# Deliverable 1.2

## CCAM vocabulary and stakeholders needs and requirements for CCAM solutions

| | |
|---|---|
| Version number: | 1.0 |
| Main author: | Lazaros Giannakos, Anna Antonakopoulou (ICCS) |
| Dissemination level: | Public |
| Internal Reviewers: | Giulia Renzi (ICOOR), ERTICO |
| Lead contractor: | ICCS |
| Due date: | 28 February 2023 |
| Delivery date: | 15 March 2023 |

| Version history | | | |
|---|---|---|---|
| **Version** | **Date** | **Main author** | **Summary of changes** |
| 0.1 | 11/11/22 | Lazaros Giannakos, Anna Antonakopoulou | First draft |
| 0.2 | 16/01/23 | ICOOR (Stakeholders' needs and requirements / VOCABULARY)<br>TUD (Stakeholders' needs and requirements / VOCABULARY)<br>ERTICO (Stakeholders' needs and requirements / VOCABULARY)<br>ARRIVA (Stakeholders' needs and requirements / VOCABULARY)<br>RELAB (VOCABULARY)<br>N-Brabant (VOCABULARY)<br>TfWM (VOCABULARY)<br>FHH (VOCABULARY)<br>e-Trikala (VOCABULARY) | Input concerning stakeholders' needs and requirements and the CCAM vocabulary from partners integrated |
| 0.3 | 31/01/2023 | Lazaros Giannakos, Anna Antonakopoulou | Second draft |
| 0.4 | 10/02/2023 | Lazaros Giannakos, Anna Antonakopoulou | Version completed for the internal review |

| | | | |
|---|---|---|---|
| 0.5 | 13/02/2023 | Giulia Renzi | Peer review |
| 0.6 | 20/02/2023 | John Paddington, Andrew Winter | Peer review |
| 0.7 | 15/03/2023 | Lazaros Giannakos, Anna Antonakopoulou | Version improved after the internal reviewers |
| 0.8 | 17/03/2023 | Andrew Winder | Final quality check |
| 1.0 | 20/03/2023 | Giulia Renzi | Submission |

**Legal disclaimer**

# Table of Contents

## List of Tables



## List of Figures

# Executive Summary

The purpose of this report is to identify the real and perceived (mobility) needs of all stakeholders in the Cooperative, Connected and Automated Mobility (CCAM) ecosystem. Highlighting and understanding gaps in the deployment of CCAM solutions is key to fostering best practices for CCAM deployments.

CCAM incorporates all digital services and functions necessary to achieve viable, efficient, equitable and inclusive automated, semi-automated or assisted driving covering a vast and ever-expanding range of advanced technologies. The CCAM ecosystem is examined herein. Digital, physical and operational road infrastructure, digital enabled platforms, vehicle technologies and cyber security and privacy are recognized as the CCAM functional areas and their purpose, building blocks and actors involved are presented. Key stakeholders in the CCAM ecosystem are accordingly recognized and classified in broader categories taking into consideration SINFONICA's goal to engage them in the participatory approach and build a knowledge base concerning their visions, priorities, needs and requirements. SINFONICA key stakeholder categories are therefore CCAM Industry, Transport / Mobility Operators, Service Providers, Public Administration, Research Sector, Legislators, Representative Bodies, Citizens, Large-Scale demonstration projects. Furthermore, multimodal complementary services enabled with Demand-Responsive Transport and shared mobility services are recognized as the main focus of CCAM related to public transportation representing a shift of the private motorized transport towards multimodal mobility and Mobility-as-a-Service.

In order to capture the interrelationships in the CCAM ecosystem, key stakeholders' needs and requirements are examined from several perspectives. Aggregated results are presented classifying needs and requirements as operational/organizational, technical, legal and regulatory, financial and social or a combination of them, capturing the respective goals and dilemmas as well as the key stakeholders involved in each one. Some of the key findings concern:

- the safety of operations and technology, cooperation and knowledge sharing between stakeholders,
- harmonization of services,
- interoperability and standardization of components and interfaces,
- consolidation of regulations, data privacy,
- affordable business models and services, and
- inclusiveness and equity for all.

Evidently, several needs are addressed for several stakeholders and from different perspectives. Furthermore, recognizing the complexity of the CCAM ecosystem and the need for a common understanding of notions and terminology related to the CCAM ecosystem by all stakeholders. SINFONICA has created a comprehensive CCAM vocabulary to be used throughout the project duration and to act as a model for future projects. A classification of terms related to the CCAM ecosystem is made accordingly as:

- General terms related to CCAM.
- Terms related to automation capabilities of vehicles.
- Terms related to vehicles equipment.
- Terms related to data, communication & connectivity.
- Terms related to CCAM services.

- Terms related to infrastructure and management.
- Terms related to CCAM legislation.
- Terms related to CCAM deployment.
- Terms related to CCAM users and social aspects of CCAM.

The CCAM Vocabulary is also intended to be used after the end of the SINFONICA project as a reference point for future CCAM projects.

# Abbreviation list

| Abbreviation | Description |
|---|---|
| API | Application Programming Interface |
| AV | Automated Vehicle |
| CAV | Connected and Automated Vehicle |
| CCAM | Cooperative, Connected and Automated Mobility |
| C-ITS | Cooperative Intelligent Transport Systems |
| DRT | Demand Responsive Transport |
| EC | European Commission |
| EU | European Union |
| GDPR | General Data Protection Regulation |
| H2020 | Horizon 2020 EU Research and Innovation Programme |
| HMI | Human-Machine Interface |
| ICT | Information and Communication Technology |
| IoT | Internet of Things |
| ITS | Intelligent Transport Systems |
| MaaS | Mobility-as-a-Service |
| ODD | Operational Design Domain |
| OEM | Original Equipment Manufacturer |
| PKI | Public Key Infrastructure |
| PSAP | Public Safety Answering Point |
| SME | Small and Medium Enterprise |
| TMC | Traffic Management Centre |
| VRU | Vulnerable Road User |
| WP | Work Package |

# 1. Introduction

## 1.1 Purpose and structure of this document

This document includes the definition of the Cooperative, Connected and Automated Mobility (CCAM) ecosystem, a comprehensive CCAM vocabulary for the full course of the SINFONICA project and the specific ecosystem visions, needs, requirements, priorities, and dilemmas as captured through literature review. The outcome of this Deliverable will be used during the next phases of the project in order facilitate the co-creation and engagement activities as well as the interactions and discussions with users (including vulnerable user groups), citizens, and stakeholders.

## 1.2 Methodology

An extensive literature and projects review has been carried out in order to identify the functional areas of CCAM, their building blocks and purpose as well as the stakeholders involved in each one. Based on the finding and preliminary findings of the SINFONICA project concerning the research groups which will be engaged during the project, key stakeholder groups are identified. Furthermore, key concepts and services related to CCAM are examined under the perspective of SINFONICA project. The vision, priorities, needs and requirements of the key stakeholder groups are also reported and classified accordingly capturing the strong interrelationships between stakeholders their respective needs and requirements. Finally, a comprehensive vocabulary related to CCAM has been created based on the literature and project review aiming to create a common understanding between all stakeholders involved in the SINFONICA project or interested in CCAM as well as to act as a reference point for future projects.

## 1.3 Intended audience

The main target group for this Deliverable is all partners and stakeholders of the project as well as all the people, stakeholders, researchers and public administration that are interested in dealing with CCAM. As a public deliverable, it is also relevant to other CCAM-related research projects and deployments. It focuses on a common well-defined framework which will facilitate the engagement of all different stakeholders to get a comprehensive and concise view of their vision, needs, requirements, priorities, and dilemmas.

## 1.4 Interrelations

This Deliverable will set the ground for the recognition and understanding of the gap of CCAM solutions deployment which will be the main focus of SINFONICA D1.3: "Understanding the Gap of CCAM solutions deployment". The CCAM vocabulary will be used during the next phases of the project. Specifically, it will be used during WP2 and WP3 in order to provide a common understanding of the CCAM ecosystem which is considered critical for the implementation of the stakeholders' engagement strategy and participatory activities. Moreover, it will form the baseline for the innovative tool, SINFONICA Knowledge Map Explorer, to be developed within WP4.

# 2. The CCAM ecosystem

## 2.1 Introduction

Mobility is at the forefront of the new digital era allowing the communication between vehicles, infrastructure, and road users. Cooperative, Connected and Automated Mobility (CCAM) in the road transport sector is expected to reshape the way we move and travel. Combining connectivity, cooperative systems and automation can enable smart traffic management, CCAM enabled shared mobility services integration with public transport and Mobility-as-a-Service (MaaS) platforms as well as automated public transport services. CCAM focuses on user-centred, all-inclusive mobility while increasing safety. It should also reduce congestion, and contribute to decarbonization with the aim to achieve Vision Zero. Research into the CCAM field continues to articulate its potential to transform urban landscapes and existing transport systems and networks representing a socio-technical transition of the mobility system.[1]

## 2.2 CCAM functional areas

CCAM incorporates all digital services and functions necessary to achieve viable, efficient, equitable and inclusive automated driving covering a vast and ever-expanding range of advanced technologies. A classification of the CCAM functional areas is presented in this section taking into consideration all physical and digital aspects related to the CCAM ecosystem. The following Table presents these functional areas along with their purpose, building blocks and actors involved in each one as recognized by the European Commission standardization project EU-ICIP[2].

*Table 1. The CCAM functional areas, their purpose, building blocks and typical actors involved*

| CCAM functional area | Purpose | Building blocks (Elements / Components / Technologies / Data (spaces)) | Typical Actors |
|---|---|---|---|
| Digital enabled platforms | To provide platform-based transport services for citizens, corporations, academia, and governments. | Transport related digital platforms may be:<br>• MaaS platform<br>• Parking solutions<br>• Online travel agencies<br>• Accommodations<br>• Home deliveries<br>• Digital freight platforms<br>• Map solutions<br>• Frontend systems for Personal ITS Station<br>• Automated driving simulators for AI algorithm development through crowd sourcing | • Government bodies<br>• and Medium Enterprises (SME)<br>• International corporations<br>• Non-profit organizations |

[1] CCAM Strategic Research and Innovation Agenda (v1.4), March 2022
[2] https://www.mobilityits.eu/

| CCAM functional area | Purpose | Building blocks (Elements / Components / Technologies / Data (spaces)) | Typical Actors |
|---|---|---|---|
| Digital roads and associated infrastructure | To provide static and dynamic digital representations of the physical world with which CCAM vehicles interact (e.g., maps, traffic regulations, traffic, and travel information). May also include datasets collected from automated driving to be used in simulators. | • National Access Points<br>• Common European data spaces<br>• Traffic information<br>• Geographic information<br>• Lidar point clouds<br>• Whether data<br>• Public transport information<br>• Parking information<br>• MaaS data sharing<br>• Standardized test data from automated driving<br>• SOAP/REST Web Service API<br>• Message Queues solutions (e.g., AMQP, MQTT) | • Government bodies:<br>  ○ Road and transport authorities<br>  ○ Public transport<br>  ○ City government<br>  ○ National mapping agencies<br>  ○ Weether services<br>• Small and Medium Enterprises (SME):<br>  ○ Parking services<br>  ○ MaaS providers<br>  ○ Roadside assistance<br>• International corporations:<br>  ○ Navigation system providers<br>  ○ Auto manufacturers<br>• Non-profit organizations:<br>  ○ Aid organizations<br>  ○ Environmental organizations |
| Operational road infrastructure | To provide fleet and traffic management functions which facilitate traffic flow by issuing information or guidance including tele-operated driving of automated vehicles, concierge services and eCall Public Safety Answering Point (PSAP). | Operational control systems may be:<br>• Regional Traffic Management Centres<br>• Vehicle Original Equipment Manufacturer system with navigation functionality<br>• Fleet management<br>• Automated Road Maintenance Management systems<br>• Tele-operation | • Vehicle manufactures and navigation systems providers<br>• Fleet operators (including operators of automated vehicles<br>• Tele-operation centres<br>• Traffic management centres |
| Physical road infrastructure | To allow vehicles and people to move in an efficient and seamless way from point to point.<br>It can expand the Operational Design Domain (ODD) of automated driving functions by providing | It comprises the physical world where vehicles operate including:<br>• roads<br>• road signs<br>• road markings<br>• pavements<br>• parking / drop-off areas<br>• sensors | • Transport authorities<br>• Road operators<br>• Road construction and maintenance contractors<br>• Toll road operators<br>• C-ITS infrastructure providers<br>• Mobile network operators |

| CCAM functional area | Purpose | Building blocks (Elements / Components / Technologies / Data (spaces)) | Typical Actors |
|---|---|---|---|
| | additional sensory input for the vehicles by means of roadside mounted cameras, radars, and whether stations, as well as status information from tunnels and bridges | • physical communication infrastructure equipment<br>• enhanced positioning infrastructure. | • Providers of enhanced positioning solutions<br>• Weather services<br>• Charging station providers<br>• Parking providers |
| Vehicle technologies | Focuses on in-vehicle technologies for connected and automated vehicles (CAVs) that will improve perception, prediction, and planning functions, enable safe collaboration with other road users, and activate protective measures in case of emergency. | • Standardization of sensing devices<br>• Infrastructure-based sensing and sensor fusion<br>• Cooperative perception<br>• Distilled AI functions for on-board decision making<br>• Cooperative manoeuvres<br>• Standardized human machine interaction (HMI)<br>• Assess chauffeur and logging of accident data<br>• Automatic call for help<br>• Sharing of vehicle data with the digital road infrastructure | • Manufactures of vehicles with automated driving functionality<br>• Suppliers of components and solutions for automated driving<br>• Vehicle type approval authorities and authorized technical services organizations<br>• Fleet operators of automated vehicles<br>• Road operators and road construction and maintenance contractors using automated road maintenance machines<br>• Tele-operation centres used as fall-back solutions for automated vehicle stranded outside their Operational Design Domain (ODD) |
| Communication, cyber security and Privacy | To enable secure, seamless, efficient, robust communications between on-road devices, vehicles, infrastructure and other road users. | • Public Key Infrastructure (PKI) authentication and verification of exchanged data<br>• Hardware security module (HSM) for storing of certificates, intrusion detection and response, secure software updates, and General Data Protection Regulation (GDPR) compliance<br>• Wireless communication (e.g., short-range ITS-G5, | • Industry<br>  ○ Automobile manufacturers<br>  ○ Automotive suppliers<br>  ○ ITS solution providers<br>  ○ Telecom industry<br>  ○ Mobile network operators<br>  ○ Cloud providers<br>• Government<br>  ○ Transport authorities<br>  ○ Road authorities<br>  ○ Road operators<br>  ○ Emergency responders<br>• Service providers |

| CCAM functional area | Purpose | Building blocks (Elements / Components / Technologies / Data (spaces)) | Typical Actors |
|---|---|---|---|
| | | long-range cellular communication)<br>• Communication protocols (e.g., HTTP, AMQP, MQTT)<br>• C-ITS hybrid communication<br>• Authentication standards (e.g., FIDO, OAuth) | ○ Roadside assistance<br>○ Public transport<br>○ Mobility and logistics providers<br>○ Insurance companies<br>○ Toll road operators |

This classification will be used during the next phases of the SINFONICA project both to facilitate the common understanding necessary for the participatory activities and the development of the innovative tool SINFONICA Knowledge Map Explorer via the exploitation of ontologies that will facilitate the effective and efficient knowledge-sharing among CCAM stakeholders.

Figure 1 depicts the CCAM functional areas as presented above and their interrelationships.

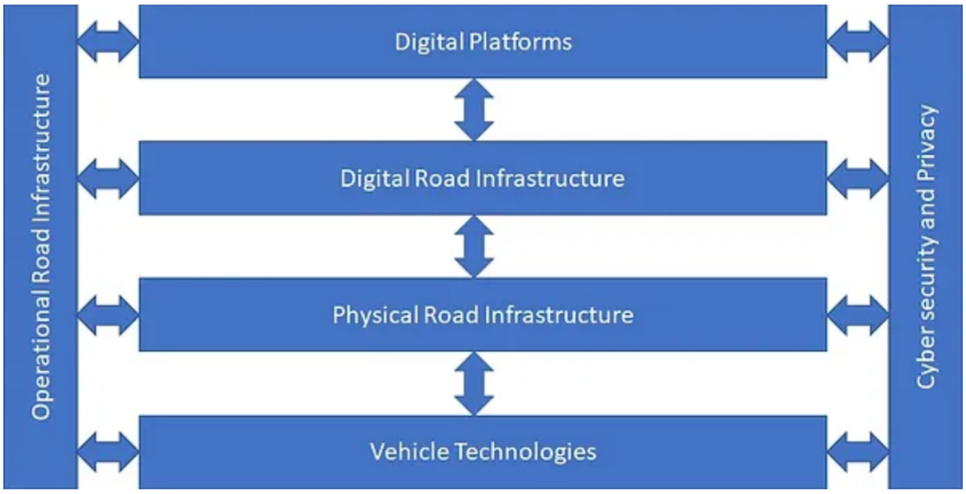


*Figure 1: The CCAM functional areas and their interrelationships*[3]

## 2.3 Actors in the CCAM ecosystem

A key objective of SINFONICA is to develop strategies to engage CCAM users and stakeholders to collect, understand and structure in a manageable way their needs, expectations, and concerns with respect to the CCAM technology. SINFONICA aims to have a wide impact and include in its final decision tools as many users, providers, and stakeholders as possible.

CCAM solutions encompass the mobility of goods and people and has a big influence in terms of urban and regional development. The hope for the future is to enhance the shift towards smart mobility concepts in an inclusive way and, in order to guarantee the possibility of taking informed decisions for social inclusive CCAM transport systems depending on their context, the information collected in SINFONICA and in other National and International projects are fundamental. Thanks to this information, each stakeholder will be able to use guidelines on the implementation and

[3] https://www.mobilityits.eu/ccam-connected-vehicles

development of CCAM solutions. It is clear that stakeholders play a key role in the CCAM future: they must work together to address CCAM challenges answering real needs.

To be sure that the stakeholders are represented within SINFONICA, they will be included both into the Groups of Interest (GoI) and into the Groups of Followers (GoF). The GoI are managed by four actors: Trikala, Hamburg, West Midlands, and Noord Brabant and they will be composed of future CCAM users and stakeholders. On the other side, the GoF are comprised of key stakeholders that are involved or interested in CCAM solutions. Based on the stakeholders involved in the CCAM functional areas and preliminary findings of the SINFONICA project concerning the composition of GoI and GoF, key stakeholder groups are identified as presented in Table 2. Several stakeholders are intended to be involved later in the SINFONICA project in order to assess all the strategies and tools that will be developed within the SINFONICA project.

*Table 2. SINFONICA Target groups*

| Stakeholders | Definition | Importance of the involvement to SINFONICA's Scope |
|---|---|---|
| **Industry**<br>(e.g., Technology Developers & Suppliers, Automobile Manufacturers, Automotive suppliers, Telecom industry) | Industrial customers purchasing a product or service with the aim of integrating it into another product or service to be sold on another industrial market or to a final consumer. | The involvement of this category of stakeholders is of fundamental importance because it allows a clear view on the customer needs, as well as the possibilities and availabilities of different products and their costs. |
| **Service providers**<br>(e.g., Technology Companies, Insurers, Cloud Providers, Mobile network operators, Digital enabled Platforms Providers, Payment Providers) | Entities that provide services to another party. Service providers in CCAM may provide services related to communication, mapping, insurance, data storage and payment. | Service providers play a significant role in the CCAM ecosystem providing specialized services based on their expertise necessary for the functionality of the whole system. Understanding their perspectives will allow a comprehensive view regarding the state of the art of the available technology and their involvement in the CCAM ecosystem. |
| **Transport/Mobility Operators**<br>(e.g., Road Authorities, Transport authorities, Road operators) | A transport/mobility operator is a provider of mobility services which are either paid for directly, by subscription, or are free at the point of use (for example some public services). | Transport and Mobility operators will be involved to have a clear view on the organization of the road, the different needs and the possible problems and obstacles that must be considered. |
| **Public Administration**<br>(e.g., Municipalities, Provinces, Regions, Local Transport Authorities) | Field in which leaders serve communities to advance the common good and effect positive change, including provision of public services that are considered essential (either direct provision, or indirectly via franchising/ | It is of utmost importance to understand the methodologies of engagement via discussion with citizens and implementation of participatory projects. For these reasons, the involvement of the public administration will be strategic: they will constitute a sort of bridge between different stakeholders and citizens, |

| Stakeholders | Definition | Importance of the involvement to SINFONICA's Scope |
|---|---|---|
| | contracting). In most cases administrations are also infrastructure owners (roads and streets) and are often also operators. | explaining point of strength and of weaknesses of cities, regions, and provinces. |
| **Research Sector**<br>(e.g., Universities, Research Centres, R&I Departments) | An establishment, laboratory or research and teaching organisation specialising in technological and human sciences. May specialise in basic research or may be oriented towards applied research. May be in partnership with universities, companies, or ministries. | There is the need to bridge the gap between technical research on CCAM and the social innovation point of view. The research sector will help all the stakeholders in the process of understanding CCAM, explaining the technical innovations and the social potentiality. |
| **Legislators**<br>(e.g., Policy makers, Regulators) | Policymakers who are entitled to improve the overall mobility of people as well as to collect the revenues. They formulate and issue laws and regulations that organize the transport sector and the connection with other relevant sectors. The top-level legislator is the government and its representative bodies, while the low-level representatives are the ministries' branches such as municipalities, regional and local authorities. | It is fundamental to involve legislators to identify the rules for the use of CCAM respecting safety, fairness, and inclusivity standards. The legislators – including insurers, policy makers and regulators - act as a funnel to gather information through consultation and research and to reduce and extract from the information, a policy or a set of policies which serve to promote CCAM in the real world and not just in the test sites. |
| **Representative bodies**<br>(e.g., Automobile Associations, Trade Associations, Technology cluster etc.) | Stakeholders' associations representing the interests of a sector and/or their own members in various ways. | It is crucial to involve representative bodies to foster dialogue on CCAM technologies understanding the current perceptions towards the use of it. Engaging representative bodies can allow gain insight into their members' needs and requirements and foster CCAM deployment. |
| **Citizens**<br>(e.g., Vulnerable Users, Commuters, People with mobility challenges, Citizens from Rural or Peripheral Areas, etc.) | Inhabitants of a particular town, city, region or country. They may be users of CCAM services or road users that participate in the surrounding traffic without being direct CCAM service users (including | Citizens are at the heart of the discussion involving CCAM, its potential benefits and social impacts. They constitute the starting point of SINFONICA, and they are the main players of the co-creation activities. Their engagement is fundamental for SIFNONICA |

| Stakeholders | Definition | Importance of the involvement to SINFONICA's Scope |
|---|---|---|
| | pedestrians, cyclists, public transport users, etc.). | as they will be the ones to decide if CCAM is successful. |
| **Large-Scale Demonstration projects** | CCAM-related projects that focus on the technical advancement, harmonization and interoperability of CCAM services across Europe and are based on cross-sectoral collaboration aiming to assess the performance of CCAM services and demonstrate value-add, benefits and positive impacts for society. | Several large-scale demonstrations have been organized in the last few years in the context of national, international, and European projects. Their experiences and their perspectives are of fundamental importance for SINFONICA not just to develop further guidelines for the next large-scale demonstrations, but also to understand who could participate to those demonstrations, who for several reasons were excluded and how all the process could be improved. |

The understanding of these stakeholders' point of view is fundamental for the SINFONICA strategies: without knowing the different needs, perspectives, ambitions and concerns it will be impossible to develop an inclusive, accessible, and equal CCAM that can be a real opportunity not just for citizens and potential users, but also for all the actors involved in the mobility sector.

