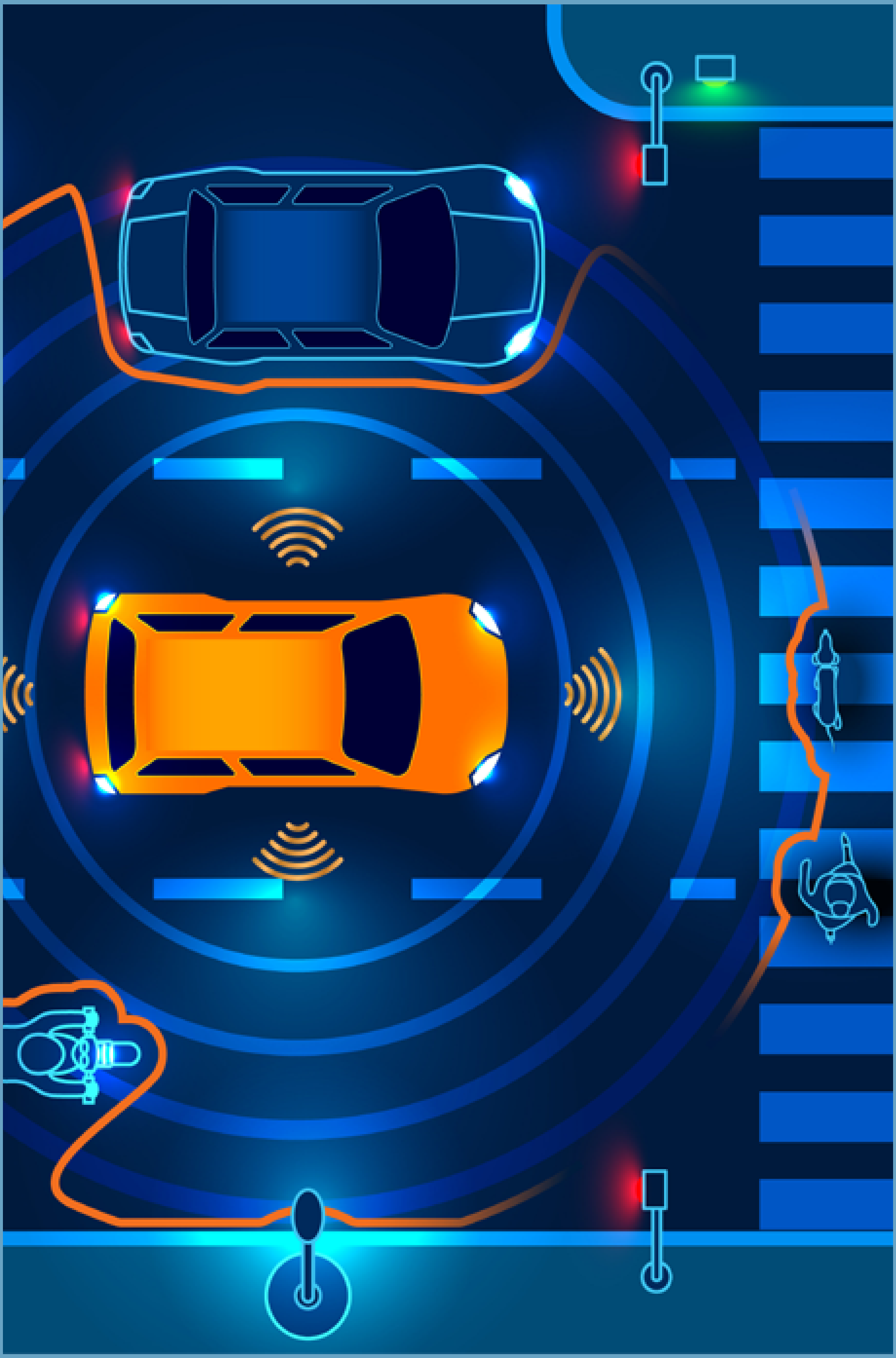

SRIA

STRATEGIC RESEARCH AND INNOVATION AGENDA

2021 - 2027

CCAM
CONNECTED, COOPERATIVE
& AUTOMATED MOBILITY

European leadership in safe and sustainable road transport through automation

Co-funded by
the European Union

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Preface

The CCAM (Connected Cooperative Automated Mobility) Partnership is a public private partnership, which aligns all stakeholders' R&I efforts to accelerate the implementation of innovative CCAM technologies and services in Europe. It aims to exploit the full systemic benefits of new mobility solutions enabled by CCAM: increased safety, reduced environmental impacts, and inclusiveness. The Partnership will develop and implement a shared, coherent and long-term R&I agenda by bringing together the complex cross-sectoral value chain actors with the joint vision: "European leadership in safe and sustainable road transport through automation".

This Strategic Research and Innovation Agenda (SRIA) is the multiannual roadmap, guiding the CCAM Partnership. It describes the CCAM Partnership strategy for achieving the expected impacts, the corresponding portfolio of activities, the resources, and timeline. It sets the Partnership's objectives and defines the process for identifying and prioritising the research and innovation activities needed to achieve these objectives.

The CCAM SRIA is the basis for the CCAM Partnership under the Horizon Europe Programme.

1. Introduction

1.1 European Partnership in Horizon Europe

The aim of European partnerships in Horizon Europe[1] is to deliver on global challenges and modernise industry. European Partnerships are key implementation tools, contributing significantly to achieving the EU's political priorities. The Partnerships are formed between the European Commission and private and public stakeholder addressing Europe's most pressing challenges through coordinated research and innovation actions. By bringing private and public partners together, European Partnerships help to avoid the duplication of investments and contribute significantly to leveraging public funding through private investments.

1.2 The Rationale for CCAM

Mobility is crossing a new – digital – frontier, allowing vehicles to communicate with each other, with the road infrastructure and with other road users. This will enable a coordination and cooperation between road users, and managing traffic and mobility at an entirely new level (e.g. warning messages not limited by line-of-sight or congestion management using real-time information).

Current road vehicles already provide advanced assistance systems and intervene when a dangerous situation is detected. Future systems will have 360° vision of the surrounding environment, significantly reduced reaction times and will be able to control the vehicle for extended periods and, at some point in the future, will no longer rely on human back-up.

> Combining **connectivity, cooperative systems and automation** will enable automated and fully orchestrated manoeuvres, bringing us closer to **Vision Zero**.

Cooperative, Connected and Automated Mobility (CCAM) is expected to reshape the way we travel and move, not only in Europe, but around the world. With CCAM, the vehicles are well integrated into the mobility and transport system, its infrastructure, operations and new services. In theory, fully automated driving could double existing average road infrastructure capacity[2] by smoothing traffic flow, while enabling off-peak usage of infrastructure for freight transportation (e.g. night-time deliveries). Smart traffic management will further increase efficiency and reduce congestion.

CCAM enabled shared mobility services will enable seamless integration with public transport and Mobility-as-a-Service (MaaS) platforms. It will provide accessible mobility to people who cannot drive (e.g. incapacitated or disabled people, and those without a driving license), or who no longer want to drive. Furthermore, by offering driverless transportation solutions, CCAM can provide vulnerable people with mobility and options for goods deliveries at low health risk, which is particularly important in epidemic situations like the COVID-19 pandemic.

> CCAM enables more **user-centred**, **all-inclusive mobility**, while increasing safety, **reducing congestion** and contributing to **decarbonisation**.

Automated public transport services will deliver profound changes, not only in how people travel, but also in the way of life. The usage of shared CCAM is expected to bring a tide of benefits, including: flexible, customizable, more widespread and accessible services, reduced noise and air pollution, and better use of urban space, while providing a safer, more comfortable and integrated travel experience.

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[1] https://ec.europa.eu/info/horizon-europe/european-partnerships-horizon-europe_en

[2] New Technology and Automation in Freight Transport and Handling Systems. Daniela Paddeu, Thomas Calvert, Ben Clark, Graham Parkhurst, University of the West of England, Bristol. UK Government Office for Science. February 2019.

As concerns freight and logistics, the shortage of truck drivers, in particular for the long haul, and the demand for better working conditions requires higher levels of automation that could support further transport productivity[3] . According to the European Transport Workers Federation and the International Road Union, a shortage of 21% professional drivers exists across the freight transport sector[4] . Moreover, CCAM coupled with innovative fleet management may enable larger quantities of freight to be transported compared with current operating practices, and guarantee the same transit time even at lower speeds (thus. saving energy)[5]. Additionally, platooning and higher-levels of automation can increase the resilience of supply chains by enabling goods to move with less, or even without, human intervention, broadening access to citizens and destinations in critical areas or under exceptional circumstances such as pandemics[6] .

CCAM is expected to bring operational efficiency to logistics hubs, integrating road transport with other logistics operations; for example, if truck arrivals at a terminal are known beforehand, yard planning can be made more efficient by avoiding congestion in the hub area. Moreover, autonomous systems could facilitate last mile operations between logistics centres and port terminals[7] , hence reducing barriers for intermodal transport.

> CCAM will also enable the provision of new mobility services for passengers and goods, fostering benefits for users and for the mobility system as a whole.

CCAM will have a remarkable economic impact. McKinsey found in their "RACE 2050"[8] report, that the economic value contribution of CCAM is one of the core requirements to create a profitable future mobility industry and maintain relevance as a global export industry. According to the McKinsey Auto 2030 model[9], European automotive revenues based on consumer spending will almost double from EUR 850 billion in 2016 to EUR 1,400 billion by 2030.

Europe has the unique opportunity to consolidate its leading role in connected, cooperative and automated mobility against rising competition in global value chains and markets by using its strengths in vehicle and system innovations to promote socio-economic benefits and sustainable development. The European Patent Office (EPO) stated in a recent report[10] that the number of related European patent applications in the area of CCAM (see Figure 1, patent statistics between 2011 and 2017) is growing 20 times faster than for other technologies. The study shows that Europe accounted for 37.2% of all patent applications related to self-driving vehicle technologies at the EPO between 2011 and 2017 - ahead of China (3%), Japan (13%) and the United States (33.7%).

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[3] Tavasszy, L.A. (2016). The value case for truck platooning, working paper, Delft University of Technology. Doi 10.13140/RG.2.2.13325.54247

[4] https://www.iru.org/resources/newsroom/iru-and-etf-urge-eu-address-unprecedented-driver-shortage-road-transport-industry

[5] in line with the Physical Internet concept: Ballot, E. et al. (2014) The Physical Internet: The Network of Logistics Networks. Paris, France: La documentation Française.

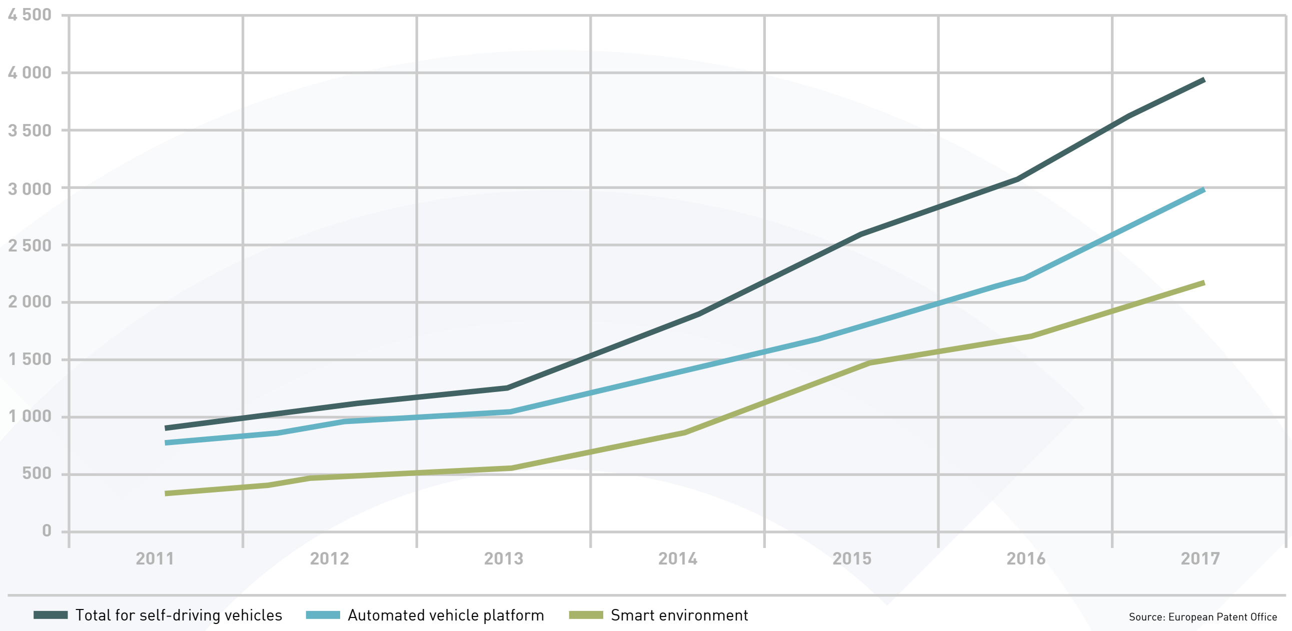
[6] Robots And Drones Are Now Used To Fight COVID-19, 18.03.2020, https://www.forbes.com/sites/bernardmarr/2020/03/18/how-robots-and-drones-are-helping-to-fight-coronavirus/

[7] Vera's First Assignment, 13.06.2019, https://www.volvotrucks.com/en-en/news-stories/magazine-online/2019/jun/Veras-First-Assignment.html

[8] McKinsey, RACE 2050: Accessed at: https://www.mckinsey.com

[9] McKinsey, Automotive revolution – perspective towards 2030, Accessed at: https://www.mckinsey.com

[10] Sharp rise in patent applications for self-driving vehicles in Europe, new study finds, 6.11.2018, https://www.epo.org/news-issues/news/2018/20181106.html



Source: European Patent Office

The patent statistics in this figure are based on patent applications filed at the Epo in self-driving vehicle technologies. They do not include patent applications filed with the national offices of the contracting states of the European Patent Convention. The reference date for each application is the filing date at the EPO.

Figure 1: Patent applications at the EPO in self-driving vehicle technologies and their sectors 2011-2017

The development of CCAM shall provide benefits to all citizens. With full integration of CCAM in the transport system, the expected positive impacts for society will be:

- **Safety**[11]: Reducing the number of road fatalities and accidents caused by human error;
- **Environment**[12]: Reducing transport emissions and congestion by optimising capacity, smoothening traffic flow and avoiding unnecessary trips;
- **Inclusiveness**: Ensuring inclusive mobility and goods access for all; and
- **Competitiveness**[13]: Strengthen competitiveness of European industries by technological leadership, ensuring long-term growth and jobs.

1.3 The Rationale for the CCAM Partnership

CCAM has a great potential to contribute to key policy goals like the UN Sustainable Development Goals[14] (SDG), Vision Zero[11], the European Green Deal[15], Europe fit for the Digital Age[16] and the Smart and Sustainable Mobility Strategy[17] (see chapter 3). Despite all the expected positive impacts, deployment of CCAM solutions is not yet happening. The Problem Drivers (PD) that hinder the implementation of CCAM (see chapter 4 for more details) are:

- Insufficient demand as society does not yet understand the potential benefits of CCAM enabled mobility. The long-term implications, benefits and impacts of integrating CCAM solutions into the mobility system are not sufficiently examined. (PD1)

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[11] Vision Zero: by 2050, move close to zero fatalities and serious injuries in road transport. In line with this goal, the EU aims at halving road casualties by 2030. (https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/3rd-mobility-pack-factsheets-safety.pdf).

[12] "Automated and connected multimodal mobility will play an increasing role, together with smart traffic management systems enabled by digitalisation. The EU transport system and infrastructure will be made fit to support new sustainable mobility services that can reduce congestion and pollution", European Green Deal, COM(2019) 640 final.

[13] GEAR 2030 final report

[14] Take action for the Sustainable Development Goals, https://www.un.org/sustainabledevelopment/sustainable-development-goals/

[15] The European Green Deal, COM(2019) 640 final, Brussels, 11.12.2019, https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

[16] Six Commission priorities for 2019-24, https://ec.europa.eu/info/strategy/priorities-2019-2024_en

[17] Sustainable and Smart Mobility Strategy – putting European transport on track for the future; COM/2020/789 final; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789

- CCAM solutions are not yet sufficiently mature for wide market take-up, and current investment levels in CCAM R&I are inadequate to maintain and extend EU industrial leadership. (PD2)
- Current R&I efforts are fragmented and lack a coherent, longer-term vision and strategy for targeting systemic solutions. (PD3)
- Demonstration and scale-up is limited since a well organised, extensive and complex cross-sectorial value chain is still required to build complete CCAM solutions. (PD4)

Addressing the four Problem Drivers in a coordinated and concentrated manner requires a shift in the mobility innovation process regarding user-involvement, timing and outreach. In the past, big innovations in vehicle technology like seat belts or airbags were introduced by industry as another component to the existing vehicle. After five to ten years of experience with these new technologies, technical standardisation (e.g. ISO standards) gave a thorough basis for developing regulations. Making CCAM solutions ready for deployment (Deployment Readiness[18]) requires that R&I, standards and regulation advance in a synchronised way. Today, vehicle technology is starting to lead to standards, but regulation needs to be in place at the same time, while it is necessary to keep up speed with all the uncertainties and permanent adaptions. To solve this situation, the most flexible and closest possible cooperation between actors and users involved in research, standardisation and regulation (national and international) is key for accelerating deployment and generating users´ and societal demand at the same time.

