______
Road Operator	☐	☐	☐	☐	______
RSU Provider	☐	☐	☐	☐	______
Software solution/ CAM service provider	☐	☐	☐	☐	______

6. Obstacles and Changes

6.1. As an OEM do you have any concerns related to accepting manoeuvre, coordination messages from a road infrastructure?

yes ☐ No ☐

If yes, please specify, what kind of concerns: ______________________________

6.2. What kinds of challenges do you see related to data issues?

6.3. Please describe the expected level of costs required for data protection, in relation to your current revenue stream.

Negligible	Minor	Moderate	Significant	Severe
☐	☐	☐	☐	☐

6.4. Please describe legal terms and other conditions that have to be established, so that you can offer 5G-CCAM services?

6.5. What other obstacles do you see that need to be resolved so that you can offer 5G-CCAM services?

The following questions in the section below, aim to obtain financial information. Due to the sensitive nature of the questions, we fully understand if you hesitate to give any statements. However, by providing even some indicative figures you would help us to precise our research results.

7. Cost Structure

7.1 Please estimate the expected increase in the following cost categories for producing/offering of 5G-CCAM services, in relation to your current total costs for the next 10 years:

	Negligible	Minor	Moderate	Significant	Major
Staff					
Equipment and materials					
Consulting / External Services					
Network / Cloud / Hosting					
Patents / Sublicense / Software license					
Others (please specify):					

7.2 Please select your preferred mode of payment (frequency) for each cost category:

	One-time payment	Payment per use	Pay per vehicle	Monthly / quarterly / yearly fees	Other, please specify:
Equipment and materials					
Consulting/External Services					
Network/Cloud/Hosting					
Patent / Sublicense / Software licenses					
Others (please specify):					

8. Revenue Streams

8.1 Please describe each of your current revenue stream in the context of connected vehicles (e.g. pay GSM operator per vehicle for cloud usage and earn from customer first year free, after first year monthly payment or when customer activate when she/he needs and pay etc.).

8.2 Please describe expected impact in revenue for your organisation through offering the following 5G-CCAM services for the next 10 years:

Impact Level:				
Negligible	Minor	Moderate	Significant	Severe

Platooning					
Infrastructure/Cloud Assisted Autonomous Driving					
Cooperative Collision Avoidance (CoCA)					
Remote Driving					
Video Streaming Apps. (e.g. See Through, HD Media Streaming)					

8.3 Please comment if you have suggestions for innovative new revenue opportunities, e.g. based on gathered data, driver profiles, reward concepts for 5G-CCAM services etc.

9. Please write here if you have any other comments or suggestions with regard to business perspectives on 5G-CCAM services:

THANK YOU FOR YOUR VALUABLE INPUTS FOR OUR RESEARCH!

Annex 2 – PRESENTATION

An example page for Platooning User Story can be seen below. The all user stories has been elaborated in this presentation.