## 2.4 CCAM concepts and services

CCAM has the potential to mitigate climate change through reducing traffic, emissions, and dependency on private vehicles. It can also play a crucial role connecting remote areas to central or urban areas. Sustainable transport can be defined through objectives for: i) economic efficiency, including improved regional connectivity, ii) social equity, including improved access to overcome socio-economic and spatial marginalisation, and iii) environmental sustainability, including reduced pollution, congestion, and noise. Sustainable and flexible transport is at the core of CCAM in order to address those objectives[4,5]. CCAM also has the potential to address logistics needs either separately or as a combination with passenger transport.

Considering public transportation, which is also the main focus of the groups of interest involved in SINFONICA, CCAM focus is on multimodal complementary services with demand-responsive or flexible characteristics[5]. Increasing demand for flexible Demand-Responsive Transport (DRT) and shared mobility concepts, able to complement public and private transport, represent a shift from the "traditional" private motorized transport to multimodal mobility and towards the concept of Mobility-as-a-Service (MaaS). This is an approach in which several transport services are technologically linked to each other and integrated in a single platform offering on-demand services to users and a single source for routing information, booking and payment options[4].

DRT is a user-oriented form of passenger transport which utilizes mainly smaller vehicles than fixed scheduled public transport does, operating on flexible routes in a shared-ride mode according to users' needs. It represents an alternative to fixed-route public transport since it is not tied to fixed

[4] Bauchinger et al., 2021
[5] UITP, 2017

pick-up and drop-off locations and a fixed schedule. Although, fixed-route public transport may be more cost-efficient if the occupancy rate is high, financial sustainability may not be achieved if the demand is low which is a usual case for rural and sparsely populated areas. Information and communication technology (ICT) and automation have strengthened the potential of DRT, addressing needs like online booking, smart systems capable to match supply and demand effectively and enabling users to request a real-time ride. Examples of DRT may include shared “robo-taxis” and “call-a-bus” (mini-bus or shuttle) service which provide first and last mile connectivity. On-demand systems may be cost-intensive to deploy and often not economically profitable. A sustainable business model could be addressed through public private partnerships[6].

Shared mobility, as part of the Sharing Economy, involves and organizes sharing of mobility services and vehicles. Shared mobility services may be arranged between operator and user, enabling available vehicles (e.g., cars, bicycles, scooters etc.) and infrastructure (e.g., parking spaces) to be used independently. Shared vehicles may be bound to fixed stations or freely available in a defined area. A high density and a well-balanced distribution of vehicles at key locations within an occupancy area are critical for systems bound to fixed locations. Sharing systems are mostly found in urban areas, however they also have the potential to offer an alternative to private car ownership and act complementary to public transport, enabling highly flexible individual multimodal mobility[6].

Introducing Connected and Automated Vehicles (CAVs) in fleets of shared and on-demand vehicles of different sizes reinforcing an efficient high-capacity public network supporting walking and cycling has the potential to address the challenges of environmental and financial sustainability, equity, and inclusiveness. Figure 2 provides an overview of the complementary multimodal mobility concepts and services.

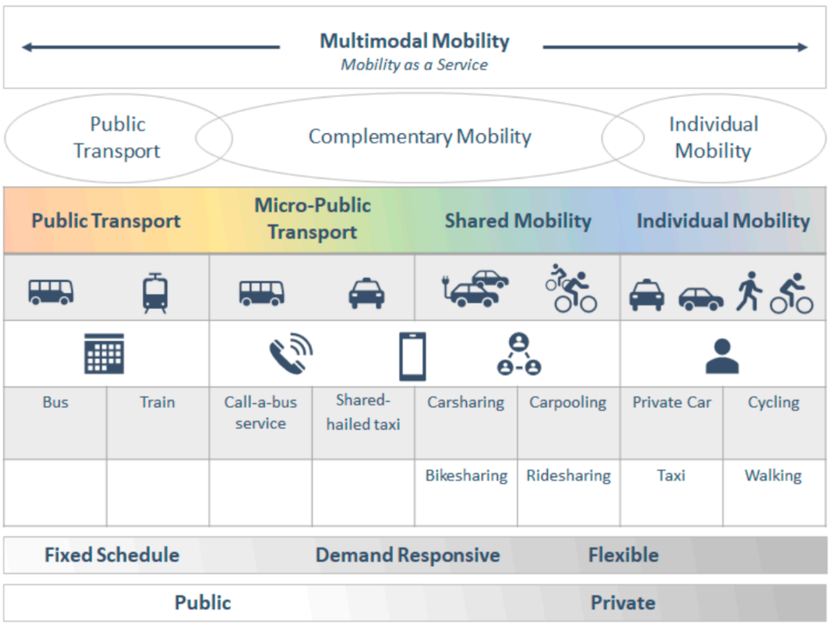


*Figure 2: Mobility concepts and services[6]*

[6] Bauchinger et al. (2021)

# 3. Stakeholders needs and requirements for CCAM solutions

SINFONICA aims to develop a better understanding of the visions, priorities, and dilemmas of the key stakeholders of the CCAM value chain, based on literature and projects review, on how to "bundle" the various offered CCAM applications so that they provide better value for money following in parallel a user-centred approach towards inclusive mobility solutions.

## 3.1 Introduction

The availability of CCAM solutions on the market is undoubtedly creating a novel situation for every stakeholder. The new technologies and possibilities that CCAM encompass urge for reshaping the "traditional" transport system since CCAM deployment impacts on several critical aspects like the infrastructure and the capacity of the road network, people's mobility, travel patterns and car ownership, safety, and accessibility, as well as the environment, economy, health, and land use patterns. The influence of CCAM and key stakeholders on each other have not yet been determined since CCAM is still new and evolving. The following critical tasks which should be iteratively addressed during CCAM solutions deployment taking into consideration the ever-evolving inherent technology dynamics which accompany CCAM are suggested[7]:

- Determining the advantages and disadvantages of introducing CCAM in its full potential,
- defining the challenges and risks of CCAM solutions deployment and recognizing stakeholders needs and requirements.

Different stakeholders have different CCAM concerns, but some aspects are common to everyone, like the reliability of the service, the safety of the service, the compliance with GDPR regulations and the opportunity to create a solution to decrease environmental impact and reduce traffic congestions within the cities. CCAM services are also intended to be accessible and user friendly to involve a wide public.

SINFONICA aims to provide guidelines and recommendations to cities interested in deploying CCAM technologies. Thanks to its innovative approach, SINFONICA will be able to identify strategies which are effective, safe, and inclusive, targeting users' groups with mobility challenges such as elderly, young people and migrants. SINFONICA also aims to create an integrated strategy to develop a final decision support tool for designers and decision makers for an equitable CCAM technology deployment. This means that all major stakeholders' concerns like road safety, data management, data sharing, and user concerns towards the CCAM technology are going to be considered.

## 3.2 CCAM deployment aspects

Certainly, different cities have different needs when it comes to CCAM and the performance of different types of CAVs will depend on each city's particular characteristics and maybe other forms of transportation, like micro mobility, would fit better in some circumstances (Richter et al., 2022). Furthermore, a range of options for deploying CCAM solutions are possible. Integrating CAVs in public transportation, operating a fleet of shared CAVs and offering Demand Responsive Transport (DRT) solutions in the form of Mobility as a Service (MaaS) are the most prominent CCAM solutions. Of course, this will depend on each city's particular characteristics and a mix of those solutions may

[7] Hamadneh et al., 2022

be implemented in most cases[8]. For this reason, different geographical areas are considered in SINFONICA, focusing on cities and regions with different characteristics.

Cooperation, automation and connectivity are intended to play an important role in easing transport congestions in cities and decreasing pollution. Several research projects have tested the viability of CCAM solutions on broader test areas. As part of the project CoEXist[9], the Urban Transport Committee of the city of Gothenburg approved the "Strategic plan for traffic innovation within the areas of electrification, digitalization and automation for the period of 2020-2023" with the aim to ensure that the City of Gothenburg would be a leading actor in the development of CCAM. The results have been unclear about how the gradual introduction of CCAM will impact the transportation system therefore the concept shall still be treated as a work in progress.

Other projects worth mentioning are C-Mobile[10], which analysed the existing C-ITS architectures to create a reference for a pan-European model, and SHOW[11], demonstrating real-life urban deployments in 20 cities across Europe with the integration of automated vehicles in public transport, demand-responsive transport (DRT), Mobility as a Service (MaaS) and Logistics as a Service (LaaS) schemes. Furthermore, the EU Project CityMobil2[12] tested automation in Public Transport, where a fleet of four vehicles and two back-ups operated in mixed traffic conditions within the city of Trikala, Greece. The results arose from that project reported uneven response from the passengers in terms of their feelings towards safety and ease with respect to travel in automated vehicles. To demonstrate the safety and reliability of autonomous vehicles, further projects to push the state of the art have been developed such as the project UP- Drive[13]. Thanks to the collaboration of research findings and industry expertise it was possible to integrate and test automated driving focusing on urban development.

### 3.2.1 Harmonization and Interoperability

A well-recognized need for CCAM solutions deployment and the implementation of C-ITS services is the harmonization and interoperability of the deployment activities and the systems' architecture. C-ROADS Platform[14] is an example of a joint initiative of the European governments and road operators for testing and implementing C-ITS services towards this direction[15]. 5G-DRIVE[16] is another project between EU and China that trialled and validated the interoperability between EU and China 5G networks for Vehicle-to-Everything communication (V2X) scenarios.

Along with the need for harmonization and interoperability of CCAM solutions comes the need for interoperability of all technological components integrated in the CCAM system. An example of the need for interoperability among the technological bricks of CCAM is the AUTOPILOT[17] project which developed open IoT vehicle platform specifications taking into consideration the core functionalities like interoperability, service-based, context-awareness, data management and open standards

---

[8] Kacperski et al., 2021b
[9] Franco et al., 2020
[10] Daisuren et al., 2017
[11] https://show-project.eu/
[12] https://cordis.europa.eu/project/id/314190/reporting
[13] Daisuren et al., 2017
[14] https://www.c-roads.eu/platform.html
[15] Ayaida & Schappacher, 2021
[16] https://5g-drive.eu/
[17] Visintainer et al., 2019

among others. Technology developers and suppliers, vehicle manufacturers and service providers should consider the core functionalities of their assets so that they are interoperable and transferable to all environments[18, 19]. They also need to make sure that the technology provided is user-friendly and with easy and equal access from all the potential users, including the part of the population which might not be familiar with new technologies. This means creating a technology that needs to be integrated into services or applications to be used by all without considering their socio-economical background or status.

The Research sector plays an important role in developing and testing CCAM solutions tailored to real world needs. A common, single architecture for optimal CCAM services is a prerequisite in order to ensure interoperability and optimal services[20]. In this context, the interoperability of CCAM solutions and C-ITS services would significantly be supported by a flexible modular structure which would allow the reuse of different technology elements by various OEMs, Tiers, component suppliers, academia and research institutes, technology suppliers and of course for different applications. This modular and reusable structure would enable the efficient and fast CCAM solutions development and deployment independent of the technology supplier. The sustainability of this modular structure would of course be dependent on the standardization of the components' interfaces that would allow the integration of different technological bricks into the system chain[21].

Large-scale demonstration projects are a technically viable reality and are already happening, but standards to ensure interoperability and data access must be put urgently in place, so that the market uptake is not hindered, and full deployments are not delayed. Furthermore, the defined infrastructure must support various technologies and C-ITS architecture should address the need of various stakeholders including end-users, drivers, people with mobility challenges, cyclists, pedestrians, and other Vulnerable Road Users (VRUs). Large-scale demonstration projects should also take into consideration the integration of an adequate number of CAVs into each trial site so that research results are valid and robust[22, 23].

### 3.2.2 Integration of CAVs

A key aspect that arises from a research point of view as well as from and operational one is the integration of different CAVs (private vehicles, shuttles, cargo etc.) in city traffic. Vehicle manufacturers must integrate CCAM components within vehicles and its infrastructure[24]. Their final goal should be related to the implementation of vehicles able to smoothly collaborate with other vehicles and devices in order to improve awareness and functions useful to increase safety and traffic efficiency.

The SHOW[25] project has shown that a traffic study is necessary in every case in order to investigate and analyse current transportation systems and assess the impact that a fleet of CAVs, particularly when deploying several types of CAVs in its trial sites. However, results are limited by the relatively small number of CAVs present in trials. Simulation models can contribute towards this direction,

[18] Franco & Niehaus, 2018
[19] Weber et al., 2019
[20] Ayaida & Schappacher, 2021
[21] Franco & Niehaus, 2018
[22] Daisuren et al., 2017
[23] Ferrandez et al., 2019
[24] Via et al., 2022
[25] Coeugnet et al., 2020

estimating the impact that a larger fleet of CAVs could have in the city traffic. This, of course, induces the need for reliable and robust traffic data sets in order to ensure the validity of the simulation results. Emerging digital twins give the opportunity to have real-time traffic data which would facilitate the integration process of vehicles with automation capabilities in the city traffic.

Furthermore, taking into consideration the safe integration of automated vehicles in mixed traffic there is the need for good understanding of interaction behaviour, enhanced sensor algorithm capability and more technological bricks that should be addressed adequately. Of course, this understanding encompasses the actual need for data in order to optimise services operations and develop value added services[25, 26].

Another need also recognized from the research sector is for data in order to optimize operations and services. Finding a balance between necessary level of detail and associated cost, a transition from big data to smart data, meaning actionable data automatically extracted from big data available in real-time, is considered of great importance. The challenge of data acquisition, processing and analysis is paving the way towards the establishment of automated process through the deployment of AI and machine learning techniques since the manual analysis of large amount of data may not be possible. Automated processes need to be implemented providing result analysis without constant interaction with data analysts[27]. Algorithms based on AI techniques are already implemented, however there is still way for CAVs to become fully autonomous in a mixed environment. This could become easier with the full adaptation of CAVs which still seems to be far away. The identification and understanding of behavioural dynamics are considered crucial for achieving optimal operation since they are the basics for the assumptions in impact assessment methodologies (number of cars, car ownership, modal shift etc.).

Taking into consideration the dynamics of the development of automated driving, new emerging companies, offering data management services for fleets of vehicles collecting automated driving data, are targeting vehicle manufacturers and service providers. These datasets contain petabytes of video and laser scanner data. The data must be well-accessible for use e.g., in neural network training. When considering e-infrastructure services for such amounts of data, the new companies can likely offer well-tailored data management. The access to data is not only limited by lack of funding for providing the data. An additional essential area is that the data contains personal data and immaterial property right data. Anonymization and de-identification are applied to overcome this limitation and provide data more openly. On the other hand, private companies might be reluctant to share data due to privacy and competition concerns. This creates resistance towards the integration, adaptability, and transferability of CCAM technology. Furthermore, many systems for route optimisation and planning exist today, but there is a lack of integration between systems and lack of CAV-readiness[28].

The availability of dedicated data spaces capable of hosting the large amount of data that vehicles with automation capabilities will generate should be considered both in a technical and a legislative base. Towards this direction, smart data can play a significant role. Moreover, event-based data extraction can provide efficient evaluation and processing in order to gain important knowledge.

[26] Weber et al., 2019
[27] Bernard et al., 2018
[28] Gellerman et al., 2018

This is currently realized through the development of National Access Points in each Member State and hopefully it will be a reality in its full potential in the next few years[29].

Undoubtedly, automation raises the concern to potential cybersecurity threats. In fact, the communication happening within the vehicle has multiple layers, like: communications inside the vehicle, communication of the infotainment system, V2X (Vehicle-To-Everything) communications. Possible threats might be addressed using Artificial Intelligence (AI) and Machine Learning Techniques, as demonstrated in the CARAMEL project[30]. Given the imperative need for high assurance levels, cyber-security evaluation is costly both in terms of monetary resources and time. Cost-efficient and agile processes targeted to the automotive ecosystem should be explicitly defined. The scope of any relevant approach devising high credibility assurance arguments should be extended at the system-level including both vehicles and infrastructure[31].

Another need that arises from the integration of vehicles with automation capabilities from the transport operators' as well as from the users' perspective is the familiarization of road users with the technology that vehicles with automation capabilities encompass in order to ensure the safety of operations and acceptance of the new arising services[32].

All the above should be based on meeting the prioritized users' requirements and needs including cybersecurity and privacy of personal data. Towards this direction, discussions in a multi-cluster approach will be needed on joint understanding concerning the required or expected maturity of key technologies as well as related time frames[33].

### 3.2.3 Infrastructure and management

From the transport / mobility operators' side of view, technological tools for implementing CCAM solutions should be based on well-defined and clear traffic management objectives. Technology should be tailored to address specific needs and requirements based on the specific characteristics of each site. It is believed that the use of automated vehicles tackles the entire network to distribute traffic more efficiently and avoid congestion by providing information about their surroundings in order to prevent or detect anomalies[34]. Although CAVs will increasingly manage themselves as a system, traffic management will still constitute a critical task for efficient movement of CAVs in the road network. This would suggest a seamless and timely communication between transport operators, vehicles, infrastructure and other road users that should be determined through common specifications among the related industry players (vehicle manufacturers, mobile network operators, technology suppliers etc.) and the traffic managers. Intelligent traffic management and control applications would enable the monitoring, support and maybe orchestration of vehicle and people movements. The opportunity to address intelligent traffic management would probably become more realistic with the large-scale penetration of high levels of automation[35].

Another critical aspect is the integration of CAVs to the Traffic Management Centre (TMC). Communication infrastructure should be developed to ensure the seamless communication between vehicles, infrastructure, people and the TMC giving this way the possibility for remote

[29] Ayaida & Schappacher, 2021
[30] I2CAT et al., 2020
[31] Massot et al. 2020
[32] Ferrandez, 2019
[33] Horizon 2020 Commission Expert Group, 2020
[34] Wijbenga, 2020
[35] Vreeswijk & Smith, 2019

intervention at critical situations as well as for the realization of services like platooning, connecting for example rural and peri-urban areas with the city centre. Nevertheless, sufficient operations speed is also considered quite important both for road operators as well as for the users[32, 36].

Furthermore, cities and local authorities, their outsourced partners and industry, including MaaS operators, will need to further collaborate on future traffic management capabilities in order to address how traffic management technologies and practices will need to be adjusted, transformed, and developed to allow for the implementation of policies emerging in this area[37].

Operational Design Domain (ODD) of CAVs is a key aspect when considering the integration of CCAM solutions into the transport system. Making the ODD as uninterrupted, stable, and predictable as possible as well as achieving vehicle's smooth driving profile in order to maximise the potential benefits from automated driving, would enable the safe integration of CAVs. However, this would probably imply a trade-off between other road users (e.g., pedestrians and cyclists). Fall-back situations should be well addressed and communicated through appropriate and user-friendly Humane Machine Interfaces (HMI) making sure user's engagement in undertaking the driving task[38].

Of course, the need for CAV tailored infrastructure is likely to be necessary since the attributes of ODD are directly connected to the way the automated driving system works and the interaction with its environment. Road networks capable of integrating CAVs should be a matter of consideration from several stakeholders' point of view like relevant industry actors (vehicle manufacturers, technology suppliers etc.), transport operators, public administrations, and legislators. An example of such an initiative is the H2020 INFRAMIX project[39] which has developed Infrastructure Support levels for Automated Driving (ISAD) in order to classify and harmonize the capabilities of a road infrastructure in order to support and guide CAVs.

A lesson learnt within the CoEXIST[40] project from CAV testing is that some technical solutions would clearly benefit from physical infrastructure support. This would mean providing additional sensory input for the vehicles by means of roadside equipment like cameras, radars and weather stations, as well as infrastructure status information in order to expand the ODD of automated driving functions. However, the improvement of the physical infrastructure in a large scale of the road network would require a longer time period than expanding digital services. Furthermore, this would raise liability issues for road operators as well as cost implications for road authorities.

Furthermore, transport operators and Road Transport Authorities (RTA) take into consideration the requirement to address more complex scenarios such as: cross-border corridors. They are the owners/managers of the infrastructure, and they focus on operating the technology in the infrastructure.

For all the above topics, it is clear that transport and mobility operators as well as RTAs are key stakeholders in the CCAM evolution: it is not possible to imagine the development, the test, and the usage of autonomous vehicles without knowing their perspectives, their needs, and their availability to change. They need to consider the effects of CCAM on the infrastructure itself (often

[36] Lücken et al., 2021
[37] Vreeswijk & Smith, 2019
[38] Weber, 2019
[39] https://www.inframix.eu/
[40] Ivari et al., 2020

infrastructure which is in less than perfect condition due to funding constraints) and the effects on other traffic (traditional vehicles, pedestrians, cyclists, animals…).

## 3.3 Developing technology tailored to citizens' needs and requirements

A key concern is the adaptation of reliable and safe technologies which are the priorities citizens and potential users. Technology should be intended to be equal, and inclusive, considering all different segments of the population including the most vulnerable ones. Citizens seem to have mixed feelings towards the new technologies and the changes that they are urging and their lack of familiarization with automation makes them more likely to be sceptical and hesitant about engaging with CCAM technologies resulting in low user acceptance[41]. SINOFONICA has a strong focus on the inclusion of people with mobility challenges, like low-income or unemployed people, elderly, people with disabilities, women, and gender-related, young people, or people living in rural areas, as well as VRUs, and aims to capture their needs and requirements to an all-inclusive CCAM system.