There is a strong need for EU-wide harmonisation and interoperability of technologies and methodologies for economies of scale, while considering societal aspects and regional differences. The development of methods for impact assessment and safety validation shall provide tools to meet society's needs and to share knowledge and compare results across Member States. Actions will develop technical specifications for interoperability, making sure that investments at local, regional, national and EU level, both of public and private nature, are complementing each other in making CCAM a key contributor towards a fully integrated European mobility system. Commitment towards coordinated European actions are needed to develop this eco-system with vehicle manufacturers and their supply chain, with local and regional authorities, road operators, service providers, telecom industry, research organisations etc. This coordination at EU level is fundamental to develop harmonised and interoperable solutions. Stakeholders will cooperate and co-create with citizens all over Europe, shifting the innovation process for new mobility services for people and goods toward user needs (e.g. in living labs).

> Europe needs more large-scale testing, demonstrations and pilot projects involving all relevant stakeholders to accelerate implementation and remove barriers[19].

Due to partly insufficient technical maturity and multi stakeholder involvement, these large-scale demonstrations actions are highly cost intensive and require significant resources. The involvement of a large cross-sectoral value chain and interaction between public and private stakeholders is another barrier for deployment of CCAM solutions.

These complex and multi-faceted challenges need more than the development of technologies.

A systemic approach involving multiple sectors and a complex eco-system of diverse stakeholders is required. A European Partnership provides the ideal framework to streamline R&I actions across Europe supporting the transformational change of the industry and accelerate innovation.

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[18] Deployment Readiness is a status defined by combining the validated safe system functioning, a good understanding of the expected impact and potential risks, with users' and society's readiness to accept, adopt and demand CCAM solutions. It can be measured by e.g. number of successful pilots or field operational trials, participants involved, number of deployed vehicles.

[19] European Commission DG Grow, Policy and Stratgie, Sectors: Automotive Industry, https://ec.europa.eu/growth/sectors/automotive/policy-strategy_en

Europe needs a CCAM Partnership with clear objectives and effective coordination across research areas.

The CCAM Partnership will accelerate the implementation of innovative CCAM technologies and services in Europe. The Partnership will develop and implement a shared, coherent and long-term R&I agenda by bringing together the complex cross-sectoral value chain actors. It aims to fully exploit the systemic benefits of new mobility solutions enabled by CCAM: increased safety, reduced environmental impacts, and inclusiveness; with the joint vision: "European leadership in safe and sustainable road transport through automation".

2.The CCAM SRIA: developed in co-creation

2.1 Purpose of the SRIA

The SRIA is the basis for implementing the CCAM Partnership: the content of the SRIA will be further specified in the work plans, which will define the concrete actions to be implemented every year. This implementation process is described in chapter 10. The SRIA provides a flexible background for identifying and defining call topics for research and innovation activities to be included in the Horizon Europe Work Programmes. It also serves as a basis to develop shared activities with national programmes and other Horizon Europe Partnerships.

The CCAM Partnership serves as a "means to an end": the SRIA describes a comprehensive roadmap to deliver on its objectives within the defined timeframe. Reaching the Partnership objectives and Deployment Readiness at the end of its duration (or earlier) will allow the CCAM stakeholders to move to the next investment phases (industrialisation, competitive development, infrastructure deployment). In case of the CCAM Partnership objectives become unlikely to be reached, exit strategies are foreseen: modifying the SRIA, looking for additional partners, or as ultimate decision, ending the Partnership prematurely.

Radical technological progress in an area relevant for CCAM, or very slow progress towards key objectives could either require an adaptation of the SRIA, or could make its targets obsolete. The SRIA will be updated in the course of the Partnership, in case of major technological advancements, emerging opportunities and challenges, as well as evolving needs. Indeed, even though the SRIA covers the full duration of the Partnership in Horizon Europe, we foresee the need for validity checks, at least every two years, against recent and ongoing developments. This regular update process shall support the Partnership's flexibility. As soon as significant changes are identified, the SRIA document shall be updated.

The SRIA is the result of a process in which all partners collaborate to link the vision of the Partnership to a portfolio of R&I actions. It also forms the basis for annual or multiannual work plans and defines the long-term logic of actions that will allow the CCAM partnership to reach its objectives. The SRIA follows and complements the CCAM Partnership Proposal[20] (submitted to the European Commission on 13th April 2020). The commitment of the partners (see table below) to the SRIA is the basis to launch the CCAM Partnership under the new Horizon Europe programme.

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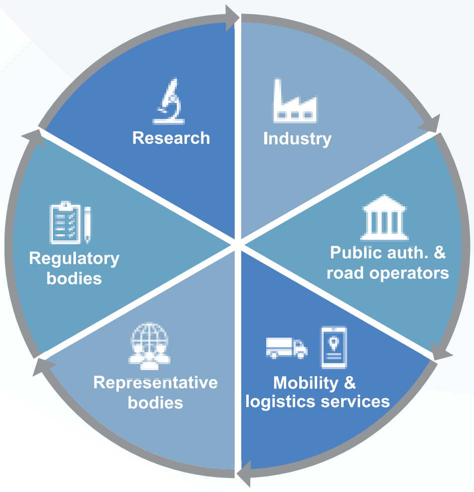
[20] Draft proposal for a European Partnership under Horizon Europe Connected, Cooperative and Automated Mobility (CCAM) Version 13 May 2020, https://ec.europa.eu/info/sites/info/files/research_and_innovation/funding/documents/ec_rtd_he-partnerships-connected-and-automated-driving-ccam.pdf

Table 1: CCAM Association Stakeholders

CCAM Association stakeholders	
Automotive manufacturers	BMW, DAF, Ford Otosan, Renault, Scania, Volkswagen AG, Volvo Cars, Volvo Group
Automotive supply chain	Applied Autonomy, Bosch, Buyutech, Continental, Denso, ESI Group, Eurocybcar, Faurecia, Hitachi Europe, IFEVS, Infineon, Michelin, Provizio, Valeo
Physical and digital infrastructure	Alstom Transport, Aventi, Digitrans, ETRA, Everis, Huawei, Indra, MAP Traffic Management, Siemens Mobility, Ubiwhere
Universities	Aalto, Budapest BME, Chalmers, FH Steyr Upper Austria, Halmstad University, Innsbruck, Istanbul Okan, Istanbul Sabanci, JKU Linz, KIT Karlsruhe, KUL Leuven, Leeds, Limerick, Luxembourg, Metropolia, Mondragon, Oulu University of Applied Sciences, Polytechnic Bari, RWTH Aachen, Tampere University, Telecom Paris, Trinity College Dublin, TU Delft, TUe Eindhoven, UCD Dublin CeADAR, UCL London MaaSLab, Unina, Univ-Eiffel, University of Groningen, University of Surrey, University of Zilina (UNIZA), UPM Madrid, VUB Brussels MOBI, Warwick, Waterford
Research providers	AIT, ALP.Lab, AVL List, Capgemini Engineering (Altran), CEA, CEIT, Cerema, CERTH, Cidaut, CTAG, CVC, DLR, FEV, FMI, Fraunhofer, IBDiM, IBV, ICCS, IFPEN, IMEC, Joanneum Research, KFV Austria Road Safety, LINKS Foundation, Łukasiewicz Research Network, LuxMobility, MOBY, Motor Transport Institute, NAITEC, RISE, SINTEF, Tecnalia, TIS, TNO, TOI, Traficon, V2C2, Vicomtech, VTI, VTT
Mobility providers	Mobility Cooperative
Other services	Covéa, DEKRA, Goggo Network, IDIADA, Macif, Unipol
Countries	Austria BMK, Innovate UK, Netherlands Minienw
National transport authorities	ASFINAG Austria, Austriatech, Germany BASt, Highways England, Hungarian Public Roads, Netherlands RDW, Netherlands Rijkswaterstaat, Norwegian Public Roads Administration, Swedish Transport Agency, TRAFICOM Finland, Trafikverket Sweden, Transport Infrastructure Ireland, Transport Scotland, Vejdirektoratet Danish NRA
Local and regional authorities	Flemish Agency for Roads and Traffic, Forum Virium Helsinki, Gothenburg, Ile-de-France Mobilités, Transport for Athens OASA
Representative bodies	ACEM, ALICE, ANEC, CEDR, CLEPA, CONEBI, EARPA, ECTRI, EFA, EPoSS, ERF, ERTICO, EUCAR, FIA, POLIS, TISA, UITP
Platforms and clusters	ACS Slovenia, Aurora Snowbox Finland, Bavarian Research Alliance, Business Upper Austria - Automotive Cluster, Drive Sweden, E-mobility Cluster Regensburg, FMC Ireland, French Mobility, ICOOR Italy, ITS Norway, PIARC Italy, SERNAUTO Spain, TechworksHub, Zone Cluster Hungary

2.2 Steps taken for the development of the SRIA

Advancing CCAM is a multi-stakeholders effort (see Figure 2: Sectors and types of stakeholders contributing to the Partnership and to the SRIA). When developing the SRIA, an open and transparent process was applied, involving public and private stakeholders across industries and value chains. Since CCAM is a new European Partnership under Horizon Europe, with no existing legal entity gathering yet the stakeholders, the consultation process was fully open, not based on membership, allowing any entity willing to contribute to do so. By the end of June 2020, more than 200 companies, organisations and associations expressed their interest to be part of this CCAM stakeholder community, and got involved in the co-design of the SRIA (see the following table). In this process, all stakeholder groups shown in Figure 2: Sectors and types of stakeholders contributing to the



Industry
- Automotive industry, including supply chain
- ITS solutions, telecom providers, connectivity
- Data handling and storage industry, ...

Representative bodies
- Road users
- Stakeholder associations
- Road safety, society, the environment, ...

Public authorities & road operators
- Cities and regions
- Transport authorities, road authorities and operators
- Member States

Regulatory bodies
– National, European and international

Mobility & logistics services
- Public transport providers
- Mobility and logistics service providers
- Insurance, maintenance, ...

Research
- Universities
- Public research institutes
- Private research institutes

Figure 2: Sectors and types of stakeholders contributing to the Partnership and to the SRIA

Partnership and to the SRIA provided an active contribution. This chapter details the result of their work.

The CCAM SRIA builds upon the work done by Working Group 1 of the CCAM Single Platform[21]. This Expert Group was launched by the European Commission in June 2019 to provide advice and support to the Commission in the field of testing and pre-deployment activities for CCAM. Working Group 1, named "Develop an EU agenda for research and pre-deployment of Safe and Automated Road Transport", gathered representatives of all relevant CCAM stakeholders, including Member States. WG 1 drafted an agenda in a joint and interactive way, and provided an initial set of recommendations for future research and for related pre-deployment areas, based on member's inputs. The results of this WG were the starting point for the CCAM Partnership proposal and later the SRIA. Additional input from other existing multi-stakeholder roadmaps was used:

- the Strategic Transport Research and Innovation Agenda (STRIA) Roadmap on Connected and Automated Transport[22]: the 2019 STRIA report was prepared under the initiative of the European Commission to jointly develop a research and innovation roadmap for Connected and Automated Transport (CAT). It builds further on the previous STRIA roadmap published in 2017. The content of the document is mainly based on the contribution of experts of different stakeholder groups from industry, academia and national authorities.
- the CAD roadmap[23] (2019) of the Working Group on Connectivity and Automated Driving of the European platform ERTRAC[24], and recommendations on systems and technologies for interconnected logistics by the ALICE[25] platform.
- the results of the EU-funded Coordination and Support Actions CARTRE[26], ARCADE[27] and SCOUT[28], which all are or were active in the field of coordination and consensus-building across stakeholders for sound and harmonised deployment of Connected, Cooperative and Automated Driving.

The following steps explain the CCAM SRIA co-creation process from January 2020 until finalisation:

1. Initiation of the Partnership Proposal drafting team, following the request for such a group expressed by EC representatives in the CCAM Single Platform WG 1 meeting, on 27th January 2020. The drafting team consisted of a wide range of European associations representing the different CCAM stakeholders.
2. Combination of inputs from recent strategic R&I recommendations, during the period November 2019 – February 2020, also including recent work by the CCAM Platform WG1.
3. Discussing aim, ambitions, vision and main R&I areas in a first Stakeholder workshop, on February 17th 2020, in Brussels, with about 140 participants. Interests of participants to contribute to the Partnership were collected at this occasion.

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[21] Expert group on cooperative, connected, automated and autonomous mobility, https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3657

[22] STRIA Roadmap on Connected and Automated Transport (CAT) Road, Rail and Waterborne, December 2020, https://trimis.ec.europa.eu/sites/default/files/2021-01/stria_cat_factsheet_2020.pdf

[23] ERTRAC Connected Automated Driving Roadmap, 8.03.2019, https://www.ertrac.org/uploads/documentsearch/id57/ERTRAC-CAD-Roadmap-2019.pdf

[24] ERTRAC is the European Road Transport Research Advisory Council. It is the European technology platform which brings together road transport stakeholders to develop a common vision for road transport research in Europe. ERTRAC activities are mainly performed in Working Groups, including the one on Connectivity and Automated Driving.

[25] ALICE is the European Technology Platform: Alliance for Logistics Innovation through Collaboration in Europe. The work is performed in 5 Thematic Groups, who jointly drafted the Roadmap towards zero emission Logistics 2050 which was used in drafting the SRIA.

[26] CARTRE Grant agreement ID: 724086, https://cordis.europa.eu/project/id/724086

[27] ARCADE Grant agreement ID: 824251, https://cordis.europa.eu/project/id/824251

[28] SCOUT Grant agreement ID: 713843, https://cordis.europa.eu/project/id/713843

4. Publication of draft Proposal and online consultation to collect feedback, in mid-March 2020: with over 90 detailed responses received, brought in by various stakeholders across the value chain.
5. Final draft of Partnership Proposal sent to European Commission services on 13 April 2020 (with a revised version published on EC website on 13 May 2020[29]).
6. In April 2020, the SRIA preparation started as fully transparent and open process, allowing all interested stakeholders to contribute to the definition of the vision, objectives and R&I priorities in seven CCAM Clusters (see Chapter 7).
7. Presentation, exchange and discussion with the CCAM Platform WG 1 experts on the Clusters, R&I actions and priorities, in the WG 1 meeting of May 4th.
8. From May 18th to 20th 2020: stakeholders involvement through a series of 7 open online workshops, specifically to validate the orientations of the SRIA content. In these meetings, the current state of the art, the ambitions and the steps to be taken were outlined, discussed and sharpened. With around 70 participants per session and a dynamic interaction, followed-up by email exchanges, ample and in-depth knowledge and explanations were gathered.
9. On June 3rd 2020, a dedicated meeting was organised to inform Member States representatives from respective Ministries on the progress of the CCAM Partnership preparation and SRIA drafting, and in particular on the willingness to set up a Member States Advisory Board within the Partnership governance in order to ensure a regular consultation of national representatives.
10. Distribution of draft SRIA content to stakeholders mid-June, and from June 16th to 18th, second series of 7 open online workshops, to discuss in detail the R&I actions and validate them with the stakeholders.
11. In July, the draft SRIA was published online and distributed to the stakeholders.
12. From September 17th to 28th, a public consultation was organised over the R&I priorities proposed for the first Work Programme 2021-2022 of the Partnership, with circulation of a draft and collection of input.
13. In September and October, the new CCAM Association that will support the Partnership activities was developed by the drafting team, gathering the views of all the different sectors to be represented. On November 5th, the call for membership to join this new association was released to the CCAM stakeholders, with distribution of the statutes and explanatory information.
14. On November 23rd, an Information Day on CCAM was organised, to present to the public the objectives of the Partnership, collect opinions about the SRIA, and inform about the new association. More than 150 participants joined this Information Day. The draft SRIA and the call to join the new association were distributed again at this occasion. The event was registered and post online, so the information stays available publicly.

The CCAM SRIA evolved through these stages and it received plenty of input and feasibility checks from key stakeholders (all of these are included in Table 2: Stakeholders involved in the CCAM SRIA development) in a wide variety of technology areas. All of these stakeholders are included in Table 2: Stakeholders involved in the CCAM SRIA development.

The stakeholders listed in Table 1 below have expressed their willingness to contribute to the Partnership, by requesting to be involved in its setup. Most of them participated in the different consultation steps of the SRIA development. The good discussions, in particular in the series of

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[29] Draft proposal for a European Partnership under Horizon Europe Connected, Cooperative and Automated Mobility (CCAM) Version 13 May 2020, https://ec.europa.eu/info/sites/default/files/research_and_innovation/funding/documents/ec_rtd_he-partnerships-connected-and-automated-driving-ccam.pdf

workshops held in May and June 2020 helped defining needed R&I actions for the SRIA. More than 400 experts contributed to these stakeholder workshops, demonstrating the availability of a strong expertise in all the research fields addressed by the Partnership.

The table below provides an overview of the interested stakeholders at the end of June 2020 when finalising the first draft of the SRIA. Since then, more contacts have announced their interest to contribute to the European Partnership. The Partnership is open for stakeholders to join from the start and during the Partnership duration. Any entity involved in R&I on CCAM and willing to commit and contribute to the CCAM SRIA will be welcomed to join the stakeholder network.

Table 2: Stakeholders involved in the CCAM SRIA development

CCAM stakeholders contributing to the Partnership SRIA development	
Research providers	AVL, AIT, Bast, CDV, CNRS, CEA, CEIT, Cerema, CERTH/HIT, Cidaut, CTAG, DLR, Eurecat, Everis, FEV, fka, FMI, Fraunhofer, I2CAT, ICCS, ICOOR, IDIADA, IFPEN, IMEC, INDRA, JRC, KTI, Lero, LINKS Foundation, Nervtech, Ricardo, RINA, RISE, SAFER, SINTEF, Tecnalia, TNO, TOI, Vicomtech, VTI, VTT
Universities	Aachen, Bari, Bordeaux, Budapest, Chalmers, Cork, Delft, Deusto, DTU, Dublin, Eiffel, Eindhoven, Florence, Galway, Gothenburg, Istanbul, Leeds, Leuven, Ljubljana, Madrid, Maynooth, Metropolia, Milano, Modena, Mondragon, Newcastle, Paris, Poznan, Prague, Sligo, Surrey, Thessaloniki, Turino, Upper Austria, Belfort-Montbéliard, Valencia, Warsaw, Zilina
Automotive	Akka, Alstom, Altran, BMW Group, Bosch, Bridgestone, CAFA Tech, Continental, DAF Trucks, Elaphe, Eminko, Eurocybcar, Farplas, Faurecia, FCA, Ford, GM, Hidria, Irizar, JLR, LAB France, Michelin, Mobivia, Navya, Pirelli, Reflective, Renault, Tofas, Valeo, Volkswagen, Volvo Group, Yamaha
ITS	Bestmile, Dynniq, Einride, HERE, Kapsch, LIT Transit, MAP TM, Mobilits, NNG, OmniOpti, PTV Group, Swarco, TomTom, TTS Italia, Trust-IT Services, Ubiwhere, YoGoKo
Telecom/IT	ELMOS, Ericsson, EVERIS, Huawei, Intel, NXP
Infrastructure	Abertis, Asfinag, Sanef, Vinci
Freight & logistics services and users	ALICE, Colruyt Group, Gebruder Weiss, IDIT, Procter & Gamble
Countries	Austria, Belgium, Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Spain, Sweden, UK
Regions, cities and public transport operators	Brussels, Catalunya, Flanders, Gothenburg, Helmond, Paris/Ile-de-France, Madrid, Rotterdam, Stuttgart, Usti, Tampere, Vienna, Wallonia
Representative bodies:	ACEA, ACEM, ALICE, AMICE, ANEC, C2C-CC, CEDR, CLEPA, CONEBI, EAPA, EARPA, ECTRI, EFA, EPoSS, ERF, ERTICO, ETNO, ETRMA, EUCAR, Eurocities, EuroRap, FEHRL, FEMA, FIA, FIGIEFA, GSMA, IRU, POLIS, UITP, 5GAA
Technology clusters and test centres, etc.	AV Living Lab, AIPSS, Aurora Snowbox, Austriatech, CARA, Catapult, Drive Sweden, FMCI, Lindholmen , Moveo, Pole MEDEE, PTCarrereta, ACS Slovenia, Business Tampere, Vedecom, VDI-VDE-IT, Zalazone, Zenzic

3. Policy context

European Partnerships are key implementation tools addressing global challenges and contributing significantly to achieving the EU's political priorities. The transformational change in mobility will have a huge impact on all road, traffic and driving situations. In addition, advancing digitalisation, extreme growth in (big) data availability and increasing connectivity for users are shaping new business models in transport, modifying the future mobility needs and perceptions in society. With the expected impacts, the CCAM Partnership will contribute to the UN Sustainable Development Goals[30] (SDG), specifically to

- **SDG 3** (Ensure healthy lives and promote well-being for all at all ages)

  e.g. by providing safer, more sustainable and efficient mobility thus contributing to reducing the number of deaths from road traffic accidents and reducing automotive emissions for improved air quality and health;

- **SDG 9** (Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation)

  e.g. by funding research and innovation following a strategic agenda for significant economic impact, providing opportunities for new products and services in an area of utmost importance to the future competitiveness of the European transport industry;

- **SDG 11** (Make cities and human settlements inclusive, safe, resilient and sustainable)

  e.g. by providing safe, affordable, accessible and sustainable transport systems for all people including persons in vulnerable situations, and by drastically reducing the number of accidents caused by human error and thus increasing safety for all road users, including unprotected ones;

- **SDG 13** (Take urgent action to combat climate change and its impacts)

  e.g. by optimising infrastructure capacity usage, reducing congestion, smoothening traffic flow, avoiding unnecessary trips and thus reducing CO_2 emissions.

Further, the CCAM Partnership will contribute to highly relevant EU policy actions. In December 2019, the European Commission announced as one of its priorities the European Green Deal[31], a comprehensive and ambitious strategy package for Europe to become the world's first climate-neutral continent by 2050, while it called for "A Europe fit for the Digital Age" as a complementing strategy[32].

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[30] Take Action for the Sustainable Development Goals, https://www.un.org/sustainabledevelopment/sustainable-development-goals/

[31] The European Green Deal, COM(2019) 640 final, Brussels, 11.12.2019, https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

[32] Six Commission priorities for 2019-24, https://ec.europa.eu/info/strategy/priorities-2019-2024_en

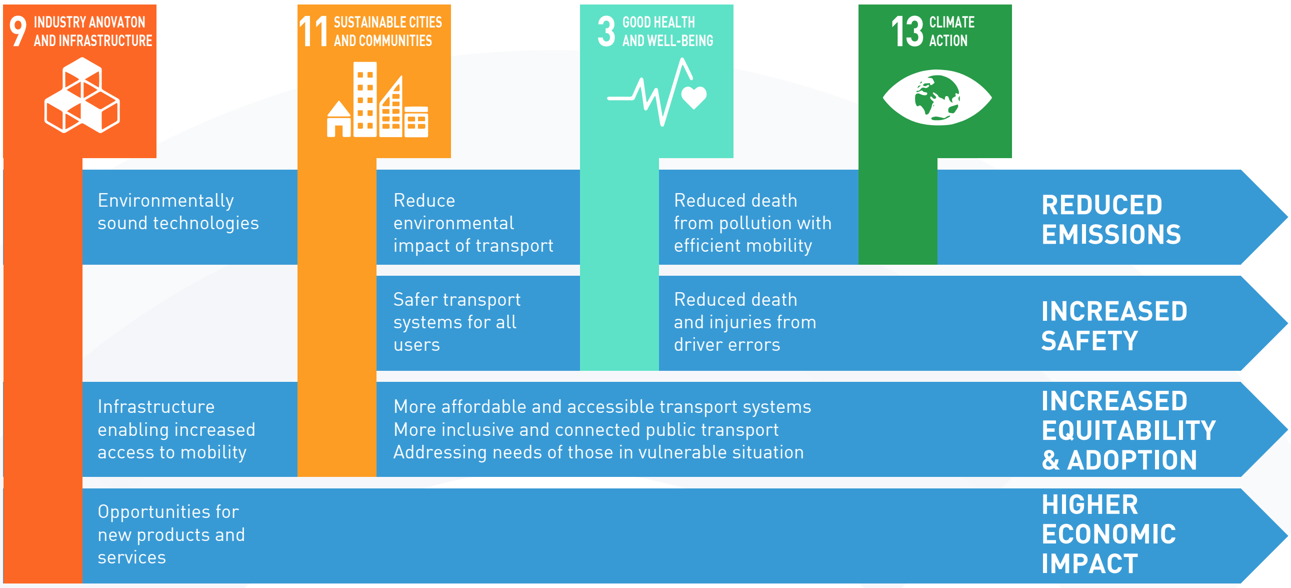

Figure 3: CCAM contributing to UN SDGs

For mobility, this includes leveraging the digitalisation of transport with smart and automated mobility systems in pursuing the ambitious sustainability objectives of the European Green Deal. Shared mobility services well integrated with public transport will accelerate the shift to sustainable and smart mobility with a reduced carbon footprint. Thus, CCAM will contribute to further reduce congestion, air pollution and CO_2 emissions with smart traffic management, reducing peak usage of road infrastructure, which also leads to a decrease in land use for road infrastructure in line with a resource-efficient economy. Leaving no one behind in this transformation is another key element of the Green Deal, which the CCAM Partnership will address directly by increasing the inclusiveness of road transport.

Since human error is a major factor in more than 90% of road crashes, CCAM has the potential to drastically improve the safety of the road transport system. It will contribute to moving closer to having zero fatalities on European roads by 2050, which was set as a goal already in the EC Transport White Paper in 2011[33] and confirmed by the 3rd Mobility Package in May 2018[34]. The latter extended this goal to serious injuries and thus implies moving towards Vision Zero, a road transport system in which no one is killed or severely injured. The CCAM partnership will bring Europe a step closer to this ideal.

Both Vision Zero and the European Green Deal are reflected in the expected impacts of the CCAM Partnership: drastically improving the safety and security of the transport system and meeting societal needs for mobility while reducing environmental impacts and strengthening our economy. At the same time, there are European policy initiatives that directly address the need for automated mobility.

In the Communication "On the road to automated mobility: An EU strategy for mobility of the future"[35] the European Commission lays down its vision, objectives and actions for an accelerated deployment of CCAM with the ambition of making Europe a world leader in this domain. This vision is further strengthened in the communication "The Smart and Sustainable Mobility Strategy"[36].

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[33] Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, COM(2011) 144 final, Brussels, 28.03.2011, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN

[34] Europe on the move – Sustainable mobility for Europe: safe, connected, and clean, COM(2018) 293 final, Brussels, 17.05.2018, https://eur-lex.europa.eu/resource.html?uri=cellar:0e8b694e-59b5-11e8-ab41-01aa75ed71a1.0003.02/DOC_1&format=PDF

[35] On the road to automated mobility: An EU strategy for mobility of the future, COM(2018) 283 final, Brussels, 17.05.2018, https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf

[36] Cf. Footnote 17.

In line with this ambition, maintaining and extending industrial leadership for new jobs and economic growth all over Europe is another expected impact of the CCAM partnership. The communication highlights Use Cases of CCAM that will be particularly relevant from the public policy perspective in the next decade. Intended actions in the areas of technology development, regulation, certification and impact assessment are outlined as well as the establishment of a partnership for CCAM, as detailed in this SRIA.

The Declaration of Amsterdam[37] highlighted the willingness of EU Member States to cooperate and agree on joint goals and actions to facilitate the introduction of connected and automated driving on European roads. Its objective is to prevent that a patchwork of regulations arises within the EU, which would be an obstacle for both industry and road users. It means that EU Member States must work on compatibility e.g. of safety requirements, liability issues, communication systems and services, in order to facilitate future market deployment, and therefore promote European competitiveness in this field. The Declaration of Amsterdam also supports the adoption of a "learning by experience" approach, "including, where possible, cross-border cooperation, sharing and expanding knowledge on connected and automated driving". The EU Member States agreed to foster a high-level structural dialogue to monitor and guide actions from the declaration and give recommendations to EC while facilitating the exchange of best practice between them. The conclusions of the 4th High Level Meeting on Connected Automated Driving[38] in October 2020 elaborated further on the need for more harmonisation to ease the testing of automated vehicles in different countries and to improve learning from the experiences of testing, recognise the importance of having a central European database collecting relevant information on CCAM research, testing, piloting and deployment activities and its results in Europe and beyond.

The CCAM Partnership will foster such cooperation and harmonisation by setting strategic objectives in terms of agreed safety standards for highly automated driving systems, improved synergies between public and private investment plans to advance vehicle and infrastructure technologies, and by providing a long-term coordination framework for R&I and large-scale testing activities. To further improve the exchange of experiences and foster cooperation, the Partnership will support the expansion and dissemination of the knowledge base on CCAM solutions, stakeholders, R&I programmes and projects, and testing activities.

The final report of the high-level group on the competitiveness and sustainable growth of the automotive industry in the European Union (GEAR 2030)[39] emphasises among others the medium and long-term recommendations for automated and connected vehicles. It references amongst others the Declaration of Amsterdam and highlights strategic planning and public private partnerships as suitable tools to take the full benefit of large scale testing and research programmes both at EU and at Member State level. More specifically, the report calls for a new approach on vehicle approval and for the assessment of the long-term impacts of increasingly automated and connected road transport, in particular on jobs and ethical issues to ensure social acceptance. All these recommendations will be directly addressed by clustered R&I activities of the CCAM Partnership on large-scale demonstrations, validation and on societal aspects and user needs with the expected impact of strengthening leadership in all technological and societal aspects of CCAM through targeted knowledge and capacity building.

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[37] Declaration of Amsterdam – Cooperation in the field of connected and automated driving, 14.04.2016, https://www.rijksoverheid.nl/documenten/rapporten/2016/04/29/declaration-of-amsterdam-cooperation-in-the-field-of-connected-and-automated-driving

[38] High-level meeting on connected and automated driving aims at strengthening cooperation, 7.10.2020, https://www.lvm.fi/en/-/high-level-meeting-on-connected-and-automated-driving-aims-at-strengthening-cooperation-1234725

[39] GEAR 2030 – Final Report 2017, DG GROW, October 2017, https://ec.europa.eu/growth/content/high-level-group-gear-2030-report-on-automotive-competitiveness-and-sustainability_en

It is evident that digitalisation and particularly technologies such as ITS-G5, 5G networks, AI, IoT and electronic components and systems will play a major role in the development of CCAM (see chapter 8 for the digital-domain partnership description). With new entrants from the digitalisation industry in the mobility market the market mechanisms could change dramatically and force established industrial actors to undertake radical changes with all the consequences on working force, investment and business models. Keeping a leading edge in innovation is mandatory to sustain a long-term economic benefit in this domain. This will be essential for staying ahead of e.g. the USA and China as Europe's main competitors and likewise most important external markets for CCAM.

In September 2020, the EC published a report from an independent expert group on "Ethics of Connected and Automated Vehicles"[40]. In this report, the authors propose 20 recommendations "promoting a safe and responsible transition to connected and automated vehicles". The relevant recommendations addressing R&I actions have been considered in the CCAM SRIA to support stakeholders in the systematic inclusion of ethical considerations in the design, development and deployment of CCAM systems and services. To fully capture and address ethical issues raised by CCAM for the long-term, close collaboration with other R&I initiatives and programmes will have to be stimulated. For example, the regular assessment of a joint portfolio of R&I projects across Horizon Europe referring to the ethical issues identified by the expert report will be necessary to detect gaps and overlaps, but also to maximise synergies and promote ethics as a strategic objective in European R&I.

3.1 Regulatory actions

In 2016, the World Forum for harmonisation of vehicle regulation amended the 1968 Vienna Convention on Road traffic enabling automated vehicles in traffic. In addition, the 10 km/h limitation for autonomous systems was removed from UN Regulation No. 79[41]. In order to accelerate progress, the World Forum created a dedicated Working Party (WP) on Autonomous and Connected Vehicles (GRVA) in 2018.

In June 2020 the proposal for a new UN Regulation on uniform provisions concerning the approval of vehicles with regards to Automated Lane Keeping System was published.[42] This Regulation is the first regulatory step for an automated driving system (as defined in ECE/TRANS/WP.29/1140) in traffic and it therefore provides innovative provisions aimed at addressing the complexity related to the evaluation of the system safety. It contains administrative and technical provisions for type approval including technical requirements, audit and reporting provisions as well as testing provisions. This timely action is an important first step in preparation of a more generic and long-lasting regulatory framework developed in the above-mentioned work on functional requirements and validation methods.