Taking into consideration citizens' view, there is the segment of the population accepting and ready to adopt to the new transport scene. On the other hand, there is the population segment showing negative acceptance of CCAM and CAVs. Public's acceptance of CCAM is diverse and no certain conclusion can be drawn about the future public acceptance of CCAM[42]. Nevertheless, safety and privacy are two critical aspects concerning public acceptance[43]. Towards users' familiarization with the new technologies, training about the use of CCAM solutions should be in place. Of course, the introduction of benefits and capabilities from the uptake of such services through well-tailored public awareness campaigns should be firstly addressed in order to ensure that the potential users will be engaged in the long term. Accordingly, a societal desirability consensus and the willingness to use CCAM solutions require more than solving exclusively technological problems.

### 3.3.1 Building knowledge and expertise

Public administration is viably aware of the need to build knowledge around CCAM, CAVs and MaaS particularly both from a policy perspective and from a technological one. Cities and local authorities should be in front of the market transitions in order to integrate CCAM solutions into their transport strategy. Thus, it is imperative that local authorities as well as policy makers would understand what these technologies could enable and their needs in terms of regulation, procurement, and exploitation so as to create more liveable cities and meet societal policy objectives.

Having this understanding, if a city decides to embrace CCAM, transport planning enabling CCAM solutions integration should be part of their transport strategy in order to both leverage citizens' view concerning the technological capabilities of driving automation functions and ensure that services are designed with a focus on citizens' needs and expectations, as well as to assess and quantify the benefits of different scenarios of CCAM solutions deployment in order to enable better policy and decision making. This knowledge should also be passed to citizens and potential users in order to strengthen public acceptance. Towards this direction, there is the need for the organization of public awareness campaigns as well as training sessions for citizens and potential users of CCAM solutions so that they become familiar with the new technologies[44, 45].

---

[41] Coeugnet et al., 2020
[42] dos Santos et al., 2022
[43] Kacperski et al., 2021
[44] Lücken et al., 2021
[45] Wihbenga et al., 2020

In order to maximize expertise, existing and future investment as well as the understanding of future requirements to support CCAM solutions deployment, cities and local authorities should look to increase knowledge sharing and collaboration both internally and with other cities. The scope of the Public Administration is to create an environment which responds to citizens needs and desires in a sustainable (financial and environmental) way. Therefore, the focus of SINFONICA is so important in enabling public administration to understand the CCAM perception of users' groups. High inter-connection between different actors of the public administration is also crucial because the municipalities, provinces, and regions, want to create an integrated system where users can safely rely on the technology and share information. It's common to have separate departments within the city councils that rarely communicate with each other in a holistic manner, for instance transport services for health and education is sometimes considered separately to transport infrastructure[46]. This means SINFONICA should focus not only on transport departments but also on other departments that may procure transport services.

Similar to public administrations' need to build knowledge about CCAM technology and the potential benefits that can bring, legislators should also be in the front line of CCAM deployment having a strong understanding of the potential that CCAM encompass in order to develop policies and guidelines for the realization and implementation of CCAM solutions. Several actions that legislators need to take towards this direction is setting up of guidelines and developing roadmaps for large-scale deployment of CCAM solutions, supporting the provision of training schemes and reskilling both for the workforce as well as for citizens based on research results, facilitating knowledge transfer and exchanging of experience, best practices and know-how, providing input to certification and standardization processes and policy recommendations[47].

Representative bodies should be an indispensable part of all discussions around CCAM technology. It is critical that all interested parties are well-represented in public discussions concerning the real-life integration of CCAM. Moreover, they should promote and share knowledge and experience about CCAM to their members focusing on their familiarization with the emerging technologies and the benefits as well as the risks that may encompass. SINFONICA takes into great consideration representative bodies such as road users and stakeholders associations. This is because the relationship with these stakeholders helps fostering the dialogue about CCAM and users' needs and desires. Given the strong social focus of the SINFONICA project, being able to gather information from representative bodies is of tremendous help in the development of the research. In fact, these stakeholders investigate population habits and needs related to transport and the implementation of CCAM technologies. Therefore, they might be able to provide data about user's habits, current struggles, and areas of improvement with respect to CCAM interaction.

### 3.3.2 User-friendly services and applications

The development of user-friendly applications with an optimized User Interface is an important element of CCAM solutions in order to engage citizens. Ease of use of those new services, as for example booking and making use of an automated service, should be addressed through well-designed and intuitive Human Machine Interfaces (HMI) making sure that the user can easily interact even if being digitally illiterate or having other disabilities. Towards this direction, auditory and visual interfaces should be integrated in the HMI[48].

[46] Cartwright et al., 2017
[47] Horizon 2020 Commission Expert Group, 2020
[48] Coeugnet et al., 2020

A holistic communication approach between CAVs and other road users should be developed. A big consideration is whether a steward should be included on board. Nevertheless, an on-board HMI should be able to ensure the trust and the feeling of safety for the user when travelling. In particular, in demanding interaction situations, on-board users need additional information in order to understand and anticipate the CAV's behaviour. Information on the on-board HMI needs to be easily understandable by the users as well as to enhance CAV's actions transparency. Fall-back situations where the operator should take control of the vehicle should be well-defined and addressed for safety critical situations. Undoubtedly, people with mobility challenges and VRUs' needs should also be addressed through user-tailored HMIs and appropriate vehicle and infrastructure design and communication interfaces in order to ensure their inclusiveness in the CCAM realm[49].

Infomobility services that would allow users to be informed easily and precisely about mobility options available to them could strengthen their acceptance of the new services. Furthermore, gamification and incentives to use the new technology could also act towards this direction. Infotainment is another asset that could potentially bring added value to automated services for end-users, however this is a matter of discussion, especially in the case that hand over procedures when the limit of ODD is approaching should take place[50].

## 3.4 Legal and Regulatory aspects of CCAM

When creating policies and regulations of CCAM operations, legislators must consider safety, equity, fairness, and inclusiveness. Special care should be taken in the matter of data sharing, where sensitive data of the users must be protected according to the General Data Protection Regulation (GDPR). SINFONICA, being a project "user-centric", meaning it takes into greater consideration the interaction between users and CCAM, is very focused in understanding where the current legislation stands, where are the possible loopholes and deficiencies and how these can be addressed according to research findings. SINFONICA will also consider whether different national and international legislation is compatible.

The European Green Deal[51] defines the strategic priorities of the European Commission in the period 2019-2024, emphasising the potential of CCAM and smart traffic management systems to contribute to smart and sustainable mobility. Furthermore, in Automated Mobility Strategy[52] sets the policy framework for the take-up of automated mobility, including the provision of financial support for private investments in the development of technologies and infrastructure related to CCAM. In addition, the 2020 Sustainable and Smart Mobility Strategy[53] has set a milestone for 2030 to achieve large-scale deployment of CCAM. Other European policy initiatives include the C-ITS Platform aiming at developing a shared vision on the interoperable deployment of C-ITS across Europe[54], the Strategic Transport Research and Innovation Agenda (STRIA) which identifies CCAM as one of the seven priority roadmap areas, the CCAM Single Platform proposing a partnership on CCAM in order to harmonise European Research and Innovation efforts to foster the deployment of

[49] Weber et al., 2019
[50] Ayaida & Schappacher, 2021
[51] European Commission, 2019
[52] European Commission, 2018
[53] European Commission, 2020
[54] European Commission, 2016

CCAM solutions, and, finally, the creation of an independent Expert Group to elaborate and make recommendations on ethical issues arising from the introduction on CAVs[55].

### 3.4.1 Adaptation of future legislation

The introduction of automation in the mobility sector challenges the “historical legislative approach” which was so far based on the strict division of functional responsibilities (vehicle, infrastructure, driver behaviour, other road users) and, thus, rules and requirements are stated in separate laws/legislations. Since vehicles are capable of taking over driver responsibilities, the division of functional responsibilities gradually disappears. Nevertheless, the main aim of legislators was and still is to ensure safety[56].

As vehicles become more and more automated, integrating more sensors, controllers and software, suitable and effective technical control and observation regulations shall be put in place in order to ensure safety. The need for consolidation of legislations has been widely recognized by many important stakeholders and decision makers. This implies the introduction of a suitable organization which can develop and implement the necessary changes primarily focusing on the division of liability between technology and human behaviour[55].

Well-established international organizations (e.g., EU/UNECE, Vienna Convention) are continuously developing the international traffic and transport legislation, but mainly focusing on their established fields (e.g., vehicle technology). Furthermore, international cooperation is mainly introduced through research projects and informal cooperation like CCAM Partnership. Moreover, the HF-IRADS (Human Factors in International Regulations for Automated Driving Systems) group has produced important research results concerning traffic safety and vehicle technology.

Nevertheless, the development of an appropriate legislative, regulatory and operational framework, meeting system architecture requirements (in collaboration with the research community and industry), is imperative and should set the ground for defining critical aspects of CCAM large-scale deployment like the development of digital and physical infrastructure, efficient communication solutions, business models, taking into consideration the GDPR and accessibility principles.

This need is widely recognized for all stakeholders in order to be able to accept and embrace CCAM. Although legislators and regulators are the main actors responsible for developing this new framework, strong collaboration with the industry, the research sector, operators, and representative bodies should be developed in order to comprehensively address all legal and ethical matters concerning the efficient, safe, inclusive, and equitable CCAM deployment. To this end, the continuous monitoring and evaluation of CCAM solutions development and deployment should be addressed through appropriate institutions set up to specifically support the design and operation processes[57].

The need for testing automated transport systems on public roads is imperatively recognized by CCAM key stakeholders in order to obtain a clear view on the specific technological and operational requirements, possibilities, and gaps. Those requirements shall be defined in future legislation regarding automated transport systems in order to become standardized. In addition, the performance of the driving task by automated vehicles raises several questions from a legal point

[55] Horizon 2020 Commission Expert Group, 2020
[56] Fürdös et al.,2021
[57] Horizon 2020 Commission Expert Group, 2020

of view which shall be comprehensively addressed and defined in future legislation. Reconsidering traffic rules in order to promote safety of CAVs may be necessary. Exemptions to non-compliance with existing rules by CAVs should therefore investigated[58].

The complexity of CCAM ecosystem and the different agents involved in CCAM, makes the identification of their obligations unclear. To this end, it should be made clear through appropriate mechanisms (e.g., shared maps) which identify the different actors' obligations towards the ethical and legal design, deployment, and use of CCAM solutions and CAVs. For example, industry and deployer actors should be held accountable for creating an innovative culture in which people have both the technical competence and the moral awareness of their role to respond to requests of explanation in the case of system's misbehaviour. Moreover, mechanisms for granting compensation in case of accidents involving CAVs should be clearly and fairly developed and could include the creation of a new insurance system[57]. Smart and event-based data can also play an important role on defining new insurance policies.

Dialogue between all key stakeholders in the CCAM ecosystem should therefore be promoted, thus, enabling actors to identify, decide and accept their role's obligations and responsibilities. Research activities on the ethics of CCAM should also be promoted and established as a solid field of academic research. Finally, policymakers in collaboration with the research sector, industry (e.g., vehicle manufacturers) and CCAM solutions deployers (e.g., operators, public authorities) should reshape the training and licensing procedures in order to make users aware of the changes that are on the way with automation[57].

### 3.4.2 Compliance with technical specifications

Regulation (EU) 2018/858 defines type approval as the procedure whereby an approval authority certifies that a type of vehicle, system, component, or separate technical unit satisfies the relevant administrative provisions and technical requirements. Specifically, the regulation defines the advanced vehicle systems that shall be equipped on all motor vehicle categories. These are the following:

- Intelligent speed assistance;
- Alcohol Interlock Installation Facilitation;
- Driver Drowsiness and Attention Warning;
- Advanced Driver Distraction Warning;
- Emergency Stop Signal;
- Reversing Detection;
- Event Data Recorder.

Manufactures shall demonstrate that all new vehicles and all new systems, components and separate technical units are type-approved in accordance with the requirements defined in the regulation. They shall also ensure that vehicles are designed, constructed and assembled so as to minimise the risk of injury to vehicle occupants and vulnerable road users.

In addition to the above, according to Regulation (EU) 2018/858 vehicles considered SAE Level 3 or higher shall also comply with the technical specifications related to:

[58] Fürdös et al.,2021

a) Systems to replace the driver's control of the vehicle, including signalling, steering, accelerating and braking;
b) Systems to provide the vehicle with real-time information on the state of the vehicle and the surrounding area;
c) Driver availability monitoring systems;
d) Event data recorders for automated vehicles;
e) Harmonized format for the exchange of data for instance for multi-brand vehicle platooning;
f) Systems to provide safety information to other road users

Nevertheless, as automation makes vehicles more and more autonomous, legislation shall be reformed and adapted to the technological advances. Policymakers shall therefore create strong collaboration schemes with the industry actors and the research sector in order to address all technological issues from the legal and ethical perspective.

### 3.4.3 Data, security, and privacy

Policymakers should set appropriate safeguards and enforce the effective application of data protection legislation in order to ensure that users' data are disclosed or forwarded only on a voluntary and informed basis relying on users' consent. Policymakers and researchers should develop such appropriate measures and practices with regards to responsible innovation processes and the strong engagement between all stakeholders in order to address ethical data sharing, transparency as well as business practices, and give guidance regarding the basis and boundaries of legally and ethically acceptable inferential analytics[59].

Furthermore, standardised transparency strategies should be developed in order to inform road users, including pedestrians and VRUs, of data collection domains that may cause directly or indirectly privacy risks as they travel through them. Strong collaboration between policymakers, deployers (e.g., operators, public administrators) and manufacturers is strongly needed to address this issue. Moreover, the formulation of explicit roles and obligations for government, pubic and educational institutions in order to adapt methods and strategies to inform and educate the public on literacy concerning data privacy issues as well as relevant techniques including AI and algorithms is policymakers' responsibility[60].

The protection of individuals' rights at group level (e.g., driver, VRU or passenger) should also be integrated in legislation and regulations so that effective strategies are in place to resolve possible conflicts between data subjects. Consequently, new guidelines concerning non-personal data, third party personal data and anonymised data should be developed in order to address the privacy risk they may impose for individuals[60].

On the other hand, valuable datasets for CCAM solutions design and deployment should be kept free and open fostering this way the large-scale deployment. Policymakers should detail this sort of data in collaboration with deployers and manufacturers as well as third party data stakeholders. In order to achieve that, data formats and processing requirements shall be harmonized and standardized in accordance with non-commercial, platform-neutral schemes and taxonomies. The successful establishment of such schemes imply the need for extensive research as well as cooperation with open source and standardization bodies[60].

[59] Horizon 2020 Commission Expert Group, 2020
[60] Horizon 2020 Commission Expert Group, 2020

Last but not least, the need for new regulations concerning cybersecurity and software updates is recognized as a priority. With cyber-attacks becoming more and more sophisticated, new cybersecurity measures shall be well-defined both from the technological and the legal perspective.

### 3.4.4 Real-life deployments

Technological development triggers legal development if potential impacts on health and safety are recognized. This implies the need for real-life trials of the new technologies in order to be able to assess its reliability and risks. To this end, exemptions from effective laws may be required, as long as the safety case can be proven. In general, national (or by extension regional / local) legislators create mechanisms to enable such experimental deployments. Nevertheless, if trial deployments take place on public roads, it is necessary for the deployment entity (research body, local authorities etc.) to apply for a permit at the responsible authority defining the objectives and characteristics of the trial deployment, including research questions and justification of the importance and benefits for the public. Certain requirements on the experience and trustworthiness of the deployment entity are applied and may be limited to research institutes, vehicle or component manufacturers, transport operators or system developers[61].

Additionally, requirements regarding road infrastructure may be in place in some national regulations. In general, physical road infrastructure where automated vehicles are capable of performing the dynamic driving task may follow certain requirements concerning road markings, signage, traffic lights etc. On the other hand, it may require additional permits for using additional digital infrastructure.

Focusing on the vehicles, there is usually no possibility for obtaining a homologated vehicle approval for the subject automated vehicles, they are therefore treated as prototypes. Nonetheless, they must fulfil a minimum set of environmental and safety requirements (e.g., exhaust gases, braking etc.).

Another major legal challenge from the operational perspective of automated vehicles is the very sensitive issue of the remote operation/supervision of the CAVs. National rules are quite diverse and may include training of the operators, explicit rules when intervention is necessary and access routines to the vehicle.

So far, there is no consensus on common rules between countries for testing or introducing automated vehicles in the road network. Therefore, national, or local legislation applies for trial deployments on public roads. This lack of a harmonized approach on trial deployments of automated vehicles may hinder the large-scale deployment of CAVs. The harmonization of the legal framework for such deployments could therefore leverage and accelerate the large-scale introduction of CAVs.

## 3.5 Financial aspects of CCAM

### 3.5.1 Business models

It is generally acknowledged that CCAM has the potential to profoundly impact current business models and revenue streams in the automotive and transportation sectors[62].

[61] Fürdös et al.,2021
[62] Pütz et al., 2019

It should be noted that, of around 260 million Europeans living in city regions with more than 100,000 inhabitants, only 20 percent live in city regions of more than 2.5 million people, while almost half (44 percent) of all urban inhabitants live in city regions of less than 500,000 inhabitants. Depending on their business model, technology developers and suppliers may need to find more affordable business development strategies to reach this massive target group. Alternatives, such as Public Private Partnerships or EU-funded innovation procurement funding schemes could be the way forward for autonomous vehicles in public transport, until technology costs are normalized to support business models comparable to those of traditional transport services, in a financially sustainable manner[63].

The business model is still unclear and does not make the system attractive. The current technology does not allow to build a clear vision of the future cost/revenue expected, neither on the impact on jobs. Nevertheless, since vehicles still have a safety driver on board, vehicle manufacturers or public transport operators do not have a viable business model, and this is an obstacle to wider deployment. Ready to buy solutions are expensive and developing customized solutions within projects requires significant resources. In an attempt to maximize revenues, the industry sector is engaged in innovation and development activities in order to increase the reliability of services and achieve efficient supply[63].

CCAM functions (such as advanced driver assistance systems or lane-keeping) would be expected to improve road safety. In terms of the overall economy, CCAM is a game-changer for the current automotive industry, which will bring a radical transformation. This transformation will result in a re-distribution of roles, add many new players (e.g., energy, telecom companies), and change the dominant business models. Regarding the latter, there is a high ambiguity about the profitability of future business models, notably in automation and sharing. Currently unprofitable business models in car-sharing and the enormous investment sums required for automated driving are reflected in the final price for users and therefore in their acceptance of the service whose primary goal is to minimise travel cost and optimize travel time[64].

### 3.5.2 Services utilization

It is quite important to maximize the utilization of vehicles as this affects revenue. A mixed mobility services approach (MaaS, LaaS and DRT) could open the way to new business models or extend existing established business. Consideration of the whole business ecosystem including all sub-systems (analysing the second and third line within the mobility service) and all users and operating roles is very important. This is needed to generate an adequate view with all chances, costs and revenue streams to get a complete picture and to identify business potential for cost reduction or increased business success[64].

For public administrations to achieve sustainable and flexible transportation solutions that demand-side desires, the public sector needs to invest in smart mobility projects. The private sector solely will not provide enough solutions for public transportation. Public transport operators should express their wishes and expectations to the supply-side as they both have similar views of smart mobility's future. To this end, users' benefits in term of minimizing travel cost and optimizing travel time should be in place with the new services. Otherwise, low acceptability of the new services would lead to unsustainable business models[65]. In terms of profitability, transport operators should

[63] Rutanen et al., 2021
[64] Worschech et al., 2020
[65] Cartwright & Knoop, 2017

seek the efficient use of the infrastructure and technology in order to provide optimized supply while maintaining and improving safety.

### 3.5.3 Research and legislation

EU's vision is evidently the large-scale, harmonized, and interoperable CCAM deployment addressing critical societal issues like safety, privacy and security, inclusivity, equity, and accessibility. To this end, dedicated European funding under R&I framework programs like the Horizon 2020 and Horizon Europe have been made available for CCAM research projects. The research community embraces this initiative rolling the way towards CCAM large-scale deployment. Key industry actors, transport/mobility operators as well as public authorities across Europe are also engaged to this attempt and pave the way towards CCAM deployment by developing new technological components, participating in real-life trials, developing expertise, and sharing knowledge. Nevertheless, taking into consideration the ever-changing CCAM scenery and the new arising technologies, the funding should continue in an uninterrupted and dedicated manner.

Legislators have a strong focus on efficiency and cost savings in public expenditure, for example in the health sector and infrastructure maintenance. On the other hand, there is a lack of resources to well define the new regulations needed to further develop the CCAM applications. New regulations should definitely adapt policies to prevent technology monopoly and promote undistorted fair competition. In the attempt to increase social welfare and Gross Domestic Product (GDP), legislators need to take into consideration the new job opportunities that arises in the CCAM ecosystem and develop appropriate regulations and policies. For example, the abundance of micro mobility solutions (scooters, e-bikes, skateboards, shared bicycles, etc.) is sometimes causing traffic increase and more often taking up pavement space due to the unregulated landscape of operations. This aspect is reflected in the greater use of electricity for the future vehicles.

## 3.6 Social aspects of CCAM

Within the SINFONCA project, a special focus is given to the social dimensions of CCAM. With deliverable D1.1 a broader view is provided on the mobility needs and requirements of European citizens. This deliverable includes a theoretical framework on mobility needs and behavioural aspects of (potential) CCAM use. The following chapter gives a short overview of the contents of this deliverable and covers stakeholders' needs and requirements for CCAM solutions from a social perspective of citizens (users and non-users) under three aspects:

1. From a citizen's perspective, a CCAM must provide equity for all users (and non-users).
2. Key mobility needs of citizens should be met by CCAM. In addition, a special focus should be given to specific user groups that might be disadvantaged by current modes of transport.
3. From a methodological perspective, co-creation processes and iterative approaches are needed to ensure higher acceptance of developing CCAMs and engage citizens. In addition, relevant measures (e.g., acceptance, intention to use) must be evaluated constantly.