Vehicle requirements, identification and registration, exemption legislation and procedures as well as road safety, traffic rules or driving licenses are regulated both by EU and/or national standards. In this context, each country has its own specific regulatory framework for Automated Driving (AD) purposes. As a consequence, the current process for obtaining a testing permission varies a lot between countries. In some countries for example, an application form indicating several fulfilled requirements (e.g. safety standards, test driver training) or ministerial discussions (also involving other experts) are needed. In other countries a "simple" description of the test case, the roads to be used and the commitment to some safety/environment recommendations is required. A harmonised European framework for testing on public roads will help streamline the different national and local

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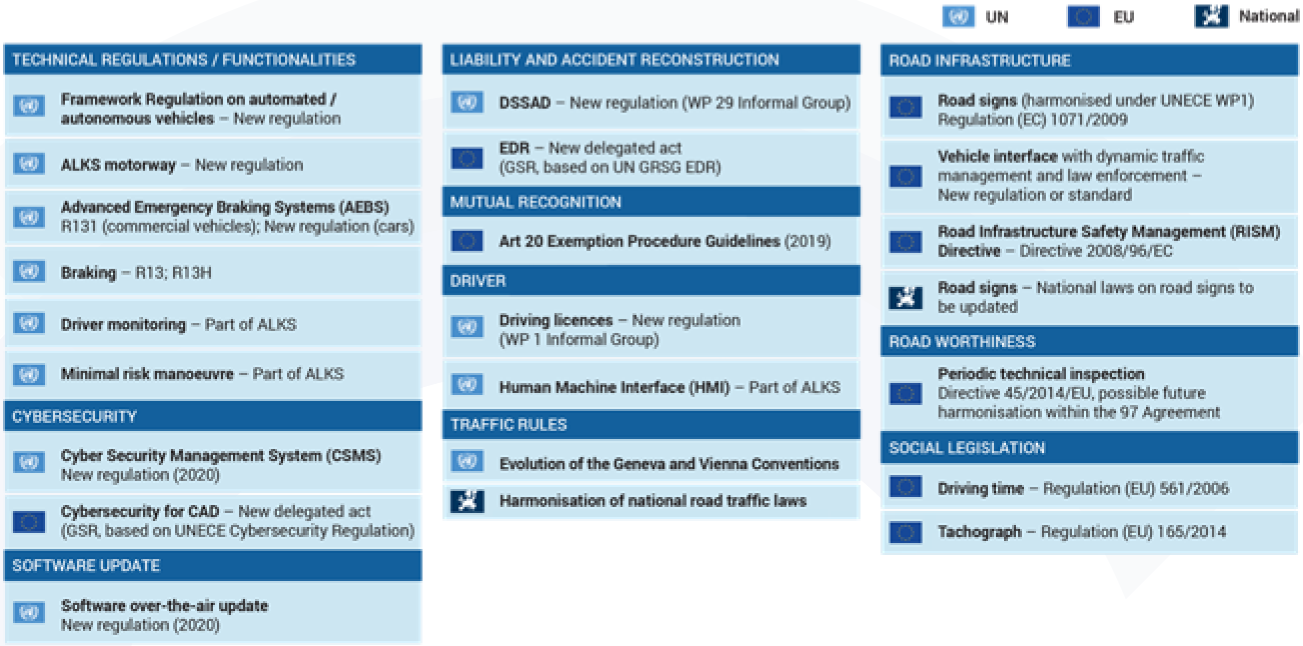
[40] Ethics of Connected and Automated Vehicles, accessed on https://ec.europa.eu/info/news/new-recommendations-for-a-safe-and-ethical-transition-towards-driverless-mobility-2020-sep-18_en

[41] The World Forum for Harmonization of Vehicle Regulations, hosted by UNECE, is the intergovernmental platform that defines the technical requirements applied by the automotive sector worldwide.

[42] UN Regulation on Automated Lane Keeping Systems is milestone for safe introduction of automated vehicles in traffic, 24.06.2020, https://www.unece.org/?id=54669

processes for obtaining testing permissions; facilitate mutual recognition of procedures across Member States.



UN · EU · National

TECHNICAL REGULATIONS / FUNCTIONALITIES

- UN **Framework Regulation on automated / autonomous vehicles** – New regulation
- UN **ALKS motorway** – New regulation
- UN **Advanced Emergency Braking Systems (AEBS)** R131 (commercial vehicles); New regulation (cars)
- UN **Braking** – R13; R13H
- UN **Driver monitoring** – Part of ALKS
- UN **Minimal risk manoeuvre** – Part of ALKS

CYBERSECURITY

- UN **Cyber Security Management System (CSMS)** New regulation (2020)
- EU **Cybersecurity for CAD** – New delegated act (GSR, based on UNECE Cybersecurity Regulation)

SOFTWARE UPDATE

- UN **Software over-the-air update** New regulation (2020)

LIABILITY AND ACCIDENT RECONSTRUCTION

- UN **DSSAD** – New regulation (WP 29 Informal Group)
- EU **EDR** – New delegated act (GSR, based on UN GRSG EDR)

MUTUAL RECOGNITION

- EU **Art 20 Exemption Procedure Guidelines** (2019)

DRIVER

- UN **Driving licences** – New regulation (WP 1 Informal Group)
- UN **Human Machine Interface (HMI)** – Part of ALKS

TRAFFIC RULES

- UN **Evolution of the Geneva and Vienna Conventions**
- National **Harmonisation of national road traffic laws**

ROAD INFRASTRUCTURE

- EU **Road signs** (harmonised under UNECE WP1) Regulation (EC) 1071/2009
- EU **Vehicle interface** with dynamic traffic management and law enforcement – New regulation or standard
- EU **Road Infrastructure Safety Management (RISM) Directive** – Directive 2008/96/EC
- National **Road signs** – National laws on road signs to be updated

ROAD WORTHINESS

- EU **Periodic technical inspection** Directive 45/2014/EU, possible future harmonisation within the 97 Agreement

SOCIAL LEGISLATION

- EU **Driving time** – Regulation (EU) 561/2006
- EU **Tachograph** – Regulation (EU) 165/2014

Table 3: Legal framework for the deployment of Automated Driving

The European Automobile Manufacturers' Association (ACEA) lists relevant regulations (existing and planned) for deployment of Automated Driving (see Table 2) in their "Roadmap for the Deployment of Automated Driving in the European Union"[43].

The CCAM Partnership will accelerate implementation and further enhance capabilities and value of CCAM solutions by providing early alignment between stakeholders on future regulations based on knowledge and scientific background from testing, demonstration and validation actions.

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[43] Roadmap for the Deployment of Automated Driving in the European Union, 3.12.2019, https://www.acea.be/publications/article/roadmap-for-the-deployment-of-automated-driving-in-the-european-union

4. Vision and challenges

4.1 CCAM Partnership Vision

The vision of the CCAM Partnership for the next 10 years is to make Europe a world leader in the development and deployment of connected and automated mobility and logistics services and systems and thereby provide a significant contribution to European leadership in safe and sustainable road transport.

Within this period, CCAM shall foster and support new mobility concepts, shifting design and development from a driver-centred to mobility-user oriented approach, providing viable alternatives for private vehicle ownership while increasing inclusiveness of mobility. CCAM solutions will be integrated in the whole transport system, accompanied by the right support measures of the public sector (e.g. incentives, legal frameworks) to fully exploit the potential benefits of CCAM and minimise potential adverse effects, such as increasingly congested traffic or new risks in mixed traffic environments.

Automated vehicles will increasingly allow the transfer of the control tasks from the driver to the vehicle system, and the driver may finally be obsolete, even in particularly challenging and complex traffic environments. This implies a step change in the safety concept of road transport and poses big challenges in terms of robustness and reliability.

The vehicles and other road users, including vulnerable ones such as pedestrians and cyclists, will benefit from increased connectivity with vehicles and the infrastructure. This connectivity will allow them to better coordinate their manoeuvres, making use of active infrastructure support and enabling smart traffic and fleet management for improved throughput and increased safety. Shared, automated mobility and freight services will become widely available, providing seamless door-to-door mobility for people and goods including fully autonomous last mile deliveries, leading to healthier, safer, more accessible, greener, cost-effective, demand-responsive and more sustainable transport everywhere.

In short, the CCAM Partnership Vision is to ensure

> **European leadership in safe and sustainable road transport through automation.**

4.2 Challenges to deploy CCAM systems and services

For the Partnership to achieve its vision and expected impacts, a multitude of complex challenges need to be addressed and solved at **societal, human, technical, regulatory, economic and operational** level. These challenges are categorised and summarised as problem drivers (PD).

> **Insufficient demand** as society does not yet understand the potential benefits of CCAM enabled mobility. The long-term implications, benefits and impacts of integrating CCAM solutions into the mobility system are not sufficiently examined. (PD1)

Society does not yet demand a transition to CCAM enabled mobility since the potential implications and benefits (such as enhanced safety or lower environmental impacts) of the integration of CCAM solutions into the mobility system have yet to be demonstrated, and they are not well understood. Consequently, there is a lack of awareness, acceptance and adoption by citizens and policy makers.

Changing public opinion requires evidence that CCAM systems are safe and that they are useful. Within this context, the partnership must prove that integrated CCAM solutions offer societal benefits with perceived advantages for each end-user and that CCAM solutions integrated in the mobility system are safe.

One main challenge will be to provide shared, on-demand and personalised transportation available to all, contributing to the inclusiveness of future transport systems. Automated taxi/pods/shuttles/buses, and shared vehicles in general, will be new options made available to help fulfil this mission which should be demonstrated in urban, peri-urban and rural areas. Essential will be the development of CCAM solutions and mobility services complementing existing public transport. that are attractive for service providers, operators and -users of automated and shared vehicles. In addition, business models and business cases for automated and shared vehicles need to be developed, as well as interoperability and integration with public transport. To support these future CCAM solutions infrastructure research, innovations and investments are also needed. The intended services need to be well integrated with urban planning and urban economics, with appropriate governance models in order to ensure a high degree of acceptance among all stakeholders.

Safety of CCAM needs to be ensured, and the main challenge for safety validation is that depending on the operational design domain (ODD[44]) many different driving situations and complex scenarios must be tested and validated. Currently available procedures[45] do not provide an efficient and cost-effective solution. Expanding these domains by high levels of automation will drastically increase the need for testing and validation to prove that functions and solutions perform safely. Cost considerations and the time needed for testing are of great relevance, and the knowledge and data gathered from pilot tests across Europe can provide a significant contribution to validate CCAM functioning and safety. Furthermore, these tests provide essential insights needed for further enhancing evaluation and validation methodologies.

CCAM solutions are not yet sufficiently mature for wider market take-up, and current investment levels in CCAM R&I are inadequate to maintain and extend EU industrial leadership. (PD2)

The technological capabilities to cope with the increased complexity of advanced CCAM solutions in operation are not yet sufficiently mature for market take-up. Low speed shared shuttles in urban areas is one example that demonstrates two major complexity drivers: moving beyond somewhat predictable traffic situations and increasing vehicle speed. Already handling traffic situations without vulnerable road users and with vehicles driving in the same direction or in confined, well described areas is a demanding task. Hence initial applications limit the operational domain like e.g. to motorways with physical separation of oncoming traffic with limited access via merging on- and off-ramps and no low-speed vehicles, bicycles or pedestrians. However, to fully exploit the potential of CCAM solutions more complex traffic situations must be tackled first at low speeds, in order to limit accident risks[46]. Since this limitation in Use Cases results in higher costs and limited benefit to society and lower interest for private investments, mixed traffic situations with enlarged ODDs must be considered in the long term requiring innovations in vehicle technologies e.g. with respect to perception and control as well as on infrastructure side like cyber-secure connectivity.

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[44] The Operational Design Domains (ODD), introduced by SAE, defines the boundaries of the system functionality at a certain level of automation, e.g. a particular road environment. Each driving mode, i.e. system feature or use case, of an automated driving system is reflecting a particular ODD. With the concept of automation levels and ODD, relevant cases can be distinguished as follows: Level 3 automation means to take the driver out of the perception and response task while keeping him or her as a fallback solution for the dynamic driving task. Level 4 in contrast means there is no driver needed due to the system fallback, but the ODD is limited, while for level 5 the ODD would be unlimited. For all levels up to including Level 4, the ODD is - by definition - limited.

[45] In the ISO-26262 standard for functional safety an Automotive Safety Integrity Level (ASIL) is defined. Currently, hazardous events are identified in the assessment and an ASIL is assigned under consideration and reactions of a (human) driver.

[46] The crash intensity/severity scales with the energy stored in the vehicle is a quadratic function of speed.

An innovation-friendly framework with effective and efficient ways to validate CCAM solutions is a prerequisite for this development.

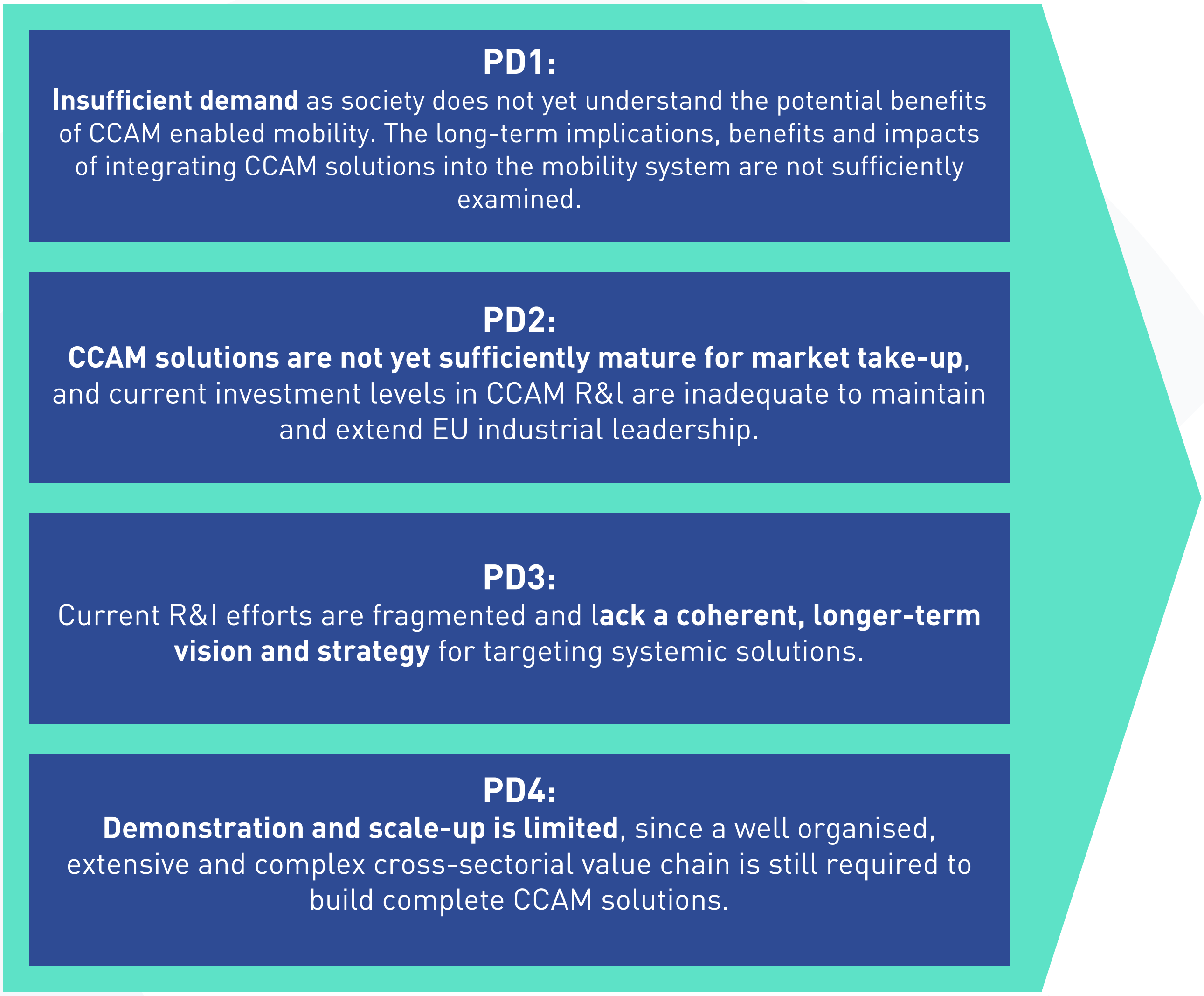
Current R&I efforts are fragmented and lack a coherent, longer-term vision and strategy for targeting systemic solutions. (PD3)

Public R&I funding and private investments in CCAM technologies are fragmented and insufficient to maintain and extend EU industrial leadership. To overcome this, it is essential that Research and Innovation efforts are taken beyond the current state with its low level of cohesion. The R&I efforts must be aligned and jointly support the full value chain, while matching a longer term vision in which societal benefits of CCAM enabled mobility represent a core value. Only when this is achieved, R&I investments, as well as other investments in relation to the deployment of CCAM technologies, can enable the European CCAM value chain to maintain and extend their international leadership. Europe's in-depth knowledge base regarding these technologies and their validation, coupled with the understanding of user needs and acceptance and the ability to assess and address CCAM impacts can simultaneously promote international competitiveness.

Demonstration and scale-up is limited, since a well organised, extensive and complex cross-sectorial value chain is still required to build complete CCAM solutions. (PD4)

To build complete CCAM solutions and fully exploit their societal benefits, a well organised extensive cross-sectorial "value network" is required, which today is only partially in place. Effective, profitable and transparent cooperation among local and regional authorities and the private sector involving a multitude of highly diverse stakeholders is mandatory. Including desired impacts as input into the process will contribute to provide end-users with inclusive, equitable and accessible services for all, and to develop interoperable systems and operating conditions. To do so, governance and management readiness is needed. Furthermore, the workforce and educational chain has to be prepared.

There are high costs, risks, barriers and long lead times before R&I investments in CCAM can lead to innovative new products and/or services being widely deployed. Automated mobility, particularly in road transport, is characterised by complex interactions within the overall mobility system. The interdependency of different parts of this system requires that a specific innovation (e.g. new vehicle automation or communication system) needs to be accompanied by timely innovation and roll-out in other segments, such as infrastructure, logistics or business models, for it to have a beneficial impact on the overall system. It also requires cross-sectors synergies with enablers (e.g. electronic components and systems, processing technologies, data driven engineering, Internet-of-Things, Artificial Intelligence) having different time scales for innovations and innovative business models (e.g. "mobility as a service", Logistics as a Service/Physical Internet) to really pay off. Moreover, the advent of automated vehicles opens important new challenges in relation to reliability, security and privacy topics. The Problem Drivers discussed above are summarised in Figure 4: Four Problem Drivers of the CCAM Partnership of the CCAM Partnership..



PD1:
Insufficient demand as society does not yet understand the potential benefits of CCAM enabled mobility. The long-term implications, benefits and impacts of integrating CCAM solutions into the mobility system are not sufficiently examined.

PD2:
CCAM solutions are not yet sufficiently mature for market take-up, and current investment levels in CCAM R&I are inadequate to maintain and extend EU industrial leadership.

PD3:
Current R&I efforts are fragmented and l**ack a coherent, longer-term vision and strategy** for targeting systemic solutions.

PD4:
Demonstration and scale-up is limited, since a well organised, extensive and complex cross-sectorial value chain is still required to build complete CCAM solutions.

Figure 4: Four Problem Drivers of the CCAM Partnership of the CCAM Partnership.

5. Objectives of the CCAM Partnership

Advancing CCAM solutions and preparing them for deployment (Deployment Readiness) are key elements of the CCAM partnership vision. The Deployment Readiness is status defined by combining the **validated safe system functioning**, a good **understanding** of the **expected impact** and potential **risks**, together with users and **society's** readiness to **accept, adopt and demand CCAM** solutions. Main actions to achieve Deployment Readiness are Large- scale Demonstrations with pilots, Field Operational Trials (FOT) and in living labs.

A set of agreed objectives address all four Problem Drivers while directing the CCAM Partnership programme towards the expected impacts. The CCAM Partnership differentiates three levels of objectives, which are further detailed in this chapter:

- **General Objectives (GO)** are about what the CCAM Partnership aims at contributing to in the longer term. These are the wider effects on society (incl. the environment), the economy and science enabled by the outcomes of R&I investments (long term). They demonstrate the link with the relevant EU priorities and strategies and targets (see Figure 5).
- **Specific Objectives (SO)** are about what the CCAM Partnership will deliver concretely, where it is to make a difference based on the diffusion and use of the results that will be delivered. (see Figure 5)
- **Operational Objectives (OO)** in the CCAM Partnership are about what is to be delivered during the lifetime of the Partnership, the concrete short-term results of the activities performed/ projects funded. The Operational Objectives are used in the CCAM Partnership to assess the progress over time towards 2030 (see Figure 6 : Operational Objectives (left, blue borderline boxes) contributing to Specific Objectives (right). and Figure 8: The three phases in the CCAM Partnership to monitor the SRIA progress.).

SO1 Validated safety and security, improved robustness and resilience of CCAM technologies and systems.	**GO1** Safe and efficient co-existence between automated and non-automated "conventional" traffic for a long transition period of mixed traffic while overall reducing number of fatalities and injuries in road transport.	**Expected Societal Impact 1:** Improving **safety** and **security** of the transport system drastically
SO2 Secure and trustworthy interaction between road users, CCAM and "conventional" vehicles, infrastructure and services to achieve safer and more efficient transport flows (people and goods) and better use of infrastructure capacity.	**GO2** Increased efficiency of transport flows (people and goods) leading to better use of infrastructure capacity and preservation of public space while reducing transport emissions and congestion	**Expected Societal Impact 2:** Meeting **societal needs** for **mobility** while **reducing environmental** impacts and strengthening our economy
SO3 High public acceptance and adoption of CCAM solutions by 2030 with a clear understanding of its benefits and limits as well as rebound effects.	**GO3** Making Europe a world leader in the development and deployment of connected and automated mobility for people and goods with more focused long-term investments in R&I, development and pre-deployment of CCAM.	**Expected Economic Impact:** Maintain and **extend industrial leadership** for new jobs and economic growth all over Europe
SO4 Better coordination of public and private R&I actions, large-scale testing and implementation plans in Europe.	**GO4** Support the creation, dissemination and capitalisation of knowledge to accelerate the development and improvement of CCAM enabled solutions	**Expected Scientific Impact:** **Strengthen** leadership in all technological and societal aspects of CCAM through targeted **knowledge and capacity building**

Figure 5: Specific Objectives, General Objectives and the Expected Impacts of the CCAM Partnership

The **Specific Objectives** together with the **Operational Objectives** (see left side in Figure 6 : Operational Objectives (left, blue borderline boxes) contributing to Specific Objectives (right).) address the Problem Drivers and ensure progress towards **Deployment Readiness** for different CCAM Solutions and a variety of Use Case. Their implementation all over Europe will contribute to all General Objectives.

Common methodologies available to validate the safe system function of CCAM use cases by 2026.

Accepted safety standards for automated mobility on public roads by 2027.

Enable trustworthy interaction between all traffic participants and CCAM by 2028.

Large-scale demonstration of user-oriented and well-integrated CCAM solutions for mobility of people and goods in at least 30 demonstration sites across Europe by 2030.

Societal impacts are sufficiently addressed and assessed by 2030.

Increased public awareness of demonstrated benefits for users and
society by 2030.

In 2021. establish a long-term coordination framework for R&I and large-scale testing activities.

Improved synergies for public and private implementation plans to deploy CCAM solutions by 2027.

A common evaluation framework fostering exchange and reuse of R&I results by 2024.

Exploit new and emerging knowledge fields for large scale demonstrations in 2027.

Expand and disseminate the knowledge base on CCAM solutions during the entire Partnership duration.

SO1

Validated safety and security, improved robustness and resilience of CCAM technologies and systems.

SO2

Secure and trustworthy interaction between road users, CCAM and "conventional" vehicles, infrastructure and services to achieve safer and more efficient transport flows (people and goods) and better use of infrastructure capacity.

SO3

High public acceptance and adoption of CCAM solutions by 2030 with a clear understanding of its benefits and limits as well as rebound effects.

SO4

Better coordination of public and private R&I actions, large-scale testing and implementation plans in Europe.

Figure 6 : Operational Objectives (left, blue borderline boxes) contributing to Specific Objectives (right).

The CCAM partnership will contribute to achieving the General Objectives and trigger the expected positive impacts for society (safety, environment, inclusiveness), economy (European competitiveness) and science. The intervention logic describes how the different levels of objectives will at the same time target the Problem Drivers and realise the expected impact (see figure below).

PD2:
CCAM solutions are not yet sufficiently mature for wider market take-up

Common methodologies available to validate the safe system function of CCAM use cases by 2026.

Accepted safety standards for automated mobility on public roads by 2027.

Enable trustworthy interaction between all traffic participants and CCAM by 2028.

SO1
Validated safety and security, improved robustness and resilience of CCAM technologies and systems.

PD4:
Demonstration and scale-up is limited

Large-scale demonstration of user-oriented and well-integrated CCAM solutions for mobility of people and goods in at least 30 demonstration sites across Europe by 2030.

Societal impacts are sufficiently addressed and assessed by 2030.

Increased public awareness of demonstrated benefits for users and society by 2030.

SO2
Secure and trustworthy interaction between road users, CCAM and "conventional" vehicles, infrastructure and services to achieve safer and more efficient transport flows (people and goods) and better use of infrastructure capacity.

PD3:
Lack a coherent, longer-term vision and strategy

In 2021. establish a long-term coordination framework for R&I and large-scale testing activities.

Improved synergies for public and private implementation plans to deploy CCAM solutions by 2027.

A common evaluation framework fostering exchange and reuse of R&I results by 2024.

SO3
High public acceptance and adoption of CCAM solutions by 2030 with a clear understanding of its benefits and limits as well as rebound effects.

PD1:
Insufficient demand

Exploit new and emerging knowledge fields for large scale demonstrations in 2027.

Expand and disseminate the knowledge base on CCAM solutions during the entire Partnership duration

SO4
Better coordination of public and private R&I actions, large-scale testing and implementation plans in Europe.

Figure 7: Intervention logic of the CCAM Partnership based on Problem Drivers, Operational Objectives. and Specific Objectives.

6. Monitoring progress for Objectives

The intervention logic foresees achieving the Specific Objectives and Operational Objectives in the Partnership timeframe. The timeline of the Programme is structured in three Phases:

- **Phase 1 (2021-2024)**: Developing the building blocks;

  This Phase is dedicated to develop the main building blocks in terms of vehicle and infrastructure technologies, key-enablers, methods to engage with users and citizens, as well as methods to validate safe system functioning. Large-scale Demonstrations will focus on less complex usecases with limited ODDs.

- **Phase 2 (2025-2027)**: Advancing technical maturity;

  In the second Phase in the programme the CCAM Partnership will advance the technical maturity of technologies by testing and validating in operational enviornments and if possible already implement in Large scale Demonstrations Projects, or further advance the TRL to prepare them for implementation in the final Programme Phase.

- **Phase 3 (2028-2030)**: Further implementing in Large-scale Demonstrations all over Europe.

  The final Phase in the Programme will combine all developments in an integrated Large-scale Demonstration action within Field Operational Trials in Living Labs all over Europe.

The CCAM Partnership allocates the Operational Objectives on the Programme timeline in their logical sequence (see Figure 8: The three phases in the CCAM Partnership to monitor the SRIA progress.).

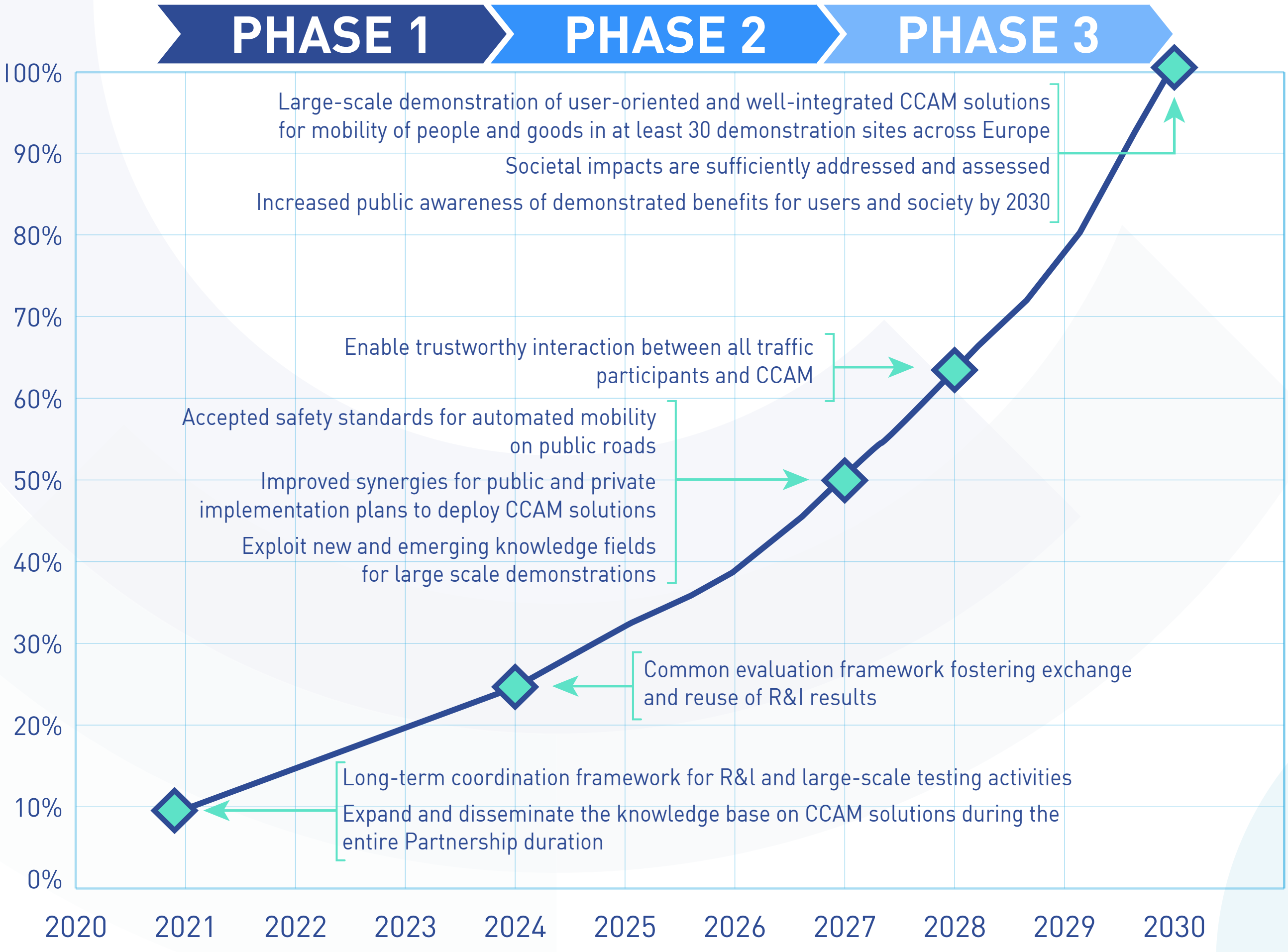


Figure 8: The three phases in the CCAM Partnership to monitor the SRIA progress.

The identified performance indicators (see tables below) support the partnership progress monitoring and include a limited number of KPIs to assess the contribution of the partnership in achieving the Operational Specific and General Objectives. Reporting on KPIs related to projects will be streamlined according to Horizon Europe rules and definitions.

Throughout the lifetime of the CCAM Partnership, the results of CCAM projects will be monitored and data will be used to support ex-post assessments of the Partnership's impact and its contributions to achieving The General Objectives of the Partnership.

KPIs for monitoring the General Objectives during the partnership lifetime do not add any value, considering the time needed for market introduction and fleet penetration. Assessing the partnership's impacts on general objectives will only be possible after its duration.

The Large-scale Demonstrations (see chapter 7) will be instrumental for assessing the performance and demonstrating value-add, benefits and positive impacts for society. Cross-sector collaboration is very important from early stages of research on CCAM elements (infrastructure, services and vehicles) onwards to enable seamless deployment for most types of R&I actions. Prospective deployment partners, such as vehicle manufacturers, national or regional road authorities, road operators and mobility service providers, and ICT industries, are key actors already in the early research phases, and work with research and technology organisations (RTOs) and universities to develop CCAM solutions.

Table 4: Monitoring and evaluation framework for General Objectives

General Objectives (GO)	**What is a measure of success?** Please use quantitative (Key Performance) and qualitative indicators, and link them to a point in time	**Which is the data source and methodology used** [project data, study, ….]	**Who is responsible for monitoring and providing the data / information? When will it be collected?**	**Baseline and target**
GO1: Safe and efficient co-existence between automated and non-automated "conventional" traffic for a long transition period of mixed traffic while overall reducing the number of fatalities and injuries in road transport.	Number of fatal and severe accidents by vehicles under test in CCAM projects	Reports from large-scale demonstrations	Project coordinators	Baseline: Prospective effectiveness analysis on fatal and severe accidents. Target: Zero fatal and severe accidents caused by vehicles under test in CCAM projects.
GO2: Increased efficiency of transport flows (people and goods) leading to better use of infrastructure capacity and preservation of public space while reducing transport emissions and congestion.	Traffic flow condition[47]: • Travel Time Index, or • Congestion Variability Index, or • Congested Road/kms, or • Peak Hour traffic speed.	CCAM projects and deliverables CORDIS, CINEA data	Partnership Association supported by CSA/ RIA projects and data from CINEA	Baseline: TBD before the test Target: Improvement.
GO3: Making Europe a world leader in the development and deployment of connected and automated mobility for people and goods with more focused long-term investments in R&I, development and pre-deployment of CCAM.	Share of new CCAM vehicles based on European innovation in the fleet of new vehicles sold per year; TEN-T core network corridors' section providing CCAM services Number of sites (e.g. cities) implementing CCAM services after successful demonstration by 2030 (resulting from actions under the CCAM partnership)	CCAM projects and deliverables CORDIS, CINEA data, TEN-T map viewer, CEDR TEN-T performance report, TRIMIS, CCAM Partnership Additional Activities Reporting	Partnership Association supported by CSA projects and data from CINEA	Baseline: Share of CCAM vehicles (SAE level 2, level 3 & level 4) in the fleet 2021 (5%, 0%, 0%), comparable to US and Japan Target: higher than US and Japan in 2023, 2025, 2027 and 2029.Baseline = no corridors with operating sections Target: all 9 core network corridors have sections providing CCAM services by 2030 Baseline: No demonstration Sites yet Target: At least 30 demonstration sites (e.g. urban nodes) implementing CCAM services after successful demonstration by 2030 Baseline: Partners of the CCAM Partnership investment in R&I in 2022. Target: Partners of the CCAM Partnership to increase the investment in R&I by 10% by 2025 and by 25% by 2030.
GO4: Support the creation, dissemination and capitalisation of knowledge to accelerate the development and improvement of CCAM enabled solutions.	Methods, tools and taxonomy used by CCAM developers and deployers in decision making. Number of CCAM projects participating in conferences and events	Qualitative KPI, survey	Project Coordinators, Partnership Association	Baseline: Use of CCAM methods, tools and taxonomy in 2021[48]. Target: Best practise sharing at the Results from Road Transport Research (RTR) conference and at the EUCAD Conference by all HE CCAM projects. Substantial increase in use of CCAM methods, tools and taxonomy

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[47] Traffic flow condition: the ideal indicator to measure the impact depends on the demonstrated use case, and it could be a combination of the indicators listed.