### 3.6.1 Equity

In the EU Charter of Fundamental Rights, the rights of equality before the law; non-discrimination; cultural, religious, and linguistic diversity; equality between women and men; the rights of the child;

the rights of the elderly and integrations of persons with disabilities are set (article 20-26)[66]. Similar citizens' rights exist in most other democratic countries outside the EU. With this common foundation of rights on equity, future CCAM systems must also follow these principles. More concretely, the International Association of Public Transport (UITP) adopted in July 2022 a declaration to include everybody in public transport[67] (Lecco declaration). This declaration is based on the following principles, which are highly relevant for equity in the transport system and partly result from the EU project TRIPS[68]:

- Freedom of movement is a human right and personal mobility should be guaranteed to all.
- Mobility is related to other rights such as participation, access to education and employment.
- Public transport supports social and environmental policies and values. It connects places and people and fosters social and economic development. Everyone should be able to use it.
- Technological developments have the potential to reduce or overcome access barriers providing new solutions.

These principles also refer to equal living conditions. For instance, peripheral regions are mostly disadvantaged by public transport options. This also contributed to urbanization and spatial polarization (e.g., development and shrinkage of peripheral areas). If mobility needs are not met in such a case, there is a higher chance of transport poverty, including the risk of social exclusion ("mobility-based social exclusion"). CCAMs should aim to reduce these disadvantages and provide equity for all people by fulfilling people's mobility needs (see next chapter).

#### 3.6.2 Mobility needs of users/non-users

Mobility needs are a combination of users' individual characteristics and situational factors and determine the users' requirements towards CCAM service characteristics, as shown in Figure 3.

[66] https://ec.europa.eu/info/aid-development-cooperation-fundamental-rights/your-rights-eu/know-your-rights/equality_en
[67] https://www.uitp.org/news/uitp-signs-declaration-improving-user-accessibility/
[68] https://trips-project.eu/

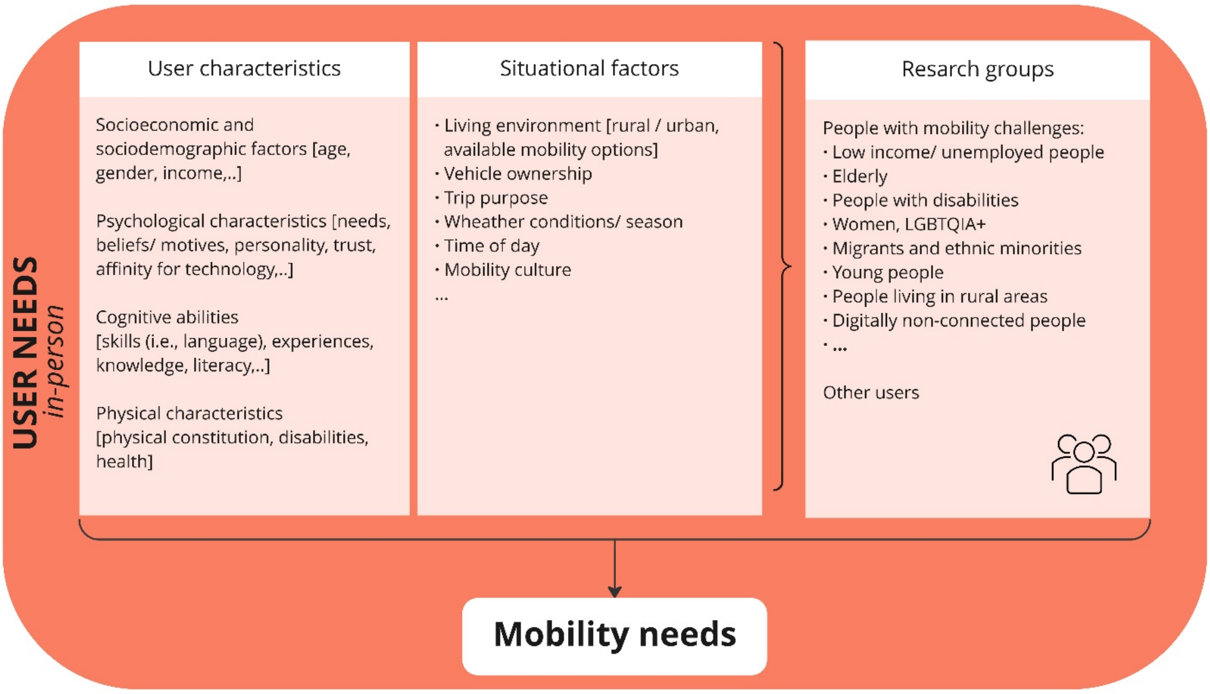


*Figure 3: Influences on mobility needs of CCAM (non-)users, own illustration – SINFONICA Deliverable 1.1*

For example, the primary mobility needs of an elderly female user with low affinity and trust towards technology might be easy information acquisition and interface design. In contrast, for a physically disabled user, one primary mobility need might be the easy accessibility of the service. Those individual user characteristics act in the context of present situational factors, i.e., trip purpose, environment (rural/urban), or time of day. In addition, mobility needs are not static but subject to change due to varying situational factors and individual user characteristics. User groups with similar mobility needs can be formed based on the combination of particular user characteristics and situational factors. In light of the SINFONICA objectives, the framework differentiates the user groups: *people with mobility challenges* and *other users*. The people with mobility challenges, like low-income or unemployed people, elderly, people with disabilities, women, and gender-related, young people, or people living in rural areas, also comprise the research groups within SINFONICA.

The literature review has revealed four global groups of mobility needs, following Arup & Urban Transport Group[69] insights, that are repeatedly cited[70] and must be met to achieve equity in transport: Availability, Accessibility, Affordability, and Acceptability. As shown in Figure 3, they presented a table providing guidance in assessing transport to enable equitable future mobility.

[69] Arup & Urban Transport Group, 2022
[70] Shrestha et al., 2017

*Table 3. The four A's – adapted from Arup, Urban Transport Group (2022)*

| Availability needs | Accessibility needs | Affordability needs | Acceptability needs |
|---|---|---|---|
| • Reachability<br>• Connectedness<br>• Availability at any time<br>• Availability of trip chaining<br>• Information access<br>• Storage spaces | • Barrier-free access<br>• Comprehensibility<br>• Simplicity/ Ease of use<br>• Child friendliness<br>• Baggage friendliness<br>• Minimal (digital) equipment requirements<br>• Minimal rebound towards other modes | • Minimum pricing<br>• Simple & consistent pricing<br>• Capped prices<br>• Ease of price comparisons<br>• Multiple payment opt-ions<br>• Ease of transport option comparisons<br>• Minimal (digital) equipment requirements<br>• Assistance availability | • Equality with other modes<br>• Convenience<br>• Welcoming<br>• Respectability<br>• Cleanliness<br>• Comfort<br>• Safety & Security<br>• Assistance availability<br>• Supporting equity<br>• Attractiveness<br>• |

### 3.6.3 Co-creation processes and measures

To realize an 'all-inclusive' mobility as a societal service for European citizens, participatory approaches are needed to encourage citizens to contribute to developing future mobility systems. Key actors in this sector lack a true understanding of the needs of people with reduced mobility or with special needs (e.g., elderly, pregnant women, students, disabled, migrants, children, unemployed persons, people living in rural areas, and others). Implementers of CCAM are mainly focused on the development of technological breakthroughs rather than the deployment of socio-centric solutions. Towards this direction, a close and early collaboration, knowledge sharing, and co-design/co-creation between private-public sector, industries, research, regulators, and policymakers, including end-users, is mandatory for the provision of aligned actions and better synchronization of investments to deliver valued CCAM solutions for the society. Societal expectations and needs steer the co-creation of future mobility solutions which are both socially viable and economically affordable. From a user perspective, participatory approaches are advantageous because user needs can be better met, and unseen challenges for specific user groups can be anticipated before technical services are provided. Other EU projects in the transport domain (TRIPS, LEVITATE, SUAAVE) have already used co-creation processes and provided valuable results that citizens accompanied on a national and EU level. As a part of co-creation processes, it is highly recommended to include relevant stakeholders regularly and develop measures iteratively. This means that the surveys, interviews, and discussions on the social requirements of CCAM must be reviewed and edited in an iterative process to ensure that all needs are met.

## 3.7 Aggregated results

In the previous sections, an attempt to comprehensively recognise stakeholders' priorities, needs, requirements and dilemmas was made. Through the analysis of the results, it becomes obvious that several needs and requirements are interrelated and addressed from several perspectives as well as for different stakeholders. In the following Table, aggregated results, classifying needs and requirements as Organizational / Operational, Technical, Legal and Regulatory, Financial, and Social, or a combination of them, are presented along with respective goals and dilemmas as well as (key) stakeholders involved, aiming to create a comprehensive understanding of the interrelations between stakeholders and their needs, requirements, goals and dilemmas.

*Table 4. CCAM stakeholders' needs and requirements, wants and dilemmas*

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| **Organizational/Operational** | Define and address future scenarios | G: Clear objectives | K: Transport/Mobility operators<br>Research sector<br>Public Administration |
| **Organizational/Operational** | Safety of operations | G: Create positive users' attitude towards automation, demonstrate that systems are safe | K: Transport/Mobility operators<br>Public Administration<br>CCAM Industry<br>Research sector |
| **Organizational/Operational** | Promote interconnections between public authorities to meet the needs of all departments for CCAM services. | G: Create an integrated system where resources are strategically allocated, and users can safely rely on the technology and share information | K: Public Administration<br>Transport/Mobility operators |
| **Organizational/Operational** | Strong cooperation with other stakeholders to create solutions | G: Create strong long-term partnership schemes to address requirements for CCAM deployment | K: Public Administration<br>All |
| **Organizational/Operational** | Determine major needs and approach towards CCAM deployment based on the specific characteristics of each city | G: Optimize transport services | K: Public Administration<br>K: Transport/Mobility operators<br>Research sector |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| **Organizational/Operational** | Develop co-creation processes for CCAM solutions deployment | G: Create a base for future research and develop new methodologies concerning CCAM technology and its acceptance | K: Research sector<br>K: Public Administration<br>Transport/Mobility Operators<br>CCAM Industry |
| **Organizational/Operational** | Understand the gap in current policies and regulations for CCAM operations and create / amend policies and regulations as required. | G: Protect safety, fairness and inclusiveness of services and operations | K: Legislators<br>K: Research sector<br>CCAM Industry<br>Service Providers |
| **Organizational/Operational** | Foster the dialogue about CCAM and users' needs and desires | G: Foster CCAM deployment based on the specific needs and desires of different groups of stakeholders | K: Public Administration<br>K: Representative bodies |
| **Organizational/Operational** | Familiarization with automation | G: Develop knowledge about CCAM<br>D: Safety, security, and reliability issues | K: Public Administration<br>K: Transport/Mobility operators<br>K: Citizens<br>All |
| **Organizational/Operational** | Test the viability of CCAM solutions on a large-scale | G: Demonstrate safe and reliable CCAM solutions | K: Large-scale demonstration projects<br>K: Research sector<br>K: Transport/Mobility operators<br>CCAM Industry<br>Service Providers |
| **Organizational/Operational**<br>**Legal** | Align with regulation standards | G: Smooth transition to automation<br>D: Willingness for data sharing due to privacy competition concerns | K: CCAM Industry<br>K: Service Providers<br>Transport/Mobility Operators |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| | | | Public Administration |
| **Organizational/Operational**<br>**Legal/Regulations**<br>**Technical** | Ensure that services are designed with a focus on citizens' needs and expectations | G: Integration of transport planning enabling CCAM solutions in transport strategy<br>D: CCAM technologies do not adversely affect other initiatives such as encouraging active travel | K: Public administration<br>K: Transport/Mobility operators<br>CCAM Industry<br>Service Providers |
| **Organizational/Operational**<br>**Technical** | Increase safety and traffic efficiency | G: Smooth collaboration between vehicles, infrastructure, and road users.<br>G: Integrate CCAM components within vehicles and infrastructure | K: Transport/Mobility operators<br>K: CCAM Industry<br>Research sector<br>Public Administration |
| **Organizational/Operational**<br>**Technical** | Easing traffic congestion and decreasing pollution | G: Integrate automation on road transport<br>D: Negatively affect active travel | K: Transport/Mobility operators<br>K: Public Administration |
| **Organizational/Operational**<br>**Technical** | Build knowledge around CCAM, CAVs and MaaS | G: Smooth transition to CCAM deployment | K: Public administration<br>K: Transport/Mobility operators<br>All |
| **Organizational/Operational**<br>**Technical** | Enable better policy and decision making | G: Assess and quantify the benefits of different scenarios of CCAM solutions deployment | K: Public administration<br>K: Transport/Mobility operators<br>Research sector<br>Large-scale demonstration projects |
| **Organizational/Operational**<br>**Technical** | Facilitate knowledge transfer and familiarization with automation | G: Provision of training schemes and reskilling both for workforce and citizens based on research results | K: Public administration<br>K: Transport/Mobility operators<br>All |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| **Organizational/Operational**<br>**Technical** | Increase knowledge sharing and collaboration both internally and with other entities/cities | G: Maximize expertise, existing and future investment and understanding of requirements to support CCAM | K: Public administration<br>Transport/Mobility operators<br>Representative bodies |
| **Organizational/Operational**<br>**Technical** | Collaboration on future traffic management capabilities | G: Address how traffic management technologies and practices will need to be adjusted, transformed, and developed | K: Transport/Mobility operators<br>Public administration<br>Research sector<br>CCAM Industry<br>Service Providers<br>Large-scale demonstration projects |
| **Organizational/Operational**<br>**Technical** | Ensure smooth transition to mixed traffic conditions | G: Demonstrate smooth collaboration between vehicles, infrastructure, and road users<br>G: Optimise services operations and develop value added services | K: Transport/Mobility operators<br>K: Public Administration<br>K: CCAM Industry<br>Research sector<br>Large-scale demonstration projects<br>Legislators |
| **Organizational/Operational**<br>**Technical** | Ensure smooth integration of different CAVs in city traffic | G: Demonstrate smooth collaboration between vehicles, infrastructure, and road users<br>G: Optimise services operations and develop value added services | K: Transport/Mobility operators<br>K: Public Administration<br>K: CCAM Industry<br>Research sector<br>Large-scale demonstration projects<br>Legislators |
| **Organizational/Operational**<br>**Technical** | Ensure smooth interactions between CAVs and pedestrians / cyclists | G: Demonstrate safe and reliable interactions between CAVs and pedestrians / cyclists | K: Transport/Mobility operators<br>K: Public Administration |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| | | | K: CCAM Industry<br>Research sector<br>Large-scale demonstration projects<br>Legislators |
| **Organizational/Operational**<br>**Technical**<br>**Legal/Regulatory** | Ensure availability of dedicated data spaces | G: Host the large amount of data that vehicles with automation capabilities will generate | K: Legislators<br>K: Service Providers<br>Transport/Mobility operators<br>Public administration<br>Research sector<br>Large-scale demonstration projects |
| **Organizational/Operational**<br>**Financial** | Achieve financial sustainability | G: Offer initiatives and cost reductions<br>G:  Invest in smart mobility projects<br>G: Public private partnerships<br>D: Low demand for CCAM services | K: Transport/Mobility operators<br>K: Public Administration<br>CCAM Industry<br>Service Providers |
| **Organizational/Operational**<br>**Social** | Achieve environmental sustainability | G: Development of environmentally sustainable solutions<br>G: Comply with regulations | K: Transport/Mobility operators<br>K: Public Administration<br>K: CCAM Industry<br>Service Providers |
| **Technical** | Harmonization and interoperability of deployment activities, technological components, and systems' architecture | G: Foster CCAM deployment across Europe | K: Research sector<br>K: Large-scale demonstration projects<br>K: CCAM Industry<br>K: Service Providers<br>Transport/Mobility operators |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| | | | Legislators |
| **Technical** | Develop flexible modular structure for CCAM solutions deployment | G: Allow the reuse of different technology bricks by various providers (e.g., OEMs, suppliers, research institutes etc.) and enable the efficient and fast CCAM deployment independent of the technology supplier<br>D: Maintaining IPR and commercial sensitivities | K: Research sector<br>K: CCAM Industry<br>K: Service Providers<br>Transport/Mobility operators<br>Large-scale demonstration projects |
| **Technical** | Standardization of the technological components' interfaces | G: Achieve sustainability of the modular structure for CCAM solutions deployment | K: CCAM Industry<br>K: Research sector<br>Service Providers<br>Legislators |
| **Technical** | Expand the ODD of automated driving functions | G: Improve physical infrastructure and provide additional sensory input for vehicles by means of roadside equipment<br>D: The improvement of the physical and digital infrastructure would require a lot of financial and time resources than expanding digital services | K: Transport/Mobility operators<br>K: CCAM Industry<br>K: Research sector<br>Large-scale demonstration projects<br>Legislators |
| **Technical** | Adapt reliable and safe technologies | G: Respond to citizens needs and desires in a sustainable, equal, and inclusive way | K: Public Administration<br>K: Transport/Mobility operators<br>CCAM Industry<br>Service Providers |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| **Technical** | Seamless and timely communication between vehicles, infrastructure, and road users | G: Optimize network performance in terms of latency and achieve sufficient operations speed | K: CCAM Industry<br>K: Service Providers<br>Transport/Mobility operators<br>Research sector<br>Large-scale demonstration projects |
| **Technical** | Address cybersecurity threats | G: Safe, secure, and reliable services | K: Research sector<br>K: Legislators<br>Public Administration<br>Transport/Mobility operators |
| **Technical** | Make the ODD as interrupted, stable, and predictable as possible and achieve smooth driving profile | G: Maximise the potential benefits from automated driving<br>D: Discourage active mobility | K: CCAM Industry<br>K: Transport/Mobility operators<br>Service Providers<br>Research sector |
| **Technical** | User-friendly HMIs | G: Intuitive use of HMIs<br>G: Users' acceptance and engagement | K: CCAM Industry<br>K: Service Providers<br>K: Citizens<br>Research sector |
| **Technical** | Technology to address specific needs based on the specific characteristics of each region | G: Well-defined and clear traffic management objectives | K: Public administration<br>K: Transport/Mobility operators<br>CCAM Industry<br>Research sector |
| **Technical** | Enable the monitoring, support, and orchestration of vehicles' movement | G: Intelligent traffic management and control applications | K: CCAM Industry<br>K: Transport/Mobility operators |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| | | | K: Research sector<br>Large-scale demonstration projects |
| **Technical** | Road users' familiarization with automation | G: Ensure safety of operations and acceptance of new services | K: Transport/Mobility operators<br>Research sector<br>Large-scale demonstration projects<br>CCAM Industry |
| **Technical** | Establishment of automated processes for data acquisition, processing, and analysis | G: Find a balance between necessary level of detail and associated cost | K: Research sector<br>Transport/Mobility operators |
| **Technical** | In priori assessment of the impact of CAVs penetration in city traffic | G: Development of traffic simulation models/transport digital twins based on reliable and robust traffic data sets / real-time traffic data<br>G: Identification and understanding of behavioural dynamics | K: Research sector<br>Large-scale demonstration projects<br>CCAM Industry |
| **Technical** | Classify and harmonize the capabilities of road infrastructure to support and guide CAVs | G: Safe integration of CAVs | K: Research sector<br>K: Transport/Mobility operators<br>CCAM Industry |
| **Technical** | Provide easy and precise information about mobility options | G: Reliable and user-friendly infomobility services | K: Transport/Mobility operators<br>K: Public administration<br>Service Providers<br>CCAM Industry |
| **Technical**<br>**Social** | Bring added value and strengthen user's acceptance | G: Provide gamification and infotainment | K: Transport/Mobility operators<br>K: Public administration |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| | | | Research sector<br>Citizens |
| **Technical**<br>**Financial** | Strengthen users' acceptance | G: Incentives for using services | K: Transport/Mobility operators<br>K: Public administration<br>Service providers |
| **Technical**<br>**Legal/Regulatory** | Demonstrate that all new vehicles, systems, components, and technical units are type-approved | G: Comply with technical specifications set up in regulations | K: CCAM Industry<br>Research sector<br>Large-scale demonstration projects |
| **Technical**<br>**Legal/Regulatory** | Development of appropriate mechanisms for security and privacy at a system-level | G: Achieve data privacy and security of services | K: Research sector<br>Legislators<br>CCAM Industry |
| **Legal/Regulatory** | Consolidation of regulations | G: Develop a holistic legislative approach towards CCAM | K: Legislators<br>Research sector<br>CCAM Industry |
| **Legal/Regulatory** | Define liability for technology and human behaviour | G: Clear responsibilities | K: Legislators<br>Research sector<br>CCAM Industry |
| **Legal/Regulatory** | Continuous monitoring and evaluation of CCAM solutions deployment | G: Support the design and operation processes | K: Legislators<br>K: Research sector<br>Transport/Mobility operators<br>Public Administration |
| **Legal/Regulatory** | Standardize technological and operational requirements for testing | G: Facilitate real-life CCAM trials | K: Legislators<br>K: Large-scale demonstration projects |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| | automated transport systems on public roads | | Research sector |
| **Legal/Regulatory** | Investigation of exemptions to non-compliance with existing rules by CAVs | G: Comprehensively address and define automated vehicles behaviour | K: Legislators<br>K: Research sector<br>Industry |
| **Legal/Regulatory** | Comprehensively identify actors' obligations through appropriate mechanisms (e.g., shared maps) | G: CCAM actors' clear objectives and accountability | K: Legislators<br>Research sector<br>CCAM industry |
| **Legal/Regulatory** | Mechanisms for granting compensation in case of accidents involving CAVs | G: Address legal, financial and ethical issues | K: Legislators<br>CCAM Industry<br>Research sector |
| **Legal/Regulatory** | Promote the dialogue between all stakeholders in the CCAM ecosystem | G: Enable actors to identify, decide and accept their role's obligations and responsibilities | K: Legislators<br>All |
| **Legal/Regulatory** | Promote and establish ethics in engineering as an important aspect of academic research | G: Address ethical issues concerning automation | K: Legislators<br>K: Research sector<br>CCAM Industry |
| **Legal/Regulatory** | Reshape licensing procedures | G: Make users aware of and ready to adapt to the changes that automation brings | K: Legislators<br>K: Industry<br>Transport/Mobility operators<br>Public administration |
| **Legal/Regulatory** | Create strong collaboration with industry and research sector | G: Reform and adapt legislation based on the technological advances | K: Legislators<br>Research sector<br>CCAM Industry |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| **Legal/Regulatory** | Address data privacy risks | G: Develop standardized transparency strategies to inform road users, including pedestrians and VRUs, of data collection domains | K: Legislators<br>Research sector<br>Transport/Mobility operators<br>CCAM Industry |
| **Legal/Regulatory** | Protect individuals' right at group level (e.g., driver, VRU, passenger) and address privacy risk that this data imposes for individuals | G: New guidelines concerning non-personal, third party and anonymised data | K: Legislators<br>Research sector<br>CCAM Industry<br>Service Providers |
| **Legal/Regulatory** | Address security and privacy issues | G: New regulations concerning cybersecurity and software updates<br>G: Address sensitive data protection issues, set appropriate safeguards- and enforce the effective application of data protection legislation | K: Legislators<br>Research sector<br>CCAM Industry |
| **Legal/Regulatory** | Harmonize the legal framework for real-life CCAM trials | G: Leverage large-scale deployment projects | K: Legislators<br>K: Large-scale demonstration projects<br>Research sector |
| **Legal/Regulatory**<br>**Operational**<br>**Technical**<br>**Financial**<br>**Social** | Address legal and ethical issues towards efficient, safe, inclusive, and equitable CCAM deployment | G: Development of an appropriate legislative, regulatory and operational framework meeting system architecture requirements<br>G: Define critical aspects like infrastructure development, efficient communication, business models etc. | K: Legislators<br>K: Research sector<br>Transport/Mobility operators<br>Industry<br>Representative bodies |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| **Legal/Regulatory**<br>**Technical** | Foster CCAM large-scale deployment | G: Standardize data formats and processing requirements for open data in collaboration with open source and standardisation bodies<br>G: Develop guidelines and roadmaps for large-scale deployment of CCAM solutions | K: Legislators<br>K: Research sector<br>Large-scale demonstration projects<br>CCAM Industry |
| **Financial** | Reach the massive target group living in city regions | G: Affordable business development strategies | K: CCAM Industry<br>K: Service Providers<br>Mobility/Transport Operators |
| **Financial** | Normalization of technology cost | G: Viable business models<br>D: Transition from traditional transport services may not be reached in a financially sustainable manner | K: Transport/Mobility operators<br>K: Public administration<br>CCAM Industry<br>Service Providers |
| **Financial** | Clear vision of the cost/revenue expected and impact on jobs | G: Viable business models<br>D: Profitability of future business models | K: Mobility/Transport operators<br>K: Public administration<br>CCAM Industry<br>Service Providers |
| **Financial** | Maximize utilization of services and vehicles | G: Viable business models | K: Transport/Mobility operators<br>Public administration |
| **Financial** | Achieve sustainable transportation solutions for the public | G: Invest in smart mobility projects | K: Public administration<br>K: Transport/Mobility operators<br>Research sector |
| **Financial** | Funding initiatives for research projects | G: Develop mature technology and services | K: Research sector |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| | | | K: CCAM Industry<br>Transport/Mobility operators<br>Public administration |
| **Financial**<br>**Legal/Regulatory** | Promote undistorted fair competition | G: Policies to prevent technology monopoly | K: Legislators<br>CCAM industry<br>Service providers |
| **Financial**<br>**Legal/Regulatory** | Increase of social welfare and GDP | G: Regulation and policies for unregulated operations and new jobs | K: Legislators<br>Transport/Mobility operators<br>Public Administration<br>Research sector<br>CCAM Industry |
| **Financial**<br>**Social** | Affordable services | G: Identify opportunities to reduce the initial and ongoing costs of CCAM services as technologies develop | K: Transport/Mobility operators<br>K: Citizens<br>Public Administration<br>Service Providers |
| **Social** | CCAM solutions to provide equity for all users (and non-users) | G: Develop frameworks to show how to provide equity for CCAM solutions<br>D: Providing equity for all might not be financially sustainable (at least initially) | K: Transport/Mobility operators<br>Public administration<br>Citizens |
| **Social** | CCAM solutions to meet mobility needs in terms of availability, accessibility, affordability, and acceptability | G: Understand the specific needs for citizens | K: Transport/Mobility operators<br>K: Public Administration<br>K: Citizens<br>Research sector |