[48] Tools and methods available as of 2021, including from ARCADE (evaluation methodologies collection and data sharing framework) but also other projects like L3Pilot (Code of practice, taxonomy), SHOW, etc.

Table 5: Monitoring and evaluation framework for specific objectives

Specific Objectives (SO)	**What is a measure of success?** Please use quantitative (Key Performance) and qualitative indicators, and link them to a point in time	**Which is the data source and methodology used** [project data, study, ...]	**Who is responsible for monitoring and providing the data / information? When will it be collected?**	**Baseline and target**
SO1: Validated safety and security, improved robustness and resilience of CCAM technologies and systems.	Methodology for safety validation of CCAM systems agreed by stakeholders along the CCAM value chain, authorities and certification bodies to set safety standards for highly automated vehicles operating on public roads.	Project deliverables, minutes of working group meetings of standardisation bodies and assessment bodies. European and international lists / databases of standards.	CCAM Partnership Association, project coordinators	Baseline: HEADSTART methodology based on national efforts (PEGASUS, VVMethods, MOVE/MOSAR and StreetWise), international cooperation (SIPAdus, SAKURA) and EU projects (e.g. L3Pilot, ENSEMBLE, and HiDrive). Target: Agreement on methodology, input to standards by relevant stakeholders by 2026
SO2: Secure and trustworthy interaction between road users, CCAM and "conventional" vehicles, infrastructure and services to achieve safer and more efficient transport flows (people and goods) and better use of infrastructure capacity.	Number of incidents per 1.000.000 km driven on Large Scale Demo project sites and successfully addressing the causes of these incidents (including malfunctions e.g. false positive detections) from large scale demonstration projects.	Project deliverables and results, assessment reports/ surveys from demonstration projects	Project Coordinators	Baseline: Number of incidents[49] observed in current projects Target: 10% less annually reported incidents per 1.000.000 km driven in projects compared to baseline
SO3: High public acceptance and adoption of CCAM solution by 2030 with a clear understanding of its benefits and limits as well as rebound effects.	Impact of CCAM use on surrogate effects such as fleet composition (of CAV), number of CAV occupants carried, number of CAV VKT (vehicle kilometres travelled), load factors for goods. Survey on acceptance.	Traffic counts in MS (via MS representation in the CCAM Partnership) and projects, surveys (e.g. from demonstration projects)	Project Coordinators	Baseline: Status of MS data from in 2021 Target: 30% improvement of surrogate effects compared to baseline (Baseline available during 2022, choice of surrogate effects starting with states representative group meeting) Baseline: Acceptance survey results from H2020 projects. Target: Increased acceptance in the two next surveys (2025, 2030).
SO4: Better coordination of public and private R&I actions, large-scale testing and implementation plans in Europe.	Active involvement of public and private members of CCAM Partnership, number of cross-border projects, involvement of MS, regional and local authorities.	CCAM projects and deliverables CORDIS, CINEA, TRIMIS data	Partnership Association supported by CSA projects and data from CINEA	75% of actors involved in the Large Scale Demos are also members of the CCAM Partnership. Baseline: 18 States (Member States and Associated Countries) in the first meeting of the CCAM States Representatives Group. 75% of EU member states actively involved in the CCAM States Representatives Group.

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[49] Definition of incidents from the regulation for open road testing.

Table 6: Monitoring and evaluation framework for Operational Objectives

Operational Objectives (OO)	**What is a measure of success?** Please use quantitative (Key Performance) and qualitative indicators, and link them to a point in time	**Which is the data source and methodology used** [project data, study, ….]	**Who is responsible for monitoring and providing the data / information? When will it be collected?**	**Baseline and target**
Enable trustworthy interaction between all traffic participants and CCAM by 2028.	Number of successfully demonstrated new functionalities for trustworthy interaction between road users, vehicles, infrastructure and services delivered by CCAM projects	CORDIS, CINEA, CCAM partnership database, periodical survey,	Partnership association, CSA	Baseline: results of H2020 projects (TrustVehicle, ADAS&ME, Mediator, AutoMate, SUaaVE, interact, BRAVE) to build upon, considering latest advances in science and technology, e.g. in human behavioural models, use of virtual and augmented reality etc. Target: Three or more vehicle-internal and/or external new HMI functionalities successfully demonstrated in various traffic scenarios and enabling safe and efficient interplay of CAVs with other road users incl. pedestrians and two-wheeler riders Recommendations for user-centric extension of the European Statement of Principles on the design of human-machine interface ESoP towards automated vehicles are available by 2028.
Accepted safety standards for automated mobility on public roads by 2027.	Number of large-scale demonstrations applying safety standards prepared by CCAM projects. Availability of safety standards recommendations.	CORDIS, CINEA, CCAM partnership database, periodical survey,	Partnership association, CSA	Baseline 2021: No directly applicable safety standards available Targets: 2026, safety standards recommendations available Target: Three or more large-scale demonstrations until 2028 apply safety standards prepared by CCAM projects
Common methodologies available to validate the safe system function of CCAM use cases by 2026.	Application of methodologies and tools for the safety validation of CCAM, as developed in the CCAM Partnership	CORDIS, CINEA, CCAM partnership database, periodical survey,	Partnership association, CSA	Baseline: H2020 results on validation methodologies: HEADSTART methodology based on national efforts (PEGASUS, VVMethods, MOVE/MOSAR and StreetWise), international cooperation (SIPAdus, SAKURA) and EU projects (e.g. L3Pilot, ENSEMBLE and HiDrive). Target: All relevant CCAM projects beyond 2026 apply common methodologies and tools for the safety validation of CCAM systems accepted by the relevant stakeholders by 2026
Large-scale demonstration of user-oriented and well-integrated CCAM solutions for mobility of people and goods in at least 30 demonstration sites across Europe by 2030.	Number of demonstration sites with explicit results on user orientation and mobility integration as well as explicit results on new freight and logistics concepts.	CORDIS, CINEA, CCAM partnership database, periodical survey,	Partnership association, CSA	Baseline: 0 CCAM projects in 2021 Target: 30 or more demonstration sites for people mobility, freight and logistic by 2030

Operational Objectives (OO)	What is a measure of success? Please use quantitative (Key Performance) and qualitative indicators, and link them to a point in time	Which is the data source and methodology used [project data, study, ….]	Who is responsible for monitoring and providing the data / information? When will it be collected?	Baseline and target
Societal impacts are sufficiently addressed and assessed by 2030.	Number of projects targeting assessment of societal impacts. Ex-post impact assessment at large-scale demonstrations.	CORDIS, CINEA, CCAM partnership database, periodical survey,	Partnership association, CSA	Baseline: Number of projects addressing societal impacts in the Knowledge Base in 2021: 7 out of 16 characterised as addressing "socio-economic impact assessment/ sustainability" by ARCADE. Extended baseline in 2024: Number of WP21-22 CCAM projects which are mapping aspects of methodology that can be related to societal impacts assessment. Target: All demonstration projects of CCAM Partnership show completed mapping of these aspects. All impact aspects defined are assessed by 2030 (Ex-post impact assessment of large-scale demonstrations)
Increased public awareness of demonstrated benefits for users and society by 2030.	Evolvement of public awareness and perceived benefits with the help of assessment reports of large-scale demos	FIA, EUROBAROMETER, CORDIS, CINEA, CCAM partnership database, periodical survey,	Partnership association, CSA	Baseline: (Surrogate measures from Eurobarometer 496 2019 and L3 Pilot survey 2021.) 1. Survey results from Eurobarometer 496 on "fully automated and connected vehicles": Awareness = has seen, heard, read something about AV last year: 60% Willingness to use "fully automated and connected vehicles": 47% 2. For level 3 cars (L3Pilot questionnaire results; 2021): Willingness to use automated vehicle: 60% Willingness to buy: 28% Target: By 2030: Public awareness: 100%; Willingness to use: 75%; Willingness to buy: (56% (=doubling)).
In 2021, establish a long-term coordination framework for R&I and large-scale testing activities.	Number of projects making datasets available or use data from other projects (e.g. linked through the Knowledge Base) Regularly updated SRIA of the CCAM Partnership.	CORDIS, CINEA, CCAM Knowledge Base, periodical survey,	Partnership association, CSA	Baseline: Best practices from Knowledge Base. Target: All CCAM projects make test data and other datasets (e.g. scenarios, edge cases, etc.) available by 2027. Baseline: SRIA and CCAM Partnership established in 2021. Target: Regular updates of the CCAM SRIA.
Improved synergies for public and private implementation plans to deploy CCAM solutions by 2027.	Active involvement of public and private members of CCAM Partnership, number of cross-border projects, involvement of MS, regional and local authorities.	CORDIS, Partnership report (e.g. Annual basis), Cluster 7 RIA,	Partnership association, CSA	75% of actors involved in the Large Scale Demos are also members of the CCAM Partnership. Baseline: 18 States (Member States and Associated Countries) in the first meeting of the CCAM States Representatives Group. 75% of EU member states actively involved in the CCAM States Representatives Group.

Operational Objectives (OO)	What is a measure of success? Please use quantitative (Key Performance) and qualitative indicators, and link them to a point in time	Which is the data source and methodology used [project data, study, ….]	Who is responsible for monitoring and providing the data / information? When will it be collected?	Baseline and target
A common evaluation framework fostering exchange and reuse of R&I results by 2024.	Common evaluation methodologies (CEM) implemented and building up a common evidence base using CEM for CCAM demonstration activities. Number of projects making reference to common evaluation methodology in their methodology definition, also beyond European projects after finalisation of the CEM.	CORDIS, CINEA, CCAM Knowledge Base, periodical survey, Project deliverables and results, assessment reports/surveys from CSA projects	Project Coordinators, Partnership association, National Member States representatives CSA	Baseline: good practices from the Knowledge Base on evaluation methodologies Extended Baseline: CEM ready for implementation by 2024 Target: 10 or more projects making reference to common evaluation methodology in their methodology definition, also beyond European projects by 2027
Exploit new and emerging knowledge fields for large scale demonstrations in 2027.	Number of projects developing and implementing new and emerging knowledge fields, such as cyber security, data sharing and AI, into CCAM solutions.	Cluster 5 RIA, CCAM Knowledge Base, TRIMIS	Project Coordinators, Partnership association	Baseline: Mapping of knowledge fields of the Cosmos project in 1. Quarter 2022 Target: 15 Horizon Europe projects addressing new and emerging knowledge fields like AI and cyber security in CCAM applications by 2027 (no baseline)
Expand and disseminate the knowledge base on CCAM solutions during the entire Partnership duration.	Number and regularity of updates of the CCAM Knowledge Base with projects and high qualitative content providing results and lessons learned	CORDIS, Partnership report (e.g. annual basis), Cluster 7 RIA,	CCAM Partnership Association	Baseline: Knowledge base in 2020 with 300 projects (covering projects as of 1996) Target: 400 or more projects in total by 2030 Baseline: 50% (all Eastern European countries, Portugal, Luxemburg, Ireland) of all the 26 European countries with projects are significantly under-represented in the Knowledge Base in 2021 with involvements in less than 8 projects. Eastern countries in particular are involved in average in 3 projects. With few exceptions (US and Japan), no project from outside EU is included in 2021. In 2021, the KB includes initiatives from EU, Norway, Switzerland and UK and very few initiatives involve US, Brazil, Canada, China, Japan, New Zealand, South Korea) Target: Increase the number of CCAM related projects from all Eastern European countries, Portugal, Luxemburg, Ireland and from non-European countries in the Knowledge Base by 2030.

7. CCAM Clusters

The CCAM Partnership will align perspectives from road users/consumers, public policymakers, road operators, and industry to make CCAM solutions and services ready for deployment and bring gains in safety, sustainability, efficiency and inclusiveness to the overall transport system.

A focal point of the CCAM Partnership approach is the design and development of a user-centred and all-inclusive mobility solution enabled through digitalisation and automation. The state-of-the-art technologies in 2020 are either limited in

- **speed (e.g. below 40 kph);**
- **operational domain (e.g. confined areas); or**
- **ability to handle complex traffic (e.g. motorway only);**
- **limiting ambiental factors.**

The ambition of the CCAM Partnership is to advance these technologies, systems and solutions, pushing these boundaries (i.e. **expanding the ODD**) that allow innovative and new Use Cases. Research and technological progress for vehicles, infrastructure and the entire transport system will push the limits:

- **higher speeds: 80 – 120 kph;**
- **extended operational domains: hub-to-hub transport; specific road class;**
- **complex traffic: urban driving;**
- **all weather conditions.**

However, a key challenge remains to ensure the safe system functioning; to design and prove that a complex CCAM solution; without the human driver as the major fallback role for the dynamic driving task, is functionally and operationally safe. A long transition phase is expected, with both conventional and CCAM vehicles with specific traffic management needs, ensuring good co-existence and vulnerable road users' protection. More efforts are required to enable and prove safe system functioning in larger operational design domains (ODD) due to the scaling complexity (i.e. **demonstrating maturity**). An unlimited operational domain seems unrealistic with the 2021 perspective on applicable state-of-the-art technologies (SAE Level 5 is a theoretical description of ultimate automation; it merely gives a direction and not a realistic outcome).

Use Cases specifies the requirements of a process or a business model and corresponds to a set of actions that in this case the CCAM solutions may perform in interaction with its users (and/or other actors/systems). This sequence of actions produces an observable result that contributes to the objectives of the actor(s) (e.g. move from A to B with reduced environmental impact). A Use Case is named according to the specific user-goal for its primary actor. Use Cases for CCAM solutions are mainly distinguished by the complexity of the traffic situations and/or vehicle speeds (linked to the ODD).

Operational Design Domains (ODDs) comprise various (also adverse) environmental and road conditions, the whole bandwidth of traffic scenarios as well as the infinite variety of technological solutions and their performance on the road including external data sources from physical and digital infrastructure support in various levels. Differences in terms of type and maturity of CCAM systems and services in the different geographical areas are expected.

The CCAM Partnership will achieve Deployment Readiness for specific Use Cases in the short-/ medium-term (3-5 years) or long-term (7-10 years) by **expanding the ODD** and **demonstrating maturity.** The selection of Use Cases (and their ODDs) for demonstrations (in short, medium and long-term) are not predefined, allowing agile and open innovation processes, considering new mobility services and solutions. Less complex Use Cases as driving on highways or in confined areas as well as low speed applications in mixed traffic will be earlier ready for deployment. Driving at higher speeds in mixed city traffic and in peri-urban environment due to scaling complexity (see above) will come later. The overall goal and long-term ambition for CCAM is providing services and solutions for passengers and freight in as many application areas as possible.

These challenges require three steps:

(1) understanding user and societal needs,

(2) advancing technologies, and

(3) demonstrating the maturity at a large scale.

Large-scale Demonstrations in Pilots, Field Operational Trials (FOTs) and in Living Labs (see definitions in Chapter 7.1) provide enough evidence for showing Deployment Readiness and partnership's success (step 3). These demonstration activities close the loop in the co-creation process by proving the match between user needs and societal requirements, providing relevant data for impact assessments, and accelerating the technical development process. They support the uptake of innovative mobility solutions and/or logistics services with connected and highly automated vehicles for passenger and freight transport.

A fully integrated Large-scale Demonstration within Living Labs across Europe with many mobility Use Cases (shared and individual) covering needs for people and goods transportation will achieve:

- **004**: Demonstrate inclusive, user-oriented and well-integrated mobility concepts enabled by CCAM with a reduced carbon footprint and reliable predicted travel times;
- **005**: Demonstrate new freight and logistics concepts and services enabled by CCAM with a reduced CO_2 emission per tonne-km, further reducing congestions;

and, provide ample evidence for **006**: Societal impacts (e.g. safety, efficiency, environment) and wider economic impacts are sufficiently assessed, addressed, and accepted.

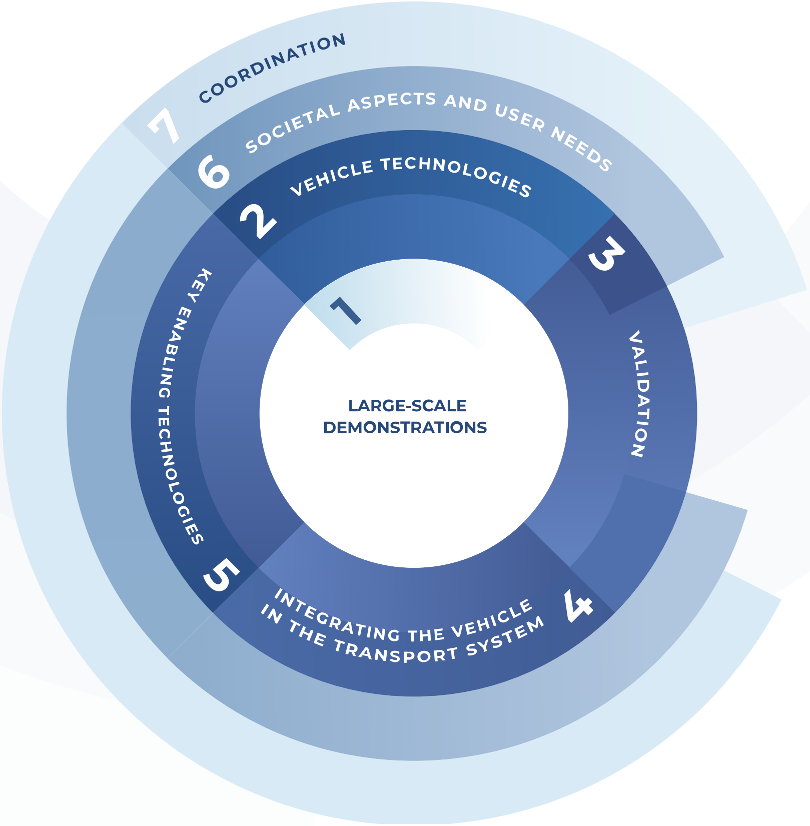


Figure 9: The seven CCAM clusters

The CCAM Cluster structure (see Figure 9) shows the links between specific R&I actions and the progress towards the Operational Objectives (Chapter 5, see Figure 10: Clusters contributing to achieving the Operational Objectives (OO) of CCAM.) of the Partnership. The Clusters are interlinked and each Cluster provides input to other Clusters. Together they form a comprehensive framework for achieving the Partnerships' Specific and General Objectives and delivering the expected impacts.

The starting point is the understanding of the **user needs and societal aspects** of mobility (see description Cluster 6), advancing technologies (see Cluster 2, Cluster 4 and Cluster 5) and demonstrating the maturity at a large scale (see Cluster 1 and Cluster 3).

Key enabling technologies (see Cluster 5) are needed to enhance solutions. These will be implemented together with future **vehicle technologies** for sensing, sensor fusion and enhanced safety systems (see Cluster 2). The overall transport system integration complements safe human-machine interaction to understand the requirements and needs for traffic and fleet management and provide physical and digital infrastructure support (see Cluster 4).

Before **demonstrating at a large scale** (see Cluster 1), safe and resilient system functioning needs to be validated (see Cluster 3). All activities are linked through **coordination** (see Cluster 7) of all relevant stakeholders, ensuring alignment, interoperability and accelerating innovation uptake.

Cluster 1: Large-scale Demonstration. The objective of Cluster 1 is to continuously implement results of all other Clusters into Large - scale Demonstrations in Pilots, FOTs and Living Labs supporting deployment readiness and a final impact assessment.

Cluster 2: Vehicle technologies. This Cluster aims to deliver the most efficient and effective future solutions which have been proven to be safe and reliable. For Europe's future mobility and transport system, significant technical research and innovation challenges must be overcome since tomorrow's highly automated vehicles will rely on advanced solutions to "sense-think-act', enabling safe interaction with other road users and providing protection in the case of emergency, while also ensuring the well-being of the vehicle occupants.

Cluster 3: Validation. This Cluster will provide the procedures, methodologies and tools which are needed for validating, verifying and rating CCAM systems, in terms of both technology itself and human factors handling the technology. This will include suitable metrics and references for system behaviour and performance.

Cluster 4: Integrating the vehicle in the transport system. The research and innovation projects in this Cluster will advance the physical and digital infrastructure support for CCAM vehicles and improve connectivity and cooperation between actors, which will support the integration of CCAM vehicles in the overall transport system so that fleet and traffic management systems can be enhanced.

Cluster 5: Key enabling technologies like Artificial Intelligence, Big Data and cybersecurity will support the whole mobility system consisting of vehicle technologies, integrating the vehicles in the transport system, as well as the validation of all aspects of the entire system. Cluster 5 is embedding the "Key enabling technologies" with technical details, contributions, requirements and risks for Cluster 2, 3 and 4.

Cluster 6: Societal aspects and user needs. This Cluster delivers the framework for understanding and taking into account user and citizen needs, and societal aspects of mobility to all other Clusters. Methods and measures for societal impact assessment will be developed and applied when executing the final societal impact assessment from Cluster 1 results.

Cluster 7: Coordination. This Cluster is coordinating all CCAM stakeholders and activities, facilitates knowledge exchange und enables lessons learned.

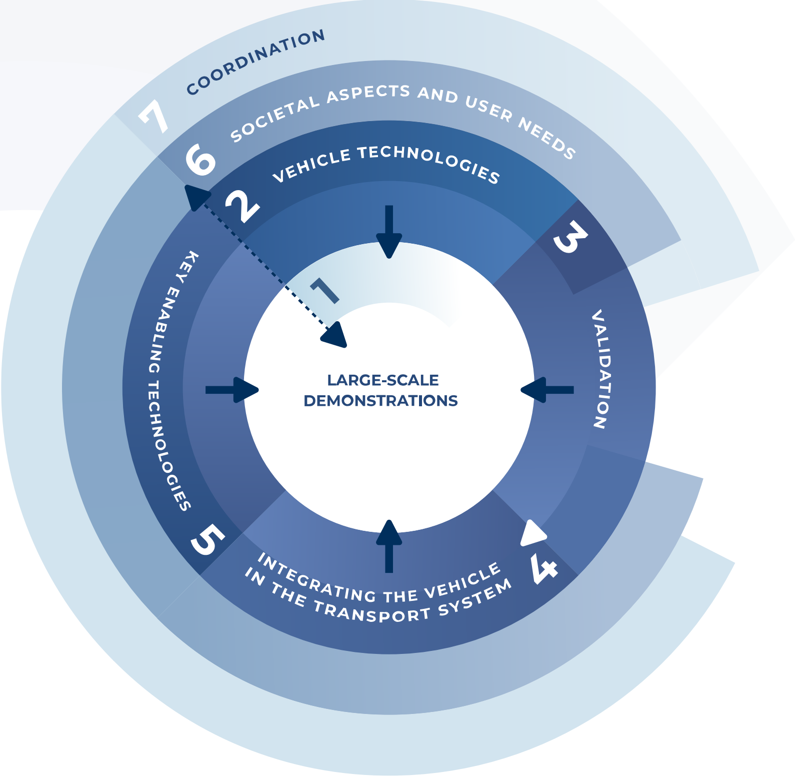
Each Cluster contributes to delivering the Operational Objectives of the CCAM Partnership as described in the following subchapters in more detail. This description includes a state of the art; an overview of required R&I actions; a timeline description; and the expected outcomes by the end of the CCAM SRIA time frame (i.e. 2030).

			Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
2021	007	Establish a long-term coordination framework for R&I and large-scale testing activities.	✓	✓	✓	✓	✓	✓	✓
2021	009	A common evaluation framework fostering exchange and reuse of R&I results by 2024.							✓
	003	Common methodologies available to validate the safe svstem function of CCAM use cases by 2026.		✓	✓	✓			
	008	Improved synergies between public and private investment plans to advance vehicle and infrastructure technologies.				✓			
	002	Accepted safety standards for automated mobility on public roads by 2027.			✓				
	0010	Exploit new and emerging knowledge fields for large scale demonstrations in 2027.					✓		
2027	001	Enable trustworthy interaction between all traffic participants and CCAM.		✓	✓	✓	✓		
	004	Large-scale demonstration of user-oriented and well-integrated CCAM solutions for moblity or people and goods in at least 30 demonstratior sites across Europe by 2030.	✓					✓	
	006	Increased public awareness demonstrated benefits for users and society by 2030.	✓					✓	
	005	Societal impacts are sufficiently addressed and assessed by 2030.	✓					✓	
2021	0011	Expand and disseminate the knowledge base on CCAM solutions during the entire Partnership duration.	✓	✓	✓	✓	✓	✓	✓

Figure 10: Clusters contributing to achieving the Operational Objectives (OO) of CCAM.

7.1. Cluster 1: Large-scale Demonstration

Introduction



CCAM solutions shall provide a more user-centred, all-inclusive mobility, while increasing safety, reducing congestion, harmful emissions and contributing to decarbonisation. Novel mobility services can enable seamless integration with existing services (e.g. public transport, logistics), and higher levels of automation are expected to support transport productivity and efficiency (e.g. transportation of goods at lower speeds to save energy, operational efficiency at logistics hubs and in hub-to-hub corridors or last mile operations). Yet, all these benefits need to be proven as well as demonstrating the technical maturity of the CCAM solutions. Previous and currently (in 2021) ongoing demonstration projects for individual and shared mobility for CCAM systems and services covering needs for transporting people and goods show that further testing of highly automated systems with high-scaling potential is necessary.

The objective of Cluster 1 is to ensure that the results of all other Clusters are capitalised and implemented into Large -scale Demonstrations in Pilots, FOTs and Living Labs to support deployment readiness and a final impact assessment. Cluster 1 will:

- Build on CCAM technologies, methods, systems and services developed in Cluster 2, 3, 4 and 5.
- Leverage on results from all Clusters by implementing and well integrating concepts in real life conditions, while involving key stakeholders such as, end users in their daily life, vehicle industry, public authorities, public and private operators, service providers, telecom, logistics etc.
- Align with Cluster 6 in order to consider society needs and expectations, assess the impacts of inclusive user-oriented integrated personal and shared mobility as well as freights and logistics new concepts enabled by CCAM with a reduced carbon footprint and reliable predicted travel times.
- Coordinate with Cluster 7, as overarching cluster, to link the R&I and testing activities across Europe in achieving a successful cross-sector collaboration between all stakeholders.
- Provide feedback and lessons learned to all Clusters, reporting on limitations of used technologies and/or proven maturity.

Advancing the State of the Art

Starting from the EU projects under Horizon 2020, AVENUE, L3PILOT and ENSEMBLE have covered the three development paths present in the ERTRAC roadmap (shared and individual mobility as well as trucks and goods). The project SHOW will extend these with a strong service orientation. The projects AWARD[50] and Hi-DRIVE[51] will demonstrate extended ODDs in Large-scale Demonstrations and include more Use Cases. All these projects build a solid framework on necessary preconditions for higher automation levels.

AVENUE[52] trials start with low-speed public transport applications on low complexity surroundings in different locations. The limited Use Cases with the ambition to go for on-demand mobility services address also elderly and handicapped persons.

L3PILOT[53] has set up an open testing methodology including data exchange formats and a code of practice, for piloting SAE Level 3 vehicles that guides through the complete development of automated technology with a focus on testing. The results from testing automated valet parking and highway automation features will support the further research work on SAE L4 Parking and SAE L3 Highway driving.

ENSEMBLE[54] showed various approaches to truck platooning support functions as well as strategic insights into truck automation ongoing. Also, the work on impact assessment will be very important. In each of these projects you can see that there are still many R&D challenges: the technology is moving forward but there are still many substantial efforts to be done.

SHOW[55] aims at supporting the migration path towards affective and persuasive sustainable urban transport through technical solutions, business models and priority scenarios for impact assessment, by deploying shared, connected, electrified fleets of L4 automated vehicles (buses, shuttles, pods, robo-taxi, automated cars and cargo vehicles) and for all operators in coordinated Public Transport (PT), Demand Responsive Transport (DRT), Mobility as a Service (MaaS) and Logistics as a Service (LaaS) operational chains in real-life urban demonstrations taking place in more than 20 cities across Europe.

The building blocks on user aspects, regulatory considerations, impact assessment, safety and cybersecurity requirements – to name the most important ones – will be implemented by Cluster 1 to plan and direct the Large-scale Demonstrations in the future towards the CCAM Partnership objectives. All other Clusters in CCAM will provide input and contributions into this process.

R&I Actions and Expected Outcomes

The R&I Actions in Cluster 1 bundle all Large-scale Demonstration activities in the CCAM Partnership, moving towards Deployment Readiness. The actions demonstrate CCAM solutions in urban, inter-urban, sub-urban/peri-urban environments and eventually smaller towns. Demonstrating automated mobility operation providing transportation for people and goods will make a big step forward to test and evaluate new operational and business models in realistic scenarios. The integration of CCAM solutions in Large-scale Demonstrations all over Europe will foster harmonisation and interoperability while facilitating co-creation with society, showing benefits and fostering adoption of new mobility services.

A structured approach will be applied to fulfill this ambitious objective of the central Cluster 1.

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[50] https://cordis.europa.eu/project/id/101006817

[51] https://cordis.europa.eu/project/id/101006664

[52] https://h2020-avenue.eu/

[53] https://www.l3pilot.eu/

[54] https://platooningensemble.eu/

[55] https://show-project.eu/

The demonstrated Use Cases in Cluster 1 will further

- increase speed limitations, and/or
- increase operational domains, and/ or
- increase complexity of driven maneuvers and handling of more complex traffic situations

by integrating results from Cluster 2, Cluster 4 and Cluster 5 (expanding the ODD).

These Use Case(s) will be demonstrated at a large-scale under real-world conditions, in Pilots and Field Operational Trials (FOTs) in Living Labs (see definitions below).

The CCAM Partnership defined Pilots, FOTs in Living Labs as:

- **Pilots (TRL 6-7)** are used for integrating and testing a number of technological enablers and demonstrate their safe use in combination. The pilots are used to prove with prototype vehicles and applications the safe functioning of the solution with test drivers in operational environments.
- **FOTs in Living Labs (TRL 8)** are used to enhance user acceptance and adoption by demonstrating functionality to end-users. FOTs in Living Labs are closer to deployment, delivering detailed test data that is comparable to real life data with impacts on users and the potential of technologies for adoption. In the CCAM Partnership, FOTs in Living Labs provide the entire infrastructure (including connectivity), mixed dynamic traffic environments and users and communities with vehicles from small-series production with fully integrated functionality and user interface. These demonstrations emphasize quality-of-service and usability as well as impacts on everyday life of citizens further exposing the technologies towards society. They provide validated data to evaluate the capabilities, benefits, risks and limitations of CCAM solutions in comparison to today´s traffic to shape the basis for the impact assessment.

The technical maturity of the Use Case (TRL) defines whether a Pilot test or a FOT in Living Labs should be used for the Large-scale Demonstration. Highly challenging Use Cases in mixed traffic (e.g. high-density inner-city traffic, or on rural roads) are expected to follow the simpler and less complex Use Cases (see above). Already mature technologies for Use Cases in limited ODDs (e.g. from Horizon 2020 ART Projects), could be demonstrated with FOTs in Living Labs (TRL8), proving functionalities and impacts with communities and society.

Integrating results from Cluster 2, Cluster 4 and Cluster 5 (e.g. infrastructure support functions, next generation of sensor technologies, high on-board/off-board computing power and AI algorithms for more complex Use Cases) will be first demonstrated in Pilots to evaluate the safe system functioning (safety and robustness of systems). These Use Cases facilitate higher levels of automation and connectivity to support transport productivity and efficiency (e.g. transportation of goods at lower speeds to save energy, operational efficiency at logistics hubs and in hub to hub corridors or last mile operations). More specifically, knowledge on human factors and user adoption as well as safety relevant information will be made gathered.

In the third (final) phase of CCAM Partnership programme Cluster 1 will demonstrate the full potential of new solutions and business models as well as facilitating (ex-post) assessment of societal impacts (Cluster 6). This requires a framework for public procurement of new road transport services, facilitating the uptake of new businesses and operational models.

For all R&I Actions in Cluster 1, public and private stakeholder collaboration will be needed to achieve the common objectives. European wide demonstrations, including non-homologated vehicles and applying a common testing regulation framework (see Cluster 7), will deliver evidence for Deployment Readiness with quantitative data for ex-post impact assessments (Cluster 6).

Expected outcomes

- Demonstration of inclusive, user-oriented and well-integrated shared CCAM systems and services for people and goods in real traffic conditions (see CCAM-1).
- Evidence on expected impacts for safety, environment, health, economy, land-use considering of the evolution of mobility services for people and goods through testing of relevant Use Cases and ODDs that both match society needs and expectations, making the traffic and transport system more efficient.
- New market opportunities and new business models identifying and reflecting on end-users needs for integrated, co-created and convincing business models, leveraging the return-on-investment potential of innovative cross-sector CCAM.
- Inclusion of all relevant stakeholders[56] needed to demonstrate CCAM for individual and shared mobility of persons and goods.
- Strengthen the close link with users and society facilitating co-creation, adoption and up-take of CCAM addressing risks, reservations and anxieties of citizens.
- Interoperability including cross-border functionality all over Europe.
- Harmonisation of definitions in the various approval frameworks of testing license procedures across countries and regions on public roads.
- Encouraged development of a standardised procedure for homologation independent of OEM or supplier and promote the framework for public procurement of new public/shared road transport (e.g. pods, shuttles).
- Training and education concepts for professional drivers and private citizens including costs related to retraining current drivers.

Timeline

The different R&I Actions in Cluster 1 depend on the technical maturity of the Use Case and the complexity of its ODD. We define 3 levels that advance through time in maturity and robustness from TRL 6 for Pilots to TRL 8 in FOTs in Living Labs (see Figure 11: Cluster 1 R&I Actions over the Partnership Programme timeline.):

Stage 1 - "Selected Use Cases in limited ODD": This level represents the 2021 state of the art technologies used in European Pilot actions. Demonstration actions in Stage 1 facilitate Use Cases within "limited ODDs" (for example slow speeds, or in confined areas, or with less complexity). With the end of Horizon 2020 Pilot projects, and their results demonstrating the safe functioning, reliability, and robustness in limited ODDs, the Stage 1 Use Cases could advance to demonstrations with FOTs in Living Labs (TRL8).