| Type | Need / Requirement | Goals/Dilemmas (G/D) | (Key [K]) Stakeholders involved |
|---|---|---|---|
| **Social** | Collaboration, knowledge sharing, co-design, and co-creation processes | G: Aligned actions and better synchronization of investments to deliver valued CCAM solutions for the society | All |
| **Social**<br>**Technical** | Citizens' familiarization with automation | G: Organize training sessions for citizens and public awareness campaigns | K: Public administration<br>K: Research sector<br>Legislators<br>Large-scale demonstration projects |
| **Social**<br>**Organizational/Operational**<br>**Technical** | Services and applications to be used by all without considering socio-economical background or status | G: Provide user-friendly technology with easy and equal access | K: Public administration<br>K: Transport/Mobility operators<br>CCAM Industry<br>Service Providers<br>Research sector |

# 4. CCAM vocabulary

In this section, the scope and methodology of the CCAM vocabulary are presented. Its value for the SINFONICA project and CCAM stakeholders, citizens and future users is also examined. The CCAM vocabulary is available at the Annex of this document and will be available online on SINFONICA's webpage as well as to other knowledge base webpages aiming to be open and accessible by all interested stakeholders.

## 4.1 Scope and methodology

SINFONICA aims to create a CCAM vocabulary in order all the participants to share the same understanding of notions and terminology related to CCAM ecosystem throughout the whole duration of the project and especially the participatory and co-creation activities. The CCAM vocabulary will also act as a reference point for future research. Furthermore, SINFONICA will not only create the knowledge base (including the CCAM vocabulary, stakeholder engagement strategies, indicators, recommendations, etc.) but will also incorporate and exploit it via the creation of the innovative tool, SINFONICA Knowledge Map Explorer, which will be able to provide user-context-based guidelines for future CCAM implementations and deployments.

The CCAM vocabulary is based on already in place CAV vocabularies in the literature, terminology used in CCAM and C-ITS projects, regulations, journal papers, standards and websites. The need for continuous update of the vocabulary is imperatively recognized both to keep updated with the advances in the CCAM field as well as to add terms that might be assessed to be useful and/or critical for achieving the desired common understanding of all stakeholders. All WP1 partners were invited to edit the CCAM vocabulary in order to achieve a robust and comprehensive result. The CCAM vocabulary defines terms and abbreviations for the CCAM ecosystem also capturing the social aspects of CCAM deployment. Italicized terms used in the CCAM vocabulary are also defined therein. An attempt to capture all technological, legal, societal, organizational, and operational aspects of the CCAM ecosystem is made. To this end, a classification of the terminology was arranged regarding the following aspects:

- General terms related to CCAM.
- Terms related to automation capabilities of vehicles.
- Terms related to vehicles equipment.
- Terms related to data, communication & connectivity.
- Terms related to CCAM services.
- Terms related to infrastructure and management.
- Terms related to CCAM legislation.
- Terms related to CCAM deployment.
- Terms related to CCAM users and social aspects of CCAM.

## 4.2 Value of the CCAM Vocabulary beyond SINFONICA

The CCAM vocabulary is for use by all partners and stakeholders involved in the SINFONICA project. It will act as a base for a common understanding throughout the project and facilitate the co-creation activities. Beyond the value for the SINFONICA project, the vocabulary will be available for use by all relevant stakeholders in the CCAM ecosystem. There are many vocabularies created addressing CAVs or connectivity and automation terminology. SINFONICA aims to create a comprehensive CCAM vocabulary, addressing the social aspects that may affect CCAM deployments and taking into account the user perspective, to be used during and after the end of the project and act as a base for future references related to CCAM terminology. It is recognized that the ever-evolving nature of CCAM is expected to be enriched with new concepts and terminology and the need for continuous editing is necessary in order to be updated with all new advances.

## 5. Conclusions and next steps

The functional areas of the CCAM ecosystem comprise digital platforms, digital road infrastructure, operational road infrastructure, physical road Infrastructure, vehicle technologies, cyber security, and privacy. Their purpose, building blocks as well as typical actors involved in each one were examined capturing the need for a multidisciplinary approach towards CCAM deployment. SINFONICA's target groups are mainly CCAM industry actors, service providers, transport and mobility operators, public administration, the research sector, legislators, representative bodies, citizens, and large-scale demonstration projects. Understanding those stakeholders' point of view is of fundamental importance for the SINFONICA strategies. CCAM concepts and services regarding public transportation which is SINFONICA's main focus reveal the potential of shared and demand-responsive mobility in the framework of MaaS.

In order to capture the interrelationships in the CCAM ecosystem, key stakeholders' needs and requirements are examined from several perspectives. Some of the key findings concern the safety of operations and technology, cooperation and knowledge sharing between stakeholders, harmonization of services, interoperability and standardization of components and interfaces, consolidation of regulations, data privacy, affordable business models and services, inclusiveness and equity for all. Key dilemmas regarding the uptake or use of CCAM services are mostly concerned with safety, liability and accountability issues, cyber-security and data privacy risks, and affordability of services and business models. Aggregated results have been presented classifying needs and requirements as operational/organizational, technical, legal and regulatory, financial and social or a combination of them, capturing the respective goals and dilemmas as well as the key stakeholders involved in each one.

The need for a comprehensive CCAM vocabulary was addressed through the utilization of existing vocabularies about ITS, C-ITS, CAVs as well as journal papers, official documents (legislation, standards) and websites, also capturing social aspects arising from CCAM. A classification of terms related to the CCAM ecosystem was made as:

- General terms related to CCAM.
- Terms related to automation capabilities of vehicles.
- Terms related to vehicles equipment.
- Terms related to data, communication & connectivity.
- Terms related to CCAM services.
- Terms related to infrastructure and management.
- Terms related to CCAM legislation.
- Terms related to CCAM deployment.
- Terms related to CCAM users and social aspects of CCAM.

The CCAM vocabulary will be used throughout the project and will facilitate the participatory and co-creation activities letting all partners and participants to have a common understanding of the notions and the terminology. The CCAM Vocabulary is also intended to be used after the end of the SINFONICA project as a reference point for future CCAM projects.

In Task *T1.3 Understanding the gap of CCAM solutions deployment*, current practices of CCAM assets and services deployments will be investigated and compared with stakeholders' needs and requirements, aiming to highlight the gaps that SINFONICA project is trying to bridge. A taxonomy capturing all stakeholders needs, expectations, requirements as well as their interrelationships will be structured and will constitute the basis of the SINFONICA Knowledge Map Explorer.

# References


Alonso Raposo, M., Grosso, M., Mourtzouchou, A., Krause, J., Duboz, A., & Ciuffo, B. (2022). Economic implications of a connected and automated mobility in Europe. *Research in Transportation Economics*, *92*. https://doi.org/10.1016/j.retrec.2021.101072

Arup & Urban Transport Group. (2022). *Equitable Future Mobility: Ensuring a just transition to net zero transport*. https://www.urbantransportgroup.org/system/files/general-docs/Arup%20UTG%20Equitable%20Mobility_final.pdf

Ayaida, M. & Schappacher, J. (2021). MS24 – EU-C-ITS Interoperability Report. In C-ROADS Platform, WG2 Technical Aspects, TF 5 Cross-Testing and Validation.

Barnard, Y., Koskinen, S., Gellerman, H., Zilocki, A., …, Jia, T., Chen, H. (2018). D4.2 Updated FESTA handbook, including a short version for automation FOTs and inventory of novel methods. In Coordination of Automated Road Transport Deployment for Europe. Grant Agreement No: 724086.

Bauchinger, L., Reichenberger, A., Goodwin-Hawkins, B., Kobal, J., Hrabar, M. & Oedl-Wieser, T. (2021) Developing Sustainable and Flexible Rural–Urban Connectivity through Complementary Mobility Services. Sustainability, 13 (3). Art. 1280. doi:10.3390/su13031280

Cartwright, M., & Knoop, L. (2017). Deliverable D3.3: Final Roadmap. In M. Cartwright, & L. Knoop, C-ITS Roadmap for European cities. CIMEC Project.

Coeugnet, S., Natacha, M., & al., e. (2020). Deliverable 1.1: Ecosystem actors needs, wants & priorities & user experience exploration tools. In Shared automation operating models for worldwide adoption (pp. 33-38). Grant Agreement Number: 875530.

Connected Automated Driving Website (last visit 10/12/2022), available at: www.connectedautomateddriving.eu

Daisuren, Y., Karkhanis, P., Kadiogullari, D., & Fünfrocken, M. (2017). Deliverable 3.1: Reference Architecture. In Y. Daisuren, P. Karkhanis, D. Kadiogullari, & M. Fünfrocken, C-Mobile, Accelerating C-ITS Mobility Innovation and Deployment in Europe. Grant Agreement No. 723311

Derendarz, W., Spehr, J., Vock, D., Kurz, H., Rufli, M., Giosan, I., . . . Hlavác, V. (2018). Deliverable 10.2: Periodic Tecnical Report, PART B. In UP-Drive, Automated Urban Parking and Driving. Grant Agreement No. 688652.

dos Santos, F. L. M., Duboz, A., Grosso, M., Raposo, M. A., Krause, J., Mourtzouchou, A., Balahur, A., & Ciuffo, B. (2022). An acceptance divergence? Media, citizens, and policy perspectives on autonomous cars in the European Union. *Transportation Research Part A: Policy and Practice*, *158*, 224–238. https://doi.org/10.1016/j.tra.2022.02.013

European Commission. (2016). Cooperative, connected and automated mobility (CCAM). Mobility and Transport - European Commission. https://ec.europa.eu/transport/themes/its/c-its_en

European Commission. (2017). Towards clean, competitive and connected mobility: The contribution of Transport Research and Innovation to the Mobility package SWD (2017) 223 final. https://ec.europa.eu/transport/sites/transport/files/swd2017022 3-transportresearchandinnovationtomobilitypackage.pdf

European Commission, 2018. Europe on the move - Sustainable Mobility for Europe: safe, connected, and clean (Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2018/293 final)

European Commission, 2019. The European Green Deal (Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2019/640 final)

European Commission, 2020. Sustainable and Smart Mobility Strategy: putting European transport on track for the future (Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2020/789 final).

Ferrandez, R., Mesones, A., Rajkarnikar, S., Kotsi, A., Mitsakis, E., …, Fünfrocken, M., Schorr, P. (2019). D6.2 Technical validation report. In Accelerating C-ITS Mobility Innovation and deployment in Europe. Grant Agreement No: 723311.

Fischer, M. & Niehaus, J. (2018). D5.14 Report on Standardization V1. In European Initiative to Enable Validation for High Automated Safe and Secure Systems. Grant Agreement No. 692455.

Franco, D., Backhaus, W., & Rupprecht, J. (2020, 05 25). CoExist. Retrieved December 9, 2022, from Grant Agreement No. 723201-2: https://www.h2020-coexist.eu

Fürdös, A., Schallauer, D., Elpuente, C., Flix, O., Anund, A., …, Oguz, S., Capkin, K. (2020). D3.1: Analysis report on legal, regulatory, institutional frameworks. In Shared automation operating models for worldwide adoption. Grant Agreement Number: 875530.

Gellerman, H., Koskinen, S., Barnard, Y., Svanberg, E., Zlocki, A. (2018). D4.1 Data exchange platform for automation pilots including a sharing strategy. In Coordination of Automated Road Transport Deployment for Europe. Grant Agreement No. 724086.

Hamadneh, J., Duleba, S., & Esztergár-Kiss, D. (2022). Stakeholder viewpoints analysis of the autonomous vehicle industry by using multi-actors multi-criteria analysis. *Transport Policy*, *126*, 65–84. https://doi.org/10.1016/j.tranpol.2022.07.005

Horizon 2020 Commission Expert Group to advise on specific ethical issues raised by driverless mobility (E03659). Ethics of Connected and Automated Vehicles: Recommendations on road safety, privacy, fairness, explainability and responsibility. (2020).

Ivari, M., van den Bosch, F., Matthews, B., Scherz, S., Heckel, C., & Franco, D. (2020). D4.6 Automation-ready Action Plan for each road authority. In CoEXist. Grant Agreement No. 723201-2

I2CAT, T-SYS, ATOS, ALTRAN, 8BELLS, UBIWR, . . . PANA. (2020). Deliverable 2.1: Report on Detailed Specification of Use Cases. In Artificial Intelligence-based Cybersecurity for Connected and Automated Vehicles. FICOSA.

Kacperski, C., Kutzner, F., & Vogel, T. (2021a). Consequences of autonomous vehicles: Ambivalent expectations and their impact on acceptance. *Transportation Research Part F: Traffic Psychology and Behaviour*, *81*, 282–294. https://doi.org/10.1016/j.trf.2021.06.004

Kacperski, C., Heinz, A., Vogel, T., Kutzner, F., Chen, H., Gronier, G., Wirtz, J., & Kühl, F. (2021b). D3.2-Connected and Autonomous Vehicle 360° Acceptance Map. In Enhance driver behaviour & Public Acceptance of Connected & Autonomous Vehicles. Grant Agreement Number: 815098.

Lücken, L., Schwamborn, M., Mintsis, E., Koutras, D., Karagounis, V.,…, Tourwe, S., Bueno, O.A.B. (2021). D6.2 Assessment of Traffic Management Procedures in Transition Areas. In Transition Areas for Infrastructure-Assisted Driving. Grant Agreement No. 723390.

Massot, G., Gay, M., Haddad, S., Maliatsos, K. & Pantazopoulos, P. (2020). D5.4 Composite Evaluation of SAFERtec Assurance Framework. In Security Assurance Framework for Networked Vehicular Technology. Grant Agreement No. 732319.

Rutanen, E., Koskinen, M., Tuuliainen, E., Nissin, O., Martijnse-Hartikka, R.,…, Unterberg, M., Hansen, T (2021). D5.6 Future application and impact of project results and learnings. In Pre-Commercial Procurement of Future Automated Bus Urban Level Operations Systems. Grant Agreement No. 780371.

Regulation (EU) 2018/858, (2018). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0858&from=ES

Richter, M. A., Hagenmaier, M., Bandte, O., Parida, V., & Wincent, J. (2022). Smart cities, urban mobility and autonomous vehicles: How different cities needs different sustainable investment strategies. *Technological Forecasting and Social Change*, *184*. https://doi.org/10.1016/j.techfore.2022.121857

Shrestha, B. P., Millonig, A., Hounsell, N. B., & McDonald, M. (2017). Review of Public Transport Needs of Older People in European Context. *Journal of Population Ageing*, *10* (4), 343–361. https://doi.org/10.1007/s12062-016-9168-9

UITP, Union Internationale des Transports Publics (2017). Policy Brief: Autonomous vehicles. A potential game changer for urban mobility.

Via, S., Fisher, E., Hetzer, D., Bouillon, M., Coulet, F., Everingham, C., . . . Gonzales Vasquez, I. (2022). Deliverable 5.2 Cost/Benefit Validation of Relevant 5GCroCo Business Potentials. In Fifth Generation Cross-Border Control. Grant Agreement 825050.

Visintainer, F., Galli, M., Bosi, I., Brevi, D., …, van den Brand, J.W., Balraj, M. (2019). D1.6 Final Open IoT Vehicle Platform Specification. In AUTOmated driving Progressed by Internet of Things. Grant Agreement No: 731993

Vreeswijk, J. & Smith, K. (2019). D8.6 White Paper. In Management of connected automated vehicles in a smart city environment. Grant Agreement No: 690727.

Weber, F., Sorokin, L., Schmidt, E., Schieben, A., Wilbrink, M., …, Romano, R., Merat, N. (2019). D4.2 Final interaction strategies for the interact Automated Vehicles. In Designing cooperative interaction of automated vehicles with other road users in mixed traffic environments. Grant Agreement No: 723395.

Wijbenga, A. (2020). Deliverable 8.2: Meta-analysis of the results. In A. Wijbenga, Transition Areas for Infrastructure-Assisted Driving (TransAID). GA Nr 723390.

Wihbenga, A., Vreeswijk, J., Mintsis, E., Rondinone, M., Sepulcre, M., Gozalvez, J.,…, Schindler, J., Schwambom, M. (2020b). D8.2 Meta-analysis of the results. In Transition Areas for Infrastructure-Assisted Driving. Grant Agreement No. 723390.

Worschech, J., Serra, A., Willenbrock, R., Quaranta, R., Chirca, M., Peyrot, C.,…, Dolins, S., Weidenauer, J. (2020). D2.1 Benchmarking of existing business/operating models & best practices. In Shared automation Operating models for Wolrdwide adoption. Grant Agreement No. 875530.

# Annex

## CCAM Vocabulary

| General terms related to CCAM | | |
|---|---|---|
| Term | Abbreviation | Definition |
| Cooperative, Connected and Automated *Mobility* | CCAM | Combining *connectivity*, *cooperative systems,* and *automation* in the road transport sector for *mobility.* It can enable smart traffic management, shared mobility services integration with public transport, Mobility-as-a-Service and automated public transport services. |
| Connected and Automated *Mobility* | CAM(1) | Combining *connectivity* and *automation* in the road transport sector for *mobility.* |
| Cooperative<br><br>Intelligent Transport Systems | C-ITS | *Systems* allowing vehicles, transport infrastructure and other road users to communicate and coordinate their actions.<br><br>Note: While *ITS* focus on digital technologies providing intelligence placed at the roadside or in vehicles, C-ITS focuses on the communication between those *systems* – whether it is a vehicle communicating with another vehicle, with the infrastructure, or with other C-ITS. |
| Connectivity | | The capability of a *system* or device to be connected to other *systems* or devices. Typically this will involve wireless communications. |
| Cooperative System | | System that allows vehicles, infrastructure and other road users to share information and accordingly coordinate their actions. |
| Intelligent Transport Systems | ITS | *Systems* in which *ICT* are applied in the field of road transport, including infrastructure, vehicles, and users, and in *traffic management* and *mobility* management, as well as for *interfaces* with other modes of transport.<br><br>Note: While ITS focus on digital technologies providing intelligence placed at the roadside or in vehicles, *C-ITS* focus on the communication between those systems – whether it is a vehicle communicating with another vehicle, with the infrastructure, or with other *C-ITS* systems. |
| Automation | | Technique that makes a vehicle, a device, a process, or a system operate automatically without human intervention. |

| | | |
|---|---|---|
| *Intelligent Transport System Architecture* | | A framework within which interrelated *systems* can be built that work together to deliver transportation services. It defines how *systems* functionally operate and the interconnection of information exchanges that must take place between these *systems* to accomplish transportation services. |
| Mobility | | The potential for movement and the ability to get from one place to another (typically a different place) to meet a particular needs. |
| Stakeholder | | Individual, team, organization, or classes thereof, having an interest in a *system.* |
| System | | Combination of interacting elements organized to achieve one or more stated purposes. |
| *System* environment (or ecosystem) | | Context determining the setting and circumstances of all influences upon a *system*.<br><br>Note: The environment of a *system* includes developmental, technological, business, operational, organizational, political, economic, legal, regulatory, and social influences. |
| *System* architecture | | Fundamental concepts or properties of a *system* in its environment embodied in its elements, relationships and in the principles of its design and evolution. |
| **Terms related to *automation* capabilities of vehicles** | | |
| Term | Abbreviation | Definition |
| Advanced Driver Assistance *System* | ADAS | Additional electronic *systems* in motor vehicles supporting the *driver* in certain driving situations. They often focus on safety aspects or on increased driving convenience. |
| Advanced emergency braking system | AEBS | A *system* which can automatically detect a potential collision, provide the driver with a warning and potentially activate the vehicle braking *system* to decelerate the vehicle with the purpose of avoiding or mitigating a collision. |
| Active safety *system* | ASS | Active safety *systems* are vehicle systems that *sense* and *monitor* conditions inside and outside the vehicle for the purpose of identifying perceived present and potential dangers to the vehicle, occupants, and/or other road users, and automatically intervene to help avoid or mitigate potential collisions via various methods, including alerts to the *driver*, vehicle *system* adjustments, and/or active control of the vehicle subsystems (brakes, throttle, suspension, etc.). |
| Advanced driver distraction warning | | A *system* that helps the *driver* to continue to pay attention to the traffic situation and that warns the *driver* when distracted. |

| | | |
|---|---|---|
| Antilock Braking *System* | ABS | A *system* that prevents wheel lock-up by automatically regulating the brakes. ABS can decrease braking distances on slippery pavement, prevent skidding, and provide greater control during sudden stops. |
| Adaptive Cruise Control | ACC | Adaptive cruise control with stop & go function includes automatic distance control (typically restricted to a speed range) and, within the limits of the *system*, detects a preceding vehicle. It maintains a safe distance by automatically applying the brakes and accelerating. On some systems, in slow-moving traffic and congestion, it governs braking and acceleration. |
| *ADS*-equipped vehicle | | Vehicle equipped with *Level* 3,4 or 5 *ADS*.<br><br>Note: See *Levels of driving automation.* |
| Automated driving *system* | ADS | The hardware and software that is collectively capable of performing all aspects of the *dynamic driving task (DDT)*. This term is used specifically to describe a *Level* 3, 4, or 5 *driving automation system*.<br><br>Note: In contrast to ADS, the generic term "*driving automation system*" refers to any *Level* 1 to 5 *system* or *feature* that performs part or all of the *DDT* on a *sustained* basis. Given the similarity between the generic term, "*driving automation system*," and the *Level* 3 to 5 specific term, "automated driving system," the latter term should be capitalized when spelled out and reduced to its abbreviation, ADS, as much as possible, while the former term should not be. |
| Automated Vehicle | AV | A vehicle in which at least some aspects of a safety-critical control function (e.g., steering, throttle, or braking) occur without direct *driver* input.<br><br>Note 1: Vehicles that provide safety warnings to *drivers* (forward crash warning, for example) but do not perform a control function are, in this context, not considered automated, even though the technology necessary to provide that warning involves varying degrees of *automation* (e.g., the necessary *data* are received and processed, and the warning is given, without *driver* input). Automated vehicles may use onboard *sensors*, cameras, *GPS*, and telecommunications to obtain information in order to make their own judgments regarding safety-critical- situations and act appropriately by effectuating control at some level.<br><br>Note 2: The terminologies that have been widely used to call a vehicle with the *automation* capability, are an automated vehicle, an autonomous vehicle, a self-driving vehicle, and a driverless vehicle. It should be noted that some people use these terminologies interchangeably without any clear distinctions while other people attempt to differentiate the terminologies and use a specific term over the other. On the other hand, SAE recommends against using terms that make vehicles, rather than driving, the object of *automation*. The |

| | | |
|---|---|---|
| | | recommended usage for describing a vehicle with *driving automation* capability is "*Level* [*1* or *2*] *driving automation system-equipped vehicle*" or "*Level* [*3, 4 or 5*] *ADS-equipped vehicle*".<br><br>Note 3: In this document, the term *automated vehicle* is used when referring to a vehicle with Level 1-5 driving automation capability. When specifically referring to vehicles with *driving automation* capability of [1 or 2] or Level [3,4 or 5], the terms *Driving-automation system-equipped vehicle* or *ADS-equipped vehicle* are used respectively. In addition, wherever Level [1-5] is used in this document, it refers to *Levels of Driving Automation*. |
| Blind Spot *Monitoring* | | One of the *ADAS* applications that *monitors* the *driver*'s blind spots at the rear quarters of the car and provides visual, audible and/or tactile alerts when a vehicle is present in a situation requiring such alerts |
| Connected and Automated Vehicle | CAV | An *Automated Vehicle* which is also a *Connected Vehicle*. |
| Connected Vehicle | CV | A road vehicle (car, truck, bus, bicycle etc.) that is equipped with a wireless communication device. A CV uses any of the available wireless communication technologies to communicate with other cars on the road (*vehicle-to-vehicle* [*V2V*]), roadside infrastructure (*vehicle-to-infrastructure* [*V2I*]), other travellers and the *cloud*. |
| Conventional vehicle | | A vehicle designed to be operated by an in-vehicle *driver* during part or all of every trip. |
| Decide (Decision-Making) | | The third and final of the three stages of in-vehicle computing required for the vehicle to perform the *DDT* (*sense*, *fuse*, decide). In this stage, the vehicle decides how to proceed based on the model it has created of its environment. |
| Distance to Stop Line | | Distance from the vehicle's front to the next stop line in the vehicle's planned path applying comfort deceleration. |
| Driver | | A person who manually exercises in-vehicle braking, accelerating, steering, and transmission gear selection input devices in order to *operate* a vehicle. |
| *Driver* drowsiness and attention warning *system* | DDAW *system* | A *system* that assesses the *driver*'s alertness through vehicle *systems* analysis and, where needed, provides a warning to the *driver* via the vehicle's *human-machine interface*. |
| *Driver* support [*driving automation system*] feature | | A general term for *Level 1* and *Level 2 driving automation system features*.<br><br>Note: See *Levels of driving automation.* |

| | | |
|---|---|---|
| *Driver* takeover | | Action by the *driver* to regain manual control of the vehicle. |
| Driverless operation [of an ADS-equipped vehicle] | | On-road operation of an *ADS-equipped vehicle* that is unoccupied, or in which on-board users are not *drivers* or in -vehicle *fallback-ready users* |
| Driving *automation* | | The performance by hardware/software *systems* of part or all of the *DDT* on a *sustained* basis. |
| *Driving automation* system | | The hardware and software that are collectively capable of performing part or all of the *DDT* on a *sustained* basis; this term is used generically to describe any *system* capable of *Level 1 to 5 driving automation*. |
| *Driving automation system*-equipped vehicle | | Vehicle equipped with *Level 1* or *2 driving automation system*.<br><br>Note: See *Levels of driving automation.* |
| Dynamic Driving Task | DDT | Dynamic driving task (DDT) includes the operational (steering, braking, accelerating, *monitoring* the vehicle and roadway) and tactical (responding to events, determining when to change lanes, turn, use signals, etc.) aspects of the driving task, but not the strategic (determining destinations and waypoints) aspect of the driving task. |
| Dual-mode vehicle [ADS-equipped] | | A type of *ADS-equipped vehicle* designed for both *driverless operation* and operation by a *conventional driver* for complete trips. |
| Electric Vehicle | EV | Mode of transport powered by electricity |
| Electronic stability control | ESC | A *system* that provides selective wheel braking to improve vehicle handling and help *drivers* regain control in certain extreme circumstances. ESC employs *components* of the anti-lock braking *system* and has been required on all passenger vehicles in Europe starting with the 2012 model year. |
| Emergency stop signal | | A light-signalling function to indicate to other road users to the rear of the vehicle that a high retardation force is being applied to the vehicle relative to the prevailing road conditions. |
| Failure mitigation strategy | | A vehicle function (not an *ADS* function) designed to automatically bring an *ADS-equipped vehicle* to a controlled stop in path following either:<br><br>(1) prolonged failure of the *fallback-ready user* of a *Level 3 ADS feature* to perform the *fallback* after the *ADS* has issued a *request to intervene*, or |

| | | |
|---|---|---|
| | | (2) occurrence of a *system failure* or external event so catastrophic that it incapacitates the *ADS*, which can no longer perform vehicle motion control in order to perform the *fallback* and achieve a *minimal risk condition*. |
| Fallback [*DDT*] | | The response by the user to either perform the *DDT* or achieve a *minimal risk condition* after occurrence of a *DDT* performance-relevant *system* failure(s) or upon *operational design domain (ODD)* exit, or the response by an *ADS* to achieve *minimal risk condition*, given the same circumstances. |
| *Fallback*-ready user [*DDT*] | | The user of a vehicle equipped with an engaged *Level 3 ADS feature* who is able to *operate* the vehicle and is receptive to *ADS*-issued requests to intervene and to evident *DDT* performance-relevant *system* failures in the vehicle compelling the user to perform the *DDT* fallback. |
| Feature [*driving automation system*] | | A *Level 1-5 driving automation system's* design-specific functionality at a given *Level of driving automation* within a particular *ODD*, if applicable. |
| Front Collision Warning | FCW | The Front Collision Warning *monitoring system* uses *sensors* to detect situations where the distance to the vehicle in front is critical and helps to reduce the vehicle's stopping distance. In dangerous situations, the *system* alerts the *driver* by means of visual and acoustic signals and/or with a warning jolt of the brakes. Front Collision Warning operates independently of the *ACC* automatic distance control. |
| Hybrid Vehicle | | Vehicle that uses two or more distinct types of power. |
| Intelligent speed assistance | | A *system* to aid the *driver* in maintaining the appropriate speed for the road environment by providing dedicated and appropriate feedback. |
| Lane centring | | Vehicle *system* that uses cameras or other inputs and automated controls to help the vehicle stay in the centre of the driven lane.<br><br>Note: Unlike lane-keeping assist, this *system* operates continuously, applying steering controls to keep the vehicle in the centre of the lane whilst in operation. Current *systems* rely on lane markings of sufficient quality and visibility to support the function. The *system* can be cancelled by use of the turn signals. |
| Lane Departure Warning | LDW | Lane Departure Warning helps to prevent accidents caused by unintentionally wandering out of lane, and represents a major safety gain on motorways and major trunk roads. If there is an indication that the vehicle is about to leave the lane unintentionally, the *system* alerts the *driver* visually and in some cases by means of a signal on the steering wheel. |

| | | |
|---|---|---|
| Lane Change Assist | LCA | The *system monitors* the areas to the left and right of the car, including the blind spot detection, and up to 50 metres behind it and warns you of a potentially hazardous situation by means of flashing warning lights in the exterior mirrors. |
| Lane Keeping Assist | LKA | Lane Assist automatically becomes active from a specific speed (typically from 50 km/h) and upwards. The *system* detects the lane markings and works out the position of the vehicle. If the car starts to drift off lane, the LKA takes corrective action. If the maximum action it can take is not enough to stay in lane, or the speed falls below 50 km/h, the LKA function warns the *driver* (e.g., with a vibration of the steering wheel). Then it is up to the *driver* to take correcting action. |
| Lateral and/or longitudinal vehicle motion control | | The *DDT* subtask comprising the activities necessary for the real-time, *sustained* regulation of the lateral and/or longitudinal component of vehicle motion. |
| Levels of *Driving Automation* | | The six Levels of *driving automation*, defined in the “Standard J3016: Taxonomy and Definitions for Terms Related to *Driving Automation Systems* for On-Road Motor Vehicles, 2021” by the Society of Automotive Engineers (SAE).<br><br>Level 0 - No driving assistance<br><br>The performance by the *driver* of the entire *Dynamic Driving Task (DDT)*, even when enhanced by *active safety systems*.<br><br>Level 1 – Driver Assistance<br><br>The *sustained* and *Operational Design Domain (ODD)*-specific execution by a *driving automation system* of either the *lateral or longitudinal vehicle motion control* subtask of the *DDT* (but not both simultaneously) with the expectation that the *driver* performs the remainder of the *DDT.*<br><br>Level 2 – Partial *Driving Automation*<br><br>The *sustained* and *Operational Design Domain (ODD)*-specific execution by a *driving automation system* of both the *lateral and longitudinal vehicle motion control* subtasks of the *DDT* with the expectation that the *driver* completes the *Object and event detection response (OEDR)* subtask and supervises the *driving automation system.*<br><br>Level 3 – Conditional *Driving Automation*<br><br>The *sustained* and *Operational Design Domain (ODD)*-specific performance by an *automated driving system (ADS)* of the entire *DDT* with the expectation that the DDT *fallback-ready user* is receptive to *ADS*-issued |

| | | |
|---|---|---|
| | | requests to intervene, as well as to *DDT* performance-relevant *system* failures in other vehicle *systems* and will respond appropriately.<br><br><u>Level 4 – High *Driving Automation*</u><br><br>The *sustained* and *Operational Design Domain (ODD)*-specific performance by an *automated driving system* of the entire *DDT* without any expectation that the user will need to intervene<br><br><u>Level 5 – Full *Driving Automation*</u><br><br>The *sustained* and unconditional (i.e., not *ODD*-specific performance by an *automated driving system* of the entire *DDT* and DDT *fallback* without any expectation that a user will need to intervene.<br><br>Note: In Level 0-3, human *driver monitors* the driving environment. In Level 4-5, *automated driving system monitors* the driving environment. |
| Localization | | Technique to estimate the position and orientation of an *AV* in its environment. |
| Manoeuvre-based *feature* | | A *driving automation system feature* equipped on a *conventional vehicle* that either:<br><br>1. Supports the *driver* by executing a limited set *of lateral and/or longitudinal vehicle motion control* actions sufficient to fulfil a specific, narrowly defined *use case* (e.g., parking manoeuvre), while the *driver* performs the rest of the *DDT* and supervises the *Level 1* or *Level 2 feature*'s performance (i.e., *Level 1* or *Level 2 driver* support *features*); or<br><br>2. Executes a limited set of *lateral and longitudinal vehicle motion control* actions, as well as associated *object and event detection and response* (*OEDR*) and all other elements of the complete *DDT* in order to fulfil a specific, narrowly defined *use case* without human supervision (*Level 3 or 4 ADS features*). |
| Mapping | | The creation process of a map, i.e., a representation of real-world features and its location as objects. For *AV*s, maps can be created beforehand or in real time. There are three main categories of mapping information that an *ADS* uses: topological, geometric, and semantic. |
| Minimal Risk Condition | MRC | A condition to which a user or an *ADS* may bring a vehicle after performing the *DDT fallback* in order to reduce the risk of a crash when a given trip cannot or should not be completed. |
| Monitor/monitoring | | A general term describing a range of functions involving real-time human or machine sensing and processing of *data*. In terms of AVs, *data* is used to *operate* a vehicle, or to support its operation. |

| | | |
|---|---|---|
| Object and event detection and response | OEDR | The subtasks of the *Dynamic driving task (DDT)* that include *monitoring* the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e., as needed to complete the *DDT* and/or *DDT fallback*). |
| Obstacle detection | | An *ADAS* feature sensing slow-moving or stationary objects ahead of the vehicle, usually when driving at low speeds, and alerting the *driver* with a flashing command to brake the vehicle, along with an audible warning and/or a vibration at the steering wheel and/or in the *driver*'s seat |
| Operate [a motor vehicle | | The activities performed by a (human) *driver*/operator (with or without support from one or more *Level 1 or 2 driving automation features*) or by an *ADS* (*Level 3-5*) to perform the entire *DDT* for a given vehicle during a trip. |
| Operational Design Domain | ODD | Operating conditions under which a given *driving automation system* or *feature* thereof is specifically designed to function, including, but no limited to, environmental, geographical, time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics. |
| Park Assist | | A *system* of *ultrasonic sensors* on the front and/or rear bumpers that provide the *driver* with visual, audible and/or tactile alerts as their vehicle approaches a stationary object. |
| Remote *driver* | | A person who is not present in the vehicle, but is able to remotely *operate* the vehicle. |
| Remote driving | | Real-time performance of part or all of the *DDT* and/or *DDT fallback* (including, real-time braking, steering, acceleration, and transmission shifting), by a *remote driver*. |
| Remote fallback-ready user | | A *fallback-ready user* of a *Level 3 ADS*-equipped vehicle in *driverless operation* located remote to the vehicle. |
| Request to intervene | | Notification by the *automated driving system (ADS)* to a human *driver* that they should promptly begin or resume performance of the *dynamic driving task*. |
| Reversing detection | | A *system* to make the *driver* aware of people and objects at the rear of the vehicle with the primary aim of avoiding collisions when reversing. |
| Robot operating system | ROS | See *ADS*. |
| Safety case | | Structured argument, supported by evidence, intended to justify that a *system* and activity is acceptably safe for a specific application in a specific operating environment. |
| Safety *driver* | | See *fallback-ready user*. |

| | | |
|---|---|---|
| Safety operator | | See *remote fallback-ready user*. |
| Sense (perception) | | The first of the three stages of in-vehicle compute required for the vehicle to perform the *DDT* (sense*, fuse, decide*). In this stage, the vehicle collects *data* from *sensors.*<br><br>See also *Fuse* and *Decision-  making.*<br><br>Note: *Sensors* may be active, sending out energy (e.g., *radar*, *LiDAR sensor*, *ultrasonic sensor*), or passive, simply taking information from the environment without sending out a wave (e.g., *camera*). |
| Fuse (Sensor *data* fusion) | | The second of the three stages of in-vehicle compute required for the vehicle to perform the *DDT* (*sense*, fuse, *decide*). In this stage, the vehicle correlates, and fuses *sensor data* to create a model of its environment.<br><br>See also *Sense* and *Decision-making.*<br><br>Note: Sensors may be active, sending out energy (e.g., *radar*, *LiDAR sensor*, *ultrasonic sensor*), or passive, simply taking information from the environment without sending out a wave (e.g., *camera*) |
| Sustained | | Performance of part or all of the *DDT* both between and across external events, including responding to external events and continuing performance of part or all of the *DDT* in the absence of external events. |
| *System* failure [*DDT* performance-relevant] | | A malfunction in a *driving automation system* and/or other vehicle *system* that prevents the *driving automation system* from reliably performing its portion of the *DDT* on a *sustained* basis, including the complete *DDT*, that it would otherwise perform. |
| Vehicle on-board diagnostic information | | The information generated by a *system* that is on board a vehicle or that is connected to an engine, and that is capable of detecting a malfunction, and, where applicable, is capable of signalling its occurrence by means of an alert *system*, is capable of identifying the likely area of malfunction by means of information stored in a computer memory and is capable of communicating that information off-board. |
| **Terms related to vehicles equipment** | | |
| Term | Abbreviation | Definition |
| Alcohol interlock installation facilitation | | A standardised *interface* that facilitates the fitting of aftermarket alcohol interlock devices in motor vehicles. |
| Camera | | Device for recording the environment of an automated vehicle in the form of video. Cameras can be placed on every side of the vehicle (front, rear, left right) in order to create a 360-degree view of the environment. |

| | | |
|---|---|---|
| Component | | A device that is intended to be part of a vehicle, that can be *type-approved* independently of a vehicle. |
| Electronic Control Unit | ECU | A unit embedded in the vehicle that controls one or more electrical *systems*, such as the engine control unit or the *human-machine interface.* |
| Event *data* recorder | | A *system* with the only purpose of recording and storing critical crash-related parameters and information shortly before, during and immediately after a collision. |
| GNSS Antenna | | Onboard *antenna* used to receive satellite signals from *GNSS*. |
| Inertial measurement unit | IMU | Electronic units on *AVs* to *monitor* inertial parameters such as acceleration, angular rate, and magnetic field toward the three axes. |
| Light Detection and Ranging sensor | LiDAR sensor | *Sensor* that uses light in form of a pulsed laser to measure ranges. |
| Odometer | | Device that registers the distance travelled by a vehicle. |
| On-Board Diagnostics | OBD | A built-in diagnostic *system* on all newer vehicles that *monitors* vehicle control *systems* for proper operation. |
| Original Equipment | OE | *Components* used to build the vehicle at the factory or are available as service replacements through franchised dealers. |
| *Original Equipment* Manufacturer | OEM | A company that produces hardware to be marketed under another company's brand name. |
| Radio Detection and ranging | Radar | *Sensor* that uses radio waves to measure ranges. |
| Sensor | | Device that detects and responds to events or changes in its environment. Onboard sensors may be *cameras*, *LiDAR*, *radars*, *ultrasonics*, *odometer*, *inertial measurement unit*, *satellite navigation*. |
| Separate technical unit | | A device that is intended to be part of a vehicle that can be *type-approved* separately, but only in relation to one or more specified types of vehicles. |
| Vehicle master control switch | | The device by which the vehicle's on-board electronics *system* is brought, from being switched off, as in the case where a vehicle is parked without the *driver* being present, to normal operation mode. |
| Ultrasonic sensor | | Device that measures the distance of an object by emitting ultrasonic radio waves. |

| **Terms related to *data*, communication & *connectivity*** | | |
|---|---|---|
| Term | Abbreviation | Definition |
| Accessibility of the *data* | | The possibility to request and obtain the *data* at any time in a digital machine-readable format. |
| Antenna | | Metallic structure that captures and/or transmits radio electromagnetic waves. |
| Artificial Intelligence | AI | The branch of computer science devoted to developing *data processing systems* that perform functions normally associated with human intelligence, such as reasoning, learning, and self-improvement |
| Authorization | | A prescription that a particular behaviour is permitted. |
| Big *data* | | Large amount of *data*, produced very quickly by a number of diverse sources, that require new technologies (e.g., *AI*) to process. |
| Cellular antenna | | *Antenna* used for *cellular communication*. |
| Cellular communication | | Communication with and between vehicles using *cellular* mobile networks (such as *4G and 5G*) |
| Cloud | | Servers, including the software and *databases* that run on them, that are accessed over the Internet and are located in *data centres*. |
| Compatibility | | The ability of a device or *system* to work with another device or *system* without modification |
| Consent | | Any freely given, specific, informed, and unambiguous indication of the *data* subject's wishes by which he or she, by a statement or by a clear affirmative action, signifies agreement to the processing of *personal data* relating to him or her. |
| Collective Perception Message | CPM | Message that contains information about objects detected by the disseminating *ITS-S*.<br><br>Note: In contrast to *Cooperative Awareness Message* (*CAM*[2]), CPM contains information about the current driving environment rather than the current state. |
| Cooperative Awareness Message | CAM[2] | Message that is intended to realize cooperative awareness (i.e., locate vehicles or cooperative infrastructure in real time and signal position and state of vehicles). CAMs are transmitted regularly by *OBU*s, *RSU*s and *ITS stations* within range can receive and process them. |

| | | |
|---|---|---|
| Cybersecurity | | A broad term referring to the processes and practices designed to protect networks, computers, programs, and *data* from attack, damage, or unauthorized access |
| Data | | A representation of facts, concepts, or instructions in a manner suitable for communication, interpretation, or processing by humans or by automatic means. |
| *Data* analysis | | A systematic investigation of the *data* and their flow in a real or planned *system*. |
| *Data* Authentication | | A process used to verify *data* integrity, e.g., verification that *data* received are identical to *data* sent, or verification that a program is not infected by a virus. |
| *Data* centre | | Facility hosting networked computers which collaborate to process, store, and share *data*. |
| *Data* communication | | Transfer of *data* among functional units according to sets of rules governing *data* transmission and the coordination of the exchange. |
| *Data* flow | | Representation of *data* flowing between two processes or between a process and other entities capable to receive inputs or send outputs. |
| *Data* inventory | | In an information processing *system*, all the data and their characteristics, including interdependencies. |
| *Data* management | | In a *data processing system*, the functions that provide access to *data*, perform, or *monitor* the storage of *data*, and control input-output operations. |
| *Data* processing | | The systematic performance of operations upon *data*. |
| *Data* processing *system* | | One or more computers, peripheral equipment, and software that perform *data processing*. |
| *Data* protection | | The implementation of appropriate administrative, technical, or physical means to guard against unauthorized intentional or accidental disclosure, modification, or destruction of *data*. |
| *Data* provider | | Individual or organization that is a source of *data*. |
| *Data* repository | | An object providing the storage function for *data*. |
| *Data* store | | Organized and persistent collection of *data* and information that allows for its retrieval. |
| *Data* update | | Any modification of the existing *data*, including its deletion or insertion of new or additional elements. |

| | | |
|---|---|---|
| Database | | A collection of interrelated *data* stored together in one or more computerized files. |
| DATEX II | | *Standard* for the exchange of traffic related *data*. |
| Decentralized Environmental Notification Message | DENM | Message that contains information related to an event that has a potential impact on road safety or traffic condition. An event is characterised by an event type, an event position, a detection time, and a time duration. These attributes may change over space and over time. |
| Dedicated Short-Range Communication | DSRC | A communication protocol developed to address the safety critical issues associated with sending and receiving *data* among vehicles and between moving vehicles and fixed roadside access points. These provide low-*latency data*-only *V2V* and *V2I* communications for use in *Connected Vehicle Applications.*<br>Note: The term "DSRC" originally was used to refer to tolling *systems* at 5.8 GHz. Now the term is also used to refer to DSRC operation at 5.9 GHz under the IEEE 802.11p standard). |
| Digital certificate | | An electronic *data* structure that binds an entity, being an institution, a person, a computer program etc., to its public key. Digital certificates are used for secure communication, using public key cryptography, and digital signatures. |
| Dynamic *data* | | *Data* that change often or on a regular basis. |
| EU C-ITS security credential management *system* | | The European Union *C-ITS* framework for the provision of trusted and secure communication using a *public key infrastructure* (*PKI*). |
| Global *Navigation* Satellite System | GNSS | Constellation of satellites providing signals from space that transmit positioning and timing *data* to GNSS receivers. The receivers use this *data* to determine location. |
| Global Positioning System | GPS | USA's *Global Navigation Satellite System*. |
| Hardware Security Module | HSM | Unit in a *PKI* environment for generating, storing, and handling *digital certificates*. |
| Human Machine Interface | HMI | An *interface* responsible for two-way communication between a vehicle and its occupants. An *HMI* may incorporate touchscreen displays, voice recognition, or integration with mobile devices. It enables a human being to interact with a machine.<br>Note: May be *PID* |

| | | |
|---|---|---|
| Interoperability | | The capacity of *systems* and the underlying business processes to exchange *data* and to share information and knowledge |
| In-vehicle generated *data* | | Any *data* created by the vehicle or by an on-board device embedded in the vehicle or personal devices offering *ITS*-applications while the vehicle is in use. |
| In-Vehicle Information Message | IVIM | Message that provides information of physical road signs such as static or variable road signs, virtual signs, or roadworks.<br><br>Note: It supports mandatory and advisory road signage such as contextual speeds and roadworks warnings. |
| In-Vehicle *IoT* platform | | (1) If vehicle considered as an *IoT* device. Similarly to *IoT platform*<br>(2) If vehicle considered as an edge computing unit and gateway for other *IoT* devices - The "*IoT platform*" is the set of functions that manages the *IoT* devices and entities, while "In-Vehicle *IoT platform*" is defined as the complex entity that includes all the software and hardware *components* deployed in the vehicle. |
| Information and Communication Technology | ICT | Various types of technologies that are used for processing and delivering information and communication. |
| Internet of Things | IoT | A network of physical objects - devices, vehicles, buildings, machines, and other items - embedded with electronics, software, *sensors*, and network *connectivity* that enables these objects to collect and exchange *data*. In its simplest terms, the IoT is about physical "things" with the ability to sense, actuate, and communicate. |
| *Internet of Things* platform | *IoT* platform | The *IoT* platform is composed of central units (*cloud*) and distributed edge computation nodes (edge) and creates a unifying view of the *IoT* entities. *IoT* enabled applications use the *interface* to the *IoT* platform in order to interact with *IoT* entities. |
| Internet of Vehicles | IoV | A network of vehicles defined as an integration of three networks: an inter-vehicle network, an intra-vehicle network, and vehicular mobile network. Based on this concept of three networks integrated into one, the Internet of Vehicles is defined as a large-scale distributed *system* for wireless communication and information exchange between vehicle, road, human and Internet, according to agreed communication protocols and *data* interaction standards. |
| Latency | | The time interval between the instant at which an instruction control unit issues a call for *data* and the instant at which the transfer of *data* is started |

| | | |
|---|---|---|
| Long-Term Evolution [4G or 5G] | LTE | A mobile telephone standard that accelerates the expansion of mobile Internet use. |
| Machine Learning | | A subfield of *artificial intelligence* whose objective is to give *systems* the ability to learn and improve by its own without being explicitly programmed to do it. |
| MapData Extended Message | MAPEM | Message that contains geographic road information such as intersection descriptions, road segment descriptions, segment of roadway etc. It provides a topological basis that in turn is used by other messages to relate additional information (e.g., *SPATEM*). |
| Metadata | | A structured description of the contents of the *data* facilitating the discovery and use of this *data*. |
| National Access Point | NAP | Node in which *ITS*-related *data* of an EU Member State are concentrated and published in the form of datasets. They are set up to facilitate access, easy exchange, and reuse of transport related *data* in Europe, in order to support the provision of EU-wide interoperable travel and traffic services to end users. |
| Over-the-Air Update | OTA Update | Software or firmware updates to a vehicle that are downloaded from the *cloud*. |
| Personal *data* | | Any information relating to an identified or identifiable natural person.<br><br>Note: an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location *data*, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural, or social identity of that natural person. |
| Privacy | | The ability of an individual or group to seclude themselves or seclude information about themselves, thereby revealing themselves selectively. Privacy is considered a huge concern with *connected vehicle* operation since a lot of communication takes place in an environment that may risk the privacy of users. |
| Public Key Infrastructure | PKI | A combination of policies, procedures and technology needed to manage *digital certificates* in a public key cryptography scheme. The purpose of a PKI is to make sure that the certificates can be trusted. |
| Real Time *Data* | RTD | *Data* that are collected continuously and made available for immediate processing. Vehicle RTD includes information about vehicles such as current fuel consumption, braking behaviour and temperature, and information on the current level of traffic or the state of the road ahead. |
| Real Time Traffic Information | RTTI | Information derived from any *data* on the infrastructure, *data* on regulations and restrictions, *data* on the state of the network and *data* on the real-time use of the network, or the combination thereof. |

| | | |
|---|---|---|
| Road *data* | | *Data* on road infrastructure characteristics, including fixed traffic signs or their regulatory safety attributes |
| Router | | Networking device that enables communication over the Internet. |
| Simultaneous Localization and Mapping | SLAM | A technique which is implemented in automated driving and allows *CAV*s to incrementally build a coherent map of their environment and simultaneously estimate its position and orientation. |
| Static *data* | | *Data* that change often or on a regular basis. |
| Signal Phase and Timing Extended Message | SPATEM | Message that contains current signalling status of one or more signalized intersections. |
| Signal Request Message | SREM | Message requesting traffic light signal priority (e.g., public transport). It may be requested for a sequence of intersections along a defined traffic route. |
| Signal Status Message | SSEM | Message acknowledging that the *SREM* has been granted, cancelled or changed in priority due to a more relevant signal request. |
| Smart *data* | | *Big data* turned into actionable *data* that is available in real-time for a variety of business outcomes, whether it is an industrial application, data-driven marketing, or process optimization. |
| Standard Message Sets | | A set of messages which are the primary means by which vehicles communicate with each other and with the roadway infrastructure (e.g., *DENM, CAM*[(2)]). |
| Travel *data* | | Basic *data* such as public transport timetables and tariffs, necessary to provide multi-modal travel information before and during the trip to facilitate travel planning, booking and adaptation. |
| Traffic *data* | | Historic and real-time *data* on road traffic characteristics. |
| V2X antenna | | *Antenna* used for *V2X* communication. |
| Vehicle to everything (V2X) communication | V2X | A communication that promotes the exchange of information between the vehicle and various counterparts including other means of transport, the infrastructure, *traffic management centres (TMC)* and various Internet applications. |
| Vehicle to Infrastructure (V2I) communication | V2I | A communication that promotes the exchange of information between the vehicles and the infrastructure. |

| | | |
|---|---|---|
| Vehicle to Pedestrian (V2P) communication | V2P | A communication that promotes the exchange of information between the vehicles and the pedestrians or other *vulnerable road users*. |
| Vehicle to Vehicle (V2V) communication | V2V | A communication that promotes the exchange of information between vehicles. |
| Interface | | A facility between *systems* which provides the media through which they can connect and interact. |
| *ITS*-G5 | | Protocol stack for supporting *vehicle-to-vehicle communications* in an ad hoc network based on IEEE 802.11-2012 and ANSI/IEEE Std 802.2.<br><br>Note: G5 is derived from the frequency band (5.9 GHz) upon which it was designed to operate. |
| Wireless fidelity | Wi-Fi | Wireless technology that allows devices to connect to a wireless local area network. |
| Vulnerable Road User (VRU) Vehicle OBU | VRU OBU | An *on-board unit (OBU)* attached to a *VRU* vehicle (e.g., moped, electric bike) and needed for *VRU* assisted applications to inform / advise a *driver* via a *Human Machine Interface (HMI)*. |
| Terms related to *CCAM* services | | |
| Term | Abbreviation | Definition |
| Bikesharing (or bicycle sharing) service | | *Shared vehicle service* that shares bicycles. |
| Booking application | | Application for booking a *transport service*. |
| *C-ITS* Day 1 & 1.5 services | | *C-ITS services* that are considered highly beneficial and should therefore be deployed quickly based on their technological maturity. Some are already being implemented.<br><br>Day 1 services include:<br><br>• In-Vehicle Signage<br>• Hazardous location notification<br>• Road works warning<br>• Signalized intersections<br>• Traffic jam ahead warning |

| | | |
|---|---|---|
| | | • Probe vehicle *data*, etc.<br><br>Day 1.5 services include:<br><br>• Traffic information & Smart routing<br>• On street parking information and management<br>• Off-street parking information<br>• Information on alternative fuel and charging stations<br>• Park & Ride information<br>• Vulnerable Road user protection<br>• Cooperative collision risk warning, etc. |
| *C-ITS* Day 2 & 3+ services | | Future *C-ITS services* that have the potential to increase traffic safety and efficiency but are yet technologically immature (e.g., *automated vehicle* guidance, cooperative automated parking, etc.) |
| *C-ITS* services | | A category of *ITS services* based on an open architecture that enables a many-to-many or peer-to-peer relationship between *C-ITS stations*.<br><br>Note: This means all *C-ITS stations* should securely exchange messages with each other and should not be limited to exchanging messages with pre-defined stations. |
| Car pooling | | Sharing a trip between several participants in one vehicle. |
| Carsharing (or passenger car sharing) service | | *Shared vehicle service* that allows the users to access cars on-demand without owning the car. |
| Demand responsive transport | DRT | *On-demand transport services* utilizing fleets of vehicles which pick up and drop off passengers in accordance with their needs. |
| Digital platform | | On-board or off-board unit enabling the deployment, provision, exploitation and integration of *ITS applications* and *services*. |
| Dynamic (route**)** *transport service* | | Concurrent *transport service* where transported items can only be received or delivered at stopping points within a pre-defined service corridor. |

| | | |
|---|---|---|
| eCall | | Post-crash technology that allows direct communication to emergency services to speed up emergency-response times and therefore reduce the number of fatalities and severe injuries. |
| First/last mile *transport service* | | A transportation service that covers the gap from public transport to a destination. |
| Fixed (route) *transport service* | | Concurrent *transport service* where transported items can only be received or delivered at stopping points contained in a pre-defined sequence. |
| Free-floating *transport service* | | *Transport service* that may be initiated and terminated at any location within a defined area meeting basic criteria. |
| In-Vehicle Infotainment | | A collection of hardware and software that provide entertainment in the vehicle; for example, *navigation systems*, radio, video players, and Wi-Fi. |
| *ITS* application | | An operational instrument for the application of *ITS.* |
| *ITS* service | | The provision of an *ITS application* through a well-defined organisational and operational framework with the aim of contributing to user safety, efficiency, comfort and/or to facilitate or support transport and travel operations |
| *ITS service provider* | | Any *service provider* of an *ITS* service, whether public or private.<br><br>Note: *C-ITS services* often require multiple entities cooperatively working together to provide a unified service where the individual entities are simultaneously *ITS service providers* and *ITS users*. |
| Mobile application | | Mobile applications can provide *C-ITS* services to end users without the need for *OBU*s. This way, limited number of services with no demands for availability of vehicle information or possibly for certain transfer speed or reliability can be provided. |
| Mobile ticketing | | The use of a mobile device to purchase and/or validate a travel ticket or to initiate a journey. |
| *Mobility* as a Service | MaaS | The integration of various forms of *transport services* into a single *mobility* service accessible on demand.<br><br>Note: The underlying idea is to replace individual car ownership with a superior *mobility* service, which serves the user's *mobility needs* better and at lower cost. MaaS could also be considered a *mobility* marketplace. |

| | | |
|---|---|---|
| *Mobility* on Demand | MoD | Concept by which *mobility* can be obtained when the need arises through a service that does not require a reservation in advance.<br><br>Note: In North America MoD is often used synonymously with *MaaS*, which is the more common term in Europe. However, MoD includes freight services which is typically not part of MaaS. |
| *Mobility* Service Provider | MSP | Public or private companies that offer *mobility* services.<br><br>Note: Not all MSPs are also *Transportation Service Providers*, in this case they are a reseller or broker for *Transportation Service Porviders*. |
| Multimodal *mobility* | | The combination of two or more modes of transport in a single trip.<br><br>Note: Walking may or may not count as a mode for this trip. |
| Navigation | | Action of leading a vehicle or pedestrian to a given destination, by calculating the optimal trajectory (according to a set of rules) and giving guidance to this trajectory and its real time position. |
| On-demand (*transport service*) | | Concurrent *transport service* where the transport provider may choose to divert from its path to service a new request from other transport users while servicing an earlier transport user. |
| Personal Information Device | PID | Provides the capability for travellers to receive formatted traveller information wherever they are. Capabilities may include traveller information, trip planning, and route guidance. Frequently a smart phone, the PID provides travellers with the capability to receive route planning and other personally focused transportation services from the infrastructure in the field, at home, at work, or while en-route. PID may operate independently or may be linked with *connected vehicle* on-board equipment |
| Public *transport service* | | *Transport service* that is publicly accessible enabling the movement of one or more persons. |
| Real-time traffic information service | | An *ITS service* that provides end-users immediately with real-time traffic information. |
| Rideshare service | | *Shared transport service* that transports passengers concurrently and where users partner to defray the cost of services. |
| Ridesourced service | | Commercial *shared transport service* that transports passengers and where the *service provider* is an individual. |

| | | |
|---|---|---|
| Ridesplit service | | *Ridesourced service* that serves passengers concurrently. |
| Satellite navigation | | *Navigation* based on satellite signals |
| Service Provider | | An organization supplying service to one or more customers. Customers can include both other organizations, and end users. |
| Shared *transport service* | | *Transport service* that relies upon the same resources to fulfil the transport needs multiple unrelated transport users and where the transport provider has the primary responsibility for the operation of the transport mode. |
| Shared vehicle service | | *Transport service* that sequentially provides the same vehicles to multiple unrelated transport users and where the transport user has the primary responsibility for the operation of the vehicle. |
| Shuttle service | | *Shared transport service* that transports passengers between specified locations. |
| Smart routing | | Intelligent *system* for *navigation* of vehicles, based on *ICT*. |
| Station-based *transport service* | | *Transport service* that may be initiated and terminated at one or more facilities managed by the *transport provider.* |
| Taxi service | | Commercial *shared transport service* that transports passengers sequentially. |
| Taxi-share service | | Commercial *shared transport service* that transports passengers concurrently. |
| Transport service | | Service that delivers one or more people and/or goods from one location to another to satisfy a transport need. |
| Transport sharing | | Using a shared *transport service*. |
| Transportation *Service Provider* | | Entity that delivers one or more *transport services*. |
| Traffic Signal Prioritisation | TSP | The adjustment of traffic signals to give priority to specified vehicles (e.g., transit vehicles, emergency vehicles). |
| Use case | | Function of the *system*, the desired behaviour (of the *system* and *actors*), specification of *system* boundaries and definition of one or more usage *scenarios*. |

| | | |
|---|---|---|
| Vehicle platooning | | The linking of two or more vehicles in a convoy using *connectivity* technology and automated driving support *systems* which allow the vehicles to automatically maintain a set, close distance between each other when connected for certain parts of a journey and to adapt to changes in the movement of the lead vehicle with little to no action from the *drivers*. |
| Vehicle sharing | | Using a *shared vehicle service*. |
| **Terms related to infrastructure and management** | | |
| Term | Abbreviation | Definition |
| Alternative fuel infrastructure | | Infrastructure for recharging or refuelling vehicles powered with electricity, natural gas, or hydrogen. |
| *C-ITS* station | | The set of hardware and software *components* required to collect, store, process, receive and transmit secured and trusted messages in order to enable the provision of a *C-ITS service*. This includes personal, central, vehicle and roadside *ITS stations* as defined in EN 302 665 v 1.1.1. |
| Central *C-ITS* | | Central *C-ITS* aims to unify connections of vertical *C-ITS* back office (BO) partners participating in the *C-ITS* system to ensure fast and reliable *data* exchange among individual *C-ITS* BÓs and the *TMC.* |
| *Central C-ITS* station | | A central server with integrated *C-ITS station* capabilities, such as in a *traffic management centre*. |
| Charging infrastructure | | Infrastructure for recharging vehicles powered with electricity. |
| Depot | | Infrastructure for storing of vehicles and may include *dispatching*, maintenance, service and fuelling areas for the stored vehicles. |
| Digital road infrastructure | | Static and dynamic digital representations of the physical world with which *CCAM* vehicles interact (e.g., maps, traffic regulations, traffic, and travel information). |
| Dispatch [in driverless operation] | | To place an *ADS-equipped vehicle* into service in *driverless operation* by engaging the *ADS*. |
| Dispatch (transport generally) | | To put a vehicle into service. |

| | | |
|---|---|---|
| Dispatching entity [driverless operation] | | An entity that *dispatches* (an) *ADS-equipped vehicle*(s) in driverless operation. |
| Fixed *C-ITS station* | | A *C-ITS station* installed in a central *system* or roadside infrastructure. |
| Fleet management | | The processes of *monitoring* fleet operation and making decisions about asset management, *dispatch* and routing, and vehicle acquisition and disposal. |
| High Occupation Vehicle Lane | HOV Lane | Reserved *traffic lane* for the exclusive use of vehicles with more than a minimum number of occupants, including *shared transport services* and transit buses. A variant of this is a High Occupancy Toll Lane where use incurs a charge. |
| Infrastructure device | | Any piece of equipment connected to the *cooperative system* that is placed on the roads, bridges, rail-lines, and similar public works that are on or near a transportation *system* or other public institution |
| *ITS* Roadway equipment | | Represents the *ITS* equipment that is distributed on and along the roadway that *monitors* and controls traffic and *monitors* and manages the roadway. This physical object includes traffic, pedestrian, cycle detectors, environmental *sensors*, traffic signals, highway advisory radios, dynamic message signs, CCTV cameras and video image processing *systems*, grade crossing warning *systems*, and ramp metering *systems*. Lane management *systems* and barrier *systems* that control access to transportation infrastructure such as roadways, bridges and tunnels are also included. This object also provides environmental *monitoring* including *sensors* that measure road conditions, surface weather, and vehicle emissions. Work zone *systems* including work zone surveillance, traffic control, *driver* warning, and work crew safety *systems* are also included. |
| *ITS* Station | ITS-S | A collection of functional *components* that participate in the provision of *ITS services* at a particular location. Thus, an *ITS* Station may exist in a vehicle, at the roadside, in a central location such as a *TMC*, or in a mobile device.<br><br>Note: It has two meanings: (1) functional and (2) physical, i.e., an actual physical device. |
| Mobile *C-ITS station* | | A *C-ITS station* installed in a vehicle or in the form of a personal handheld device. |
| On-Board Unit (or Vehicle *ITS Station*) | OBU<br><br>(Or V-ITS-S) | The On-Board Units (OBU), located directly in individual, motorized vehicles, provide communication with *roadside equipment*, possibly also with OBUs in other equipped vehicles |
| Operational road infrastructure | | *Fleet management* and *traffic management* functions which facilitate the traffic flow by providing information or guidance. |

| | | |
|---|---|---|
| | | Note: This also includes tele-operated driving of *automated vehicles* and *eCall*. |
| Physical road infrastructure | | The physical world where vehicles operate, including road, road signs, road markings, physical communication infrastructure equipment etc.<br><br>Note: There is not a consensus on whether electronic equipment should be defined as physical road infrastructure. |
| Recharging point | | An *interface* that is capable of charging an *electric vehicle* or exchanging a battery of an *electric vehicle.* |
| Reserved lane | | *Traffic lane* restricted to a specific subset of road vehicles or user categories |
| Road authority | | Any public authority responsible for the planning, control or management of roads falling in its territorial competence. |
| Road operator | | Any public or private authority responsible for the construction, maintenance and management of road and management of traffic flows. |
| Roadside Unit (or Roadside *ITS Station*) | RSU<br><br>(Or R-ITS-S) | A *Dedicated Short-Range Communication (DSRC)* or C-V2X transceiver that is mounted along a road or pedestrian passageway. An RSU may also be mounted on a vehicle or is hand carried, but it may only operate when the vehicle or hand carried unit is stationary. Furthermore, an RSU operating under this part is restricted to the location where it is licensed to operate. However, portable, or hand-held RSUs are permitted to operate where they do not interfere with a site licensed operation. A RSU broadcasts *data* to *OBU*s or exchanges *data* with *OBU*s in its communications zone. An RSU also provides channel assignments and operating instructions to *OBU*s in its communications zone, when required |
| Tolling operator | | Any public or private entity taking the role of toll *service provider* or toll charger. |
| Traffic light controller | | A specific type of roadside *system*. It includes the input from loop detectors or other *sensors*, a control logic, and the actuation of the traffic lights. |
| Traffic management | | The organization, arrangement, guidance, and control of both stationary and moving traffic, including pedestrians, bicyclists, and all types of vehicles. Its aim is to provide for the safe, orderly, and efficient movement of persons and goods, and to protect and, where possible, enhance the quality of the local environment on and adjacent to traffic facilities. |
| Traffic Management Centre | TMC | *Monitors* and controls traffic and the road network. It represents centres that manage a broad range of transportation facilities including freeway *systems*, rural and suburban highway *systems*, and urban and |

| | | |
|---|---|---|
| | | suburban traffic control *systems*. It communicates with *ITS Roadway Equipment* and *RSU*s to *monitor* and manage traffic flow and *monitor* the condition of the roadway, surrounding environmental conditions, and field equipment status. It manages traffic and transportation resources to support allied agencies in responding to, and recovering from, incidents ranging from minor traffic incidents through major disasters. |
| Traffic Information System | TIS | The functional back-office *system* of a *road operator* to collect and process *real time data* from *traffic data systems* (e.g., roadside *sensor systems* (loops, cameras) or *connected vehicles*) and to distribute real-time and/or aggregated information on traffic state (speed, flow, and travel times) or road state to *TMS* or external *systems* like a *Service Provider* Back Office. |
| Traffic lane | | Portion of carriageway designed to accommodate a single line of moving road vehicles. |
| Traffic Management *System* | TMS | The functional back-office *system* of the responsible *road operator* to enforce legal actions on urban or high-way road sections or intersections based on *real-time traffic data* from loops, cameras speed *sensors*, etc. or actions by *traffic light controllers.* |
| Traffic/*Mobility* hub | | Dedicated public spaces (e.g., train stations, airports) where passengers swap from one mode of transport to another. |
| Transport/*Mobility* operator | | *Service provider* to whom it is possible to subscribe in order to grant access to a *mobility* service. |
| Variable Message Sign | VMS | Digital road sign used to inform *drivers* about specific temporary events and real-time traffic conditions. It is often linked to a manned control centre via a local network or a radio link. |
| Zone access control | | Control the passage of traffic from one part of the network to another, or between networks, where specific conditions apply. |
| **Terms related to *CCAM* legislation** | | |
| Term | Abbreviation | Definition |
| Accountability | | A specific form of responsibility arising from the obligation to explain something that has happened and one's role in that happening. A fair *system* of accountability requires that: (a) formal and informal fora and mechanisms of accountability are created with respect to *CAV*s; (b) different actors are sufficiently aware of and able to discharge their duty to justify the operation of the *system* to the relevant fora; (c) and the system of which *CAV*s are a part is not too complex, opaque, or unpredictable. |

| | | |
|---|---|---|
| Approval authority | | Within the EU, the authority or authorities of a Member State, notified to the Commission by that Member State, with competence for all aspects of the *type-approval* of a vehicle, *system*, *component* or *separate technical unit*, or of the individual vehicle approval, for the authorisation process for parts and equipment, for issuing and, if appropriate, for withdrawing or refusing approval certificates, for acting as the contact point for the approval authorities of the other Member States, for designating the *technical services*, and for ensuring that the manufacturer meets its obligations regarding the conformity of production.<br><br>Note: Outside the EU, countries will undertake the same function themselves. |
| Certificate of conformity | | The document issued by the manufacturer which certifies that a produced vehicle conforms to the approved type of vehicle and complies with all regulatory acts that were applicable at the time of its production. |
| Component *type-approval* | | The procedure whereby an *approval authority* certifies that a type of *component* independently of a vehicle satisfies the relevant administrative provisions and technical requirements. |
| Homologation | | The whole vehicle *type-approval* process issuing (or not) a certificate allowing the vehicle to enter a market. |
| EU *type-approval* | | The procedure whereby an *approval authority* certifies that a type of vehicle, *system*, *component,* or *separate technical unit* satisfies the relevant administrative provisions and technical requirements of the Regulation (EU) 2018/858.<br><br>Note: Other countries will have their own type-approval processes. |
| Market surveillance | | The activities carried out and measures taken by the *market surveillance authorities* to ensure that vehicles, *systems*, *components,* and *separate technical units* as well as parts and equipment made available on the market comply with the requirements set out in the relevant Union harmonisation legislation and do not endanger health, safety, the environment, or any other aspect of public interest protection. |
| *Market surveillance* authority | | The *national authority* or authorities responsible for carrying out *market surveillance* on the territory of the Member State. |
| National authority | | An *approval authority* or any other authority involved in and responsible for *market surveillance*, border control or registration in a Member State in respect of vehicles, *systems*, *components*, separate technical units, parts, or equipment. |
| National *type-approval* | | The procedure whereby an *approval authority* certifies that a type of vehicle, *system*, *component,* or *separate technical unit* satisfies the relevant administrative provisions and technical requirements laid down by the law of a Member State, the validity of such approval being restricted to the territory of that Member State |

| | | |
|---|---|---|
| On-site assessment | | A verification in the premises of a *technical service* or of one of its subcontractors or subsidiaries. |
| Registration | | An administrative authorisation for the entry into service in road traffic of an approved vehicle, involving the identification of the vehicle and the issuing to it of a serial number, known as the registration number, whether on a permanent or temporary basis. |
| Standard | | A *technical specification* approved by a recognised standardisation body for repeated or continuous application, with which compliance is not compulsory and which is one of the following:<br>- international standard: a standard adopted by an international standardisation organisation and made available to the public,<br>- European standard: a standard adopted by a European standardisation body and made available to the public,<br>- national standard: a standard adopted by a national standardisation body and made available to the public |
| Surveillance *on-site assessment* | | A periodic routine *on-site assessment* that is neither the *on-site assessment* undertaken for the initial designation of the *technical service* or of one of its subcontractors or subsidiaries, nor the *on-site assessment* undertaken for the renewal of that designation. |
| Technical regulation | | *Technical specifications* and other requirements, including the relevant administrative provisions, the observance of which is compulsory, de jure or de facto, in the case of marketing or use in a Member State or a major part thereof, as well as laws, regulations or administrative provisions of Member States |
| Technical documentation | | Document containing all *technical specifications* of a product (e.g., vehicle, *system*, *component,* or *separate technical unit*. |
| Technical service | | An organisation or body designated by the *approval authority* as a testing laboratory to carry out tests, or as a conformity assessment body to carry out the initial assessment and other tests or inspections. |
| Technical specification | | A specification contained in a document which lays down the characteristics required of a product such as levels of quality, performance, safety, or dimensions, including the requirements applicable to the product as regards the name under which the product is sold, terminology, symbols, testing and test methods, packaging, marking, or labelling and conformity assessment procedures |
| Type-approval | | The procedure whereby an *approval authority* certifies that a type of vehicle, *system*, *component,* or *separate technical unit* satisfies the relevant administrative provisions and technical requirements. |

| | | |
|---|---|---|
| | | Note: In other words, it is the verification of a vehicle, *system,* or *component* with regards to several regulations. |
| *Type-approval* certificate | | The document whereby the *approval authority* officially certifies that a type of vehicle, *system*, *component,* or *separate technical unit* is type-approved. |
| **Terms related to CCAM deployment** | | |
| Term | Abbreviation | Definition |
| Citizens' awareness campaign plan | | Design of the citizens' awareness campaign and evaluation plan. |
| Cost-benefit analysis | | A systematic evaluation of the economic advantages (benefits) and disadvantages (costs) of a set of investment alternatives. |
| Demand analysis | | Daily demand foreseen in a specific site*, modal share,* and *modal shift* predicted for the automated transport system. |
| Design/system dimensioning | | Process of designing and dimensioning a transportation system including *demand analysis*, *supply dimensioning*, *urban integration*, *citizens' awareness campaign plan*, *feasibility study*, *financial analysis*. |
| Feasibility study | | Detailed analysis considering all critical aspects of a project in order to determine the likelihood of succeeding. |
| Financial analysis | | Assessment of the viability, stability and profitability of a business or project. |
| Impact assessment | | The process of identifying the future consequences of a current or proposed action. |
| Large-scale deployment | | Installation, integration and operation of transport systems and fleets in a wide area of a city or region. |
| Modal share/split | | The percentage share of each mode of transport in total inland transport, expressed in passenger-kilometres (pkm). |
| Modal shift | | The percentage shift from one mode of transport to another, expressed in passenger-kilometres (pkm). |
| Pilot | | An initial *small-scale deployment* that is used to prove the viability of a project idea |

| | | |
|---|---|---|
| Risk assessment | | The determination of quantitative and qualitative value of risk related to a concrete situation and a recognized threat. |
| Scale up | | Expand or replicate *pilot* or small-scale projects to reach more people and/or broaden the effectiveness of an intervention. |
| Small-scale deployment | | Installation, integration and operation of transport systems and fleets in a small area of a city or region. |
| Supply dimensioning | | Transport system supply required to serve the daily demand. |
| Traffic study | | The investigation and analysis of a transportation *system* in a specific area, supported by an extensive collection of *data*. |
| Trial | | Part of a committed project intended to test the implementation approach and manage the risk of implementation roll out. |
| Urban integration | | Urban integration plan of the system. |
| Vehicle routing | | The determination of optimal routes originating from a central depot to a set of customers under capacity constraints. |
| **Terms related to social aspects *CCAM* users** | | |
| Term | Abbreviation | Definition |
| Acceptance | | Acceptance is the act of agreeing with something and approving of it (passive *component* of acceptance). But acceptance is also related to the readiness to do or use something which gives it an active *component*. As acceptance is object to change it is not a stable construct. |
| Accessibility | | The ease with which a person can get to places in order to reach an activity.<br><br>Note: Accessibility has the following different dimensions: the transport dimension (options for transport), the land use dimension (quality and spatial distribution of activity locations), the individual dimension based on the (different) needs, capabilities, and perceptions of (different) individuals, and the temporal dimension, as activities are often only available at particular times. |
| Affordability | | The ability to purchase basic goods and services. In transportation, it is the ability to purchase access to basic goods and activities. |

| | | |
|---|---|---|
| Attitudes | | Attitudes in the *TPB* are a result of the behavioural beliefs that a person associates with certain consequences that are more or less desirable (i.e., arriving in time; having to stand for the duration of the ride) and are linked to a subjective likelihood to occur due to experiences. |
| Availability | | The quality of being available. |
| Citizen participation | | See "*Participation process*" |
| Co-creation process | | See "*Participation process*" |
| Equity | | Equity describes a situation in which everyone is treated equally. In contrast to equality, which aims to provide equal resources to each individual person or group, equity means acknowledging that different user groups face relative disadvantages. |
| Inclusiveness | | Inclusiveness is the quality of including many different types of people and treating them all fairly and equally. |
| Intention to use | | Intention to use, also known as behaviour intention is part of the *TPB* and describes the intention to show (nor not show) a specific behaviour. |
| *ITS* user | | Any user of *ITS applications* or *services* including travellers, *vulnerable road users*, road transport infrastructure users and operators, fleet managers and operators of emergency services |
| *Mobility* needs | | *Mobility* needs can be defined as all physical or psycho-logical user-related requirements towards *mobility* solutions, like *CCAM*, that arise from a users' individual psychological needs, characteristics and situational factors and determine the (intention to) use. |
| Participation process | | Participation processes describe the involvement of interested or affected citizens in (technical) developments and decision-making. Common approaches include public meetings, publishing websites, focus groups, surveys, or the formation of advisory committees. *Synonyms: *co-creation process*, *citizen participation*, *public participation* |
| People with *mobility* challenges | | People with *mobility* challenges experience barriers in transport, and comprise different groups, like low-income or unemployed people, elderly, people with disabilities, women, and gender-related, young people, or people living in rural areas. These groups also comprise the research groups within SINFONICA and are described in more detail in Deliverable 1.1. |

| | | |
|---|---|---|
| Perceived behavioural control | | Perceived behavioural control within the *TPB* describes the perceived difficulty of performing a behaviour, i.e., a person thinks to have the skills (self-efficacy) and opportunity (perceived controllability) to use a *CCAM* service. |
| Public participation | | See "*Participation process*" |
| Safety & Security | | A user's sense of safety and security impacts on the user's *acceptance*. Safety refers to the perception of being exposed to traffic risks, e.g., involvement in a crash. Security is the user's perception of being at the risk of becoming a victim of crime while in a vehicle. |
| Social *Equity* | | The situation in which all people within a society or group have the same status with respect to access to and use of *CV* technology and products. |
| Subjective norm | | The subjective norm within the *TPB* reflects the feelings of social pressure, e.g., to use a *CCAM* service, and provides a sense of belonging when conforming (Ajzen, 1991) |
| Technology Acceptance Model | TAM | Theoretical model aimed to give an explanation of the determinants of technology *acceptance* that is general,<br><br>capable of explaining user behaviour across a broad range of technologies and user populations, while at the same time being both parsimonious and theoretically justified. |
| Theory of Planned Behaviour | TPB | Theory to predict an individual's intention to engage in a behaviour at a specific time and place. The key *component* to this model is behavioural intent; behavioural intentions are influenced by *attitude, social norms* and *perceived behavioural control*. |
| Trust (in *Automation*) | | Trust can be defined as the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability. In this definition, an agent can be *automation* or another person that actively interacts with the environment on behalf of the person. |
| User experience | UX | The user experience can be defined as the valuation of the experience that a user has when interacting with a product or service. User experience emphasise the practical, emotional, meaningful and appreciated aspects of interaction design and product ownership as well as user's perception of the everyday facets such as utility, ease of use and efficiency of a *system*. |
| Vulnerable groups | | Vulnerable groups are physically, mentally, or socially disadvantaged persons who may be unable to meet their basic needs and may therefore require specific assistance. Persons exposed to and/or displaced by conflict or natural hazard may also be considered vulnerable. Vulnerable groups may experience a higher risk of poverty and/or social exclusion. |

| | | |
|---|---|---|
| | | Note: *People with mobility challenges* may belong to one or more vulnerable groups. |
| Vulnerable Road Users | VRUs | Non-motorised road users, such as pedestrians and cyclists as well as motorcyclists and persons with disabilities or reduced *mobility* and orientation |
| Willingness to pay | WTP | Willingness to pay is defined as the maximum amount a person would be willing to offer for a good. |
| Willingness to accept | WAP | Willingness to accept is defined as the minimum monetary amount required for an individual to forgo some good, or to bear some harm. |

## VOCABULARY References

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Alpos, T., Iliopoulou, C., Kepaptsoglou, K. (2023). Nature-Inspired Optimal Route Network Design for Shared Autonomous Vehicles. *Vehicles*, *5*, 24-40. https://doi.org/10.3390/vehicles5010002

Beresford P. (2002). User involvement in research and evaluation: liberation or regulation. Soc Policy Soc:1 (2): 96–105.

Brehm JW, Brehm SS (1981) Psychological reactance: A theory of freedom and control. San Diego, CA: Academic Press

BSI Flex (2022). Connected and automated vehicles – Vocabulary v4.0:2022-03.

Capriglione, D., Carratù, M., Catelani, M., Ciani, L., Patrizi, G., Pietrosanto, A., Signorini, L., Singuaroli, R., & Sommella, P. (2021). Characterization of Inertial measurement units using sine-on-random vibration test. Measurement: Sensors, 18. https://doi.org/10.1016/j.measen.2021.100104

COM/2021/813: Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport.

C-ROADS, C-ITS European Handbook for MAPEM and SPATEM Creation, Release 2.0.1 (2022-03)

C-ROADS, C-ITS Message Profiles, Release 2.0.5 (2022-10)

C-ROADS (2018). Report on Legal and Organisational Structures for C-ITS Operation. In C-ROADS Platform, WG1 C-ITS Organisation.

C-ROADS (2022). C-ITS Service and Use Case Definitions v.2.0.5.

C (2022) 492. Commission Delegated Regulation of 2 February 2022 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide real-time traffic information services.

C (2019) 1789. Commission Delegated Regulation of 13 March 2019 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the deployment and operational use of cooperative intelligent transport systems.

Daisuren, Y., Karkhanis, P., Kadiogullari, D., & Fünfrocken, M. (2017). Deliverable 3.1: Reference Architecture. In Y. Daisuren, P. Karkhanis, D. Kadiogullari, & M. Fünfrocken, C-Mobile, Accelerating C-ITS Mobility Innovation and Deployment in Europe. Grant Agreement No. 723311

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science, 35, 8, pp. 982-1003. http://www.jstor.org/stable/2632151.

Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport. OJ L 207, 6.8.2010.

Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure. OJ L 307, 28.10.2014.

ETSI (2019). Technical Report 103 562 V2.1.1: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Analysis of the Collective Perception Service (CPS); Release 2.

Glossary of Connected and Automated Vehicle Terms, University of Virginia Centre for Transportation Studies, March 2018

Gomes, C.C., Preto, S. (2018). Artificial Intelligence and Interaction Design for a Positive Emotional User Experience. In: Karwowski, W., Ahram, T. (eds) Intelligent Human Systems Integration. IHSI 2018. Advances in Intelligent Systems and Computing, vol 722. Springer, Cham. https://doi.org/10.1007/978-3-319-73888-8_11

Guillaume Trehard, Zayed Alsayed, Evangeline Pollard, Benazouz Bradai, Fawzi Nashashibi (2014). Simultaneous Localization and Mapping with a LIDAR. IROS - International Conference on Intelligent Robots and Systems, Chicago, United States. ffhal-01067931

Horizon 2020 Commission Expert Group to advise on specific ethical issues raised by driverless mobility (E03659). Ethics of Connected and Automated Vehicles: Recommendations on road safety, privacy, fairness, explainability and responsibility. (2020).

ISO/IEC/IEEE 24765:2017. Systems and software engineering – Vocabulary (2nd edition).

ISO/TS 14812:2022. Intelligent transport systems — Vocabulary

NSAI (2016). I.S. EN 16803-1:2016. Space – Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) – Part 1: Definitions and system engineering procedures for the establishment and assessment of performances.

Official Journal of the European Communities, L 204, 21 July 1998

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

Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC. OJ L 151, 14.6.2018, p. 1-218.

Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users, amending Regulation (EU) 2018/858 of the European Parliament and of the Council and repealing Regulations (EC) No 78/2009, (EC) No 79/2009 and (EC) No 661/2009 of the European Parliament and of the Council and Commission Regulations (EC) No 631/2009, (EU) No 406/2010, (EU) No 672/2010, (EU) No 1003/2010, (EU) No 1005/2010, (EU) No 1008/2010, (EU) No 1009/2010, (EU) No 19/2011, (EU) No 109/2011, (EU) No 458/2011, (EU) No 65/2012, (EU) No 130/2012, (EU) No 347/2012, (EU) No 351/2012, (EU) No 1230/2012 and (EU) 2015/166. , OJ L325, 16.12.2019, p.1-40.

Rodrigues, J. M., Cardoso, P. J., Monteiro, J., & Ramos, C. M. (Eds.). (2020). *Smart Systems Design, Applications, and Challenges*. IGI Global. https://doi.org/10.4018/978-1-7998-2112-0

SAE International (2021). J3016_202104: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles.

Salonen, A. O. (2018). Passenger's subjective traffic safety, in-vehicle security, and emergency management in the driverless shuttle bus in Finland. Transport Policy, 61, 106-10. doi:10.1016/j.tranpol.2017.10.011

SINFONICA Deliverable 1.1 - Mobility needs and requirements of European citizens

Visintainer, F., Galli, M., Bosi, I., Brevi, D., …, van den Brand, J.W., Balraj, M. (2019). D1.6 Final Open IoT Vehicle Platform Specification. In AUTOmated driving Progressed by Internet of Things. Grant Agreement No: 731993

Wong, K., Gu, Y., & Kamijo, S. (2021). Mapping for autonomous driving: Opportunities and challenges. IEEE Intelligent Transportation Systems Magazine, 13(1), 91–106. https://doi.org/10.1109/MITS.2020.3014152

URLS

https://www.apm.org.uk/

https://dictionary.cambridge.org/

https://digital-strategy.ec.europa.eu/en/policies/big-data

https://www.dot.state.mn.us/

https://www.eltis.org/glossary

https://www.euspa.europa.eu/

https://show-project.eu/ccav-glossary/

https://www.iaia.org/

https://www.its.leeds.ac.uk/projects/konsult

https://www.enisa.europa.eu/

https://www.mobilityits.eu/ccam-connected-vehicles

https://napcore.eu/description-naps/

https://www.oxfordlearnersdictionaries.com/

https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/BehavioralChangeTheories3.html

https://inee.org/eie-glossary/vulnerable-groups

https://www.i-scoop.eu/

https://www.arc-it.net/

## For more information

SINFONICA Project Coordinator

UNIMORE – University of Modena and Reggio Emilia

Via Giovanni Amendola, 2

42122 Reggio Emilia, IT

sinfonica@sinfonica.eu

www.sinfonica.eu

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101064988.