Stage 2 - "Combined Use Cases in extended ODD": Use Cases in Stage 2 work within an increased ODD (compared to Stage 1) by further integrating results from Cluster 2, 4 and 5. These Use Cases cover extended ODDs with increased complexity, yet limited domains. These CCAM solutions will then firstly (from 2023 onwards) test safety, reliability and robustness in operational environments through Pilot testing. After successful Pilot testing, these Use Cases could be implemented in FOTs in Living Labs from 2026 onwards and demonstrate the functionality and impacts to end-users while facilitating adoption. These FOTs will differ in users, society, business and operational demands.

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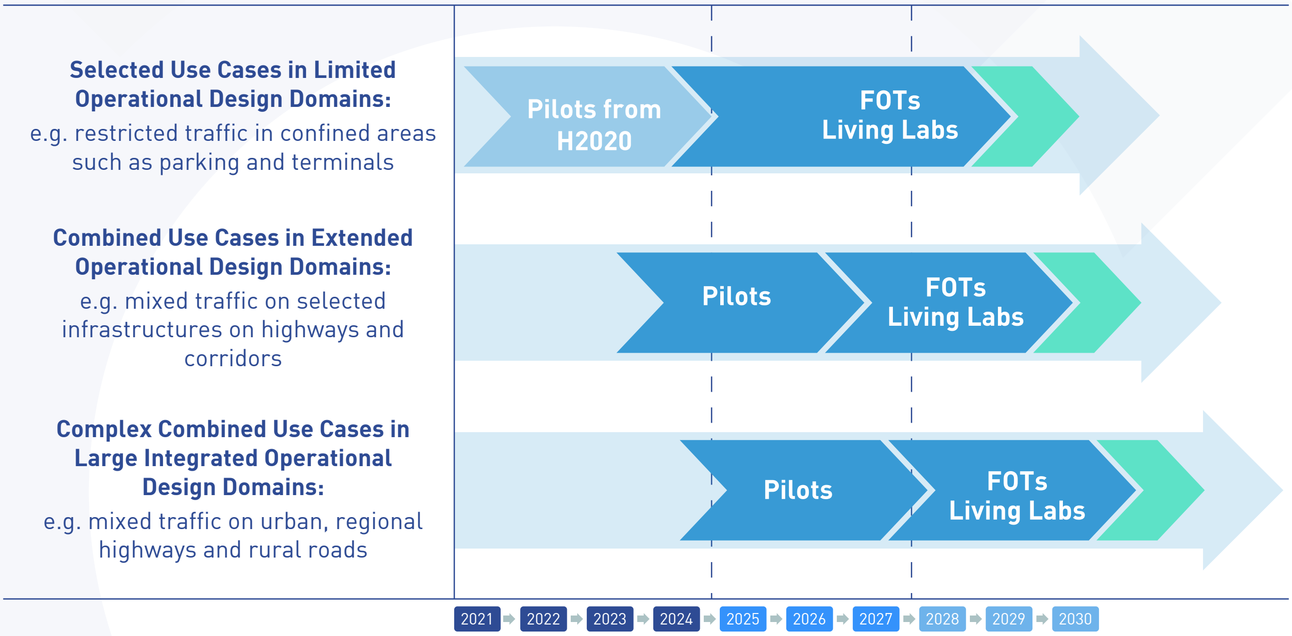
[56] Private and commercial end-users, all participating industries, transport/mobility operators for persons and goods, as well as public authorities including ports, terminals, cities and municipalities

Stage 3 - "Complex combined Use Cases in large integrated ODD": This Stage 3 facilitates many complex Use Cases in a large integrated ODD covering different road categories at their speed limits, handling complex urban traffic, adverse weather conditions, road constructions and tunnels, etc. This level will further integrate results from Cluster 2, Cluster 4 and Cluster 5 while building on Use Cases from Stage 1 and Stage 2 as well as new identified Use Cases enabled through the large integrated ODD.

In the third phase of the CCAM Partnership Programme (from 2027 onwards), the stakeholders will implement a Large-scale Demonstration action with FOTs in Living Labs all over Europe, integrating many Use Cases and new mobility services in a complex large integrated ODD .

Cluster 1



Selected Use Cases in Limited Operational Design Domains:
e.g. restricted traffic in confined areas such as parking and terminals

Combined Use Cases in Extended Operational Design Domains:
e.g. mixed traffic on selected infrastructures on highways and corridors

Complex Combined Use Cases in Large Integrated Operational Design Domains:
e.g. mixed traffic on urban, regional highways and rural roads

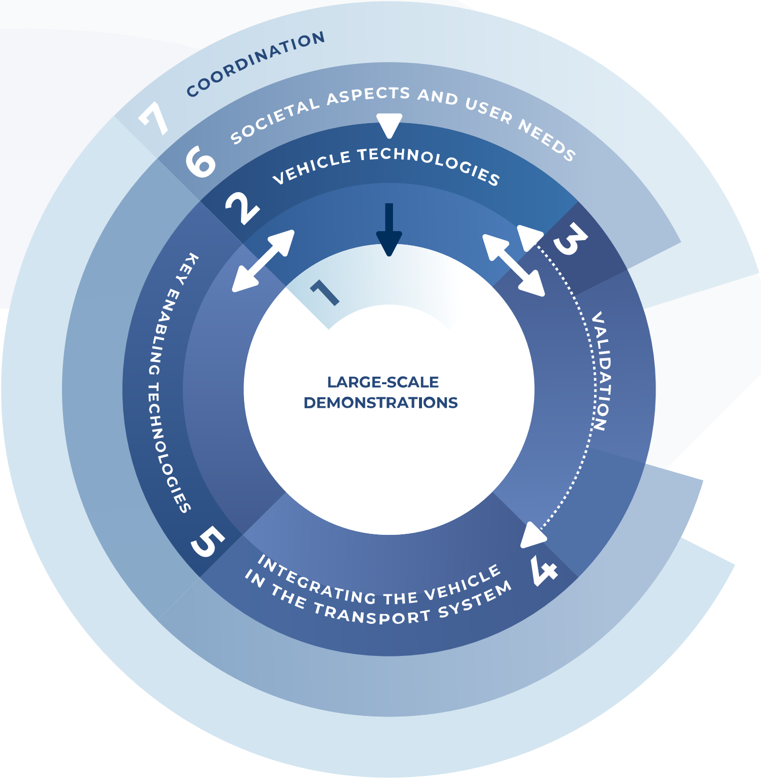
Figure 11: Cluster 1 R&I Actions over the Partnership Programme timeline.

7.2. Cluster 2: Vehicle Technologies

Introduction

Cluster 2 “Vehicle Technologies” focuses on the development of technologies on-board of connected and automated vehicles (CAVs) to perceive the environment and take decisions, enabling safe interaction with other road users and providing protection in the case of emergency while also ensuring the comfort and well-being of the vehicle occupants.

Robust and accurate environment perception is absolutely essential for highly automated vehicles to enable the extraction of reliable information for real-time driving decision-making which must be performed in a safe and unambiguous way, concentrating on the combination of system, human and environment status within the framework of digital traffic rules.



Cluster 2 will

- Deliver vehicle technology ready for demonstration on public roads, including functional safety[57], safety of the intended functionality[58] and cybersecurity (to Cluster 1).
- Provide recommendations for a European Statement of Principles (ESoP) for automated vehicles have been elaborated to enable conformity checks (to Cluster 3).
- Provide improved vehicle technologies (e.g. sensor fusion, on-board decision making) contributing to better performance of vehicle-transport system integration (to Cluster 4).
- Specify vehicle technology needs for advancing e.g perception capabilities through key enabling technologies (to Cluster 5).

Indeed, safe and reliable CCAM solutions will not be feasible without robust and accurate environment perception technologies.

Essentially, comprehensive environment perception capabilities are required that can reliably identify, track, and discriminate between benign and hazardous objects in the path of the vehicle under the full range of environmental conditions in which the vehicle is intended to operate (e.g. adverse weather and lighting conditions).

A significant technological challenge is presented by the wide variety of traffic participants with completely different characteristics that might enter the viewing area of the sensors, thus enforcing

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[57] ISO 26262-1:2018 Road Vehicles – Functional Safety, https://www.iso.org/standard/68383.html

[58] ISO/PAS 21448:2019 Road Vehicles – Safety of the intended functionality (SOTIF), https://www.iso.org/standard/70939.html

the need for a multitude of different sensing devices with different attributes depending on the specific task. To address this challenge, a variety of technical solutions have been adopted to date, the result being that a multitude of different sensor set-ups exist which vary considerably in terms of the number and type of sensors and their positioning on the vehicles.

Essentially automated driving requires that multiple systems interact with each other within a "Sense-Think-Act" process: The vehicle needs to perceive all surrounding objects and localise itself in the environment ("environment perception") before selecting all relevant objects to be considered for the subsequent motion planning task ("decision-making"). Hence the vehicle systems need to take into account not only the current situation, but also predict the relative movement of the ego-vehicle (the vehicle equipped with the automated functionality that performs the Dynamic Driving Task autonomously) with respect to all relevant objects.

Advancing the State of the Art

Several different sensing sources (using technologies including radar, lidar, ultrasonic sensors, cameras, etc.) can be aggregated with "sensor-fusion" to enable the vehicle to perceive its surroundings before function-specific software uses the information as input to think and act appropriately, deciding which actions the vehicle shall take before executing them accordingly. A series of recent and on-going EU projects have addressed environment perception and on-board decision-making, and the development of relevant technologies.

The **RobustSENSE**[59] project focused on introducing reliable, secure and trustable sensors and software by implementing self-diagnosis, adaptation and robustness, developing metrics to measure sensor system reliability on every level of assistance and automation systems.

Research on how to deal with the variety of environmental conditions has been performed in the **DENSE**[60] project, the objective being to develop and validate an all-weather sensor-suite for traffic services, driver assistance and automated driving. The new sensor-suite is based on a smart integration of three different technologies to demonstrate the potential of all-weather environment perception: radio radar, gated short-wave infrared camera with pulsed laser illumination, and short-wave infrared LIDAR.

The **Dreams4Cars**[61] project aimed at setting up an offline simulation mechanism in which robots can produce a simulated world by recombining aspects of real-world experience, collectively interacting to safely develop and improve sense-think-act systems, focusing in particular on the analysis of rare events.

In addition to perceiving the surrounding environment, locating the ego-vehicle in this environment is an important step for the execution of automated driving functions, requiring the utilisation of advanced digital mapping technologies.

As the amount of data and information increases with higher levels of automation, so too does the need for more computational power with new software required to handle and process the data, increasingly involving AI and Machine-Learning techniques. Such software-intensive systems must be designed to provide very high safety levels so that the rate of errors in the requirements, specifications, and coding is sufficiently low for the system to be effectively as safe as, or safer than, human driving.

For future, highly automated vehicles in which the human driver cannot be considered as a backup, systems must be "fail operational" such that, in the event that the limit of the Operation Design

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[59] https://robustsense.eu/

[60] http://www.dense247.eu/

[61] http://www.dreams4cars.eu/

Domain (ODD) is reached, the vehicle brings itself into a into a safe state with a minimum risk manoeuvre. Hence the automated driving system must be provided with comprehensive fault detection, identification and accommodation capabilities so that malfunctions can be immediately diagnosed and enable switching to a fall-back mode of operation in order to ensure safety.

Active safety functions need to enable automated vehicles to navigate safely in both expected and unexpected scenarios, with advanced passive safety systems also being required to protect passengers in new, unconventional seating positions.

In practice, highly automated vehicles will bring new challenges in terms of traffic rules and new regulations may be needed. In this context, the EU Project OSCCAR[62] is applying a comprehensive, integrated approach for the development of future advanced occupant protection systems, providing a unique human body model -based development and assessment framework. With respect to a wide range of relevant accident scenarios for mixed traffic, the aim is to address the challenges posed by demographic changes and ageing population, and future vehicle interior designs with new occupant sitting positions, etc.

Additionally, new challenges arise with higher levels of automation which require a specific focus on the human-machine interaction (HMI), such as handing over the driving task between automated and manual driving which may be opportune in the event that the limit of the ODD is reached. The functional interaction between automated vehicles and the driver must be designed in a safe and intuitive way in terms of task division as well as with respect to the minimum time required to resume manual control.

HMI solutions should ensure transparent communication between the vehicle, the driver and the other road users in order to clarify responsibility for the driving task and avoid mode confusion. These objectives can be supported by the harmonisation of key HMI aspects which should be based on the results of R&I studies for higher levels of vehicle automation. In this context, the HADRIAN[63] project addresses the driver's role in Connected and Automated Vehicles by developing a holistic driving system solution, focusing on the utility of dynamically adjusting human-machine interfaces that take environmental and driver conditions into account.

Freeing the driver from the need to be regularly coupled to the vehicle controls, effectively becoming a passenger in the autonomous vehicle, increases the risk of experiencing motion sickness which can also jeopardise driving performance in the event of taking back control of the vehicle; hence automated vehicles should minimise this risk by ensuring a smooth ride.

In terms of achieving of high-levels of acceptance and adoption of CCAM with a variety of different types of private and public vehicles, it is also essential to understand and optimise the on-board experience and overall satisfaction of all users in terms of comfort, well-being, safety and security. In this regard, the approach being taken by the BRAVE[64] project is to assume that the launch of automated vehicles on public roads will be successful only if a user-centric approach is adopted where the technical aspects go hand-in-hand with compliance in terms of societal values, user acceptance, behavioural intentions, road safety, social, economic, legal and ethical considerations.

Indeed, automation will add new opportunities and challenges in terms of comfort and on-board physical well-being. At the same time, automated public transport vehicles that do not require a human driver onboard will generate new challenges in terms of ensuring the safety of passengers and their protection from possible threats and unsociable behaviour e.g. criminal acts including assaults, harassment, vandalism, theft etc. while meeting new potential users' demands in terms of comfort and privacy.

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[62] http://www.osccarproject.eu/

[63] https://hadrianproject.eu/

[64] http://www.brave-project.eu/

R&I Actions and Expected Outcomes

Correspondingly, the specific R&I actions relating to "Vehicle Technologies" are the following:

- **Environment perception technologies for CCAM**

Robust and accurate environment perception is essential for highly automated vehicles. Vehicle environment and traffic scenario perception systems are required to enable the extraction of reliable information for real-time decision-making including sensor fusion. On-board sensor systems are available for partially automated driving for specific Use Cases and ODDs. Considering more extensive safety requirements going along with higher levels of automation and strong demand for multiple applications in less limited ODDs, there is need for significant further progress in innovation in environment perception technologies.

- **Safe and reliable on-board decision-making technologies**

Advanced on-board decision-making functionalities are required to handle the diversity of Use Cases in their respective operational domains while guaranteeing the safety, reliability and conformity of future automated vehicles which will integrate complex in-vehicle systems-of-systems with advanced sensors, control and actuators, relying on extensive computational power.

- **Preventive and protective safety for highly automated vehicles**

To exploit the potential of CCAM in terms of improving the safety of the transport system as a whole, on-board systems need to anticipate risks reliably, prevent crashes and minimise the consequences of unavoidable collisions. Furthermore, provision of the required technologies must be accompanied by the development of suitable assessment tools for the newly developed prevention and protection systems while supporting the definition of standards as well as the potential needs for traffic rules adaptation.

- **Human Machine Interaction (HMI) development for on-board CCAM technology**

The design of vehicle technologies must focus on enhancing user acceptance, and generating trust and reliance on automated systems through well-designed, user-relevant and informative human-machine interfaces which allow intuitive and seamless transfer of control between the driver and the vehicle, while also responding to the needs of all users.

- **Addressing User-Centric Development of CCAM**

As the driving task is gradually delegated to the car, and as shared mobility becomes increasingly accepted and practiced, understanding and optimising the on-board experience and overall satisfaction of users, particularly in terms of inclusiveness, comfort, well-being, privacy and security, through the user-centric design of future road vehicles will be paramount for the widespread adoption of CCAM.

On the basis of these R&I actions, the expected outcomes include:

- Determination of appropriate, accurate, robust, reliable, cost-effective sensor-suite compositions (enabling safe and reliable Connected and Automated Vehicles, in all conditions and environments, with expanded ODDs); ability to perform advanced environment and traffic recognition/prediction (supported by big data and digital maps with dynamic real-time information), limiting false or non-detections of threats, focusing on VRUs; improved data fusion with infrastructure-based sensing and other vehicles; standardisation mandate for performance requirements.

- Capacity to determine the appropriate course of action in an open-world context with a wide range of traffic scenarios, respecting traffic rules; ability to perform state prediction to take timely actions and prevent activation under unsuitable conditions; determination of the required control system performance and quality/quantity of data needed to describe complex traffic scenarios, considering also human behaviour, with remote software updates.
- Reliable technologies for advanced safety systems to prevent crashes or minimise the consequences of unavoidable accidents, including improved minimum risk manoeuvres; protection systems designed for unconventional seating positions and body postures, ensuring inclusiveness, considering all situations/conditions while taking into account different crash configurations in mixed traffic; consistent design methodologies and tools for performance assessment of the new protection systems; evidence-based support to regulatory bodies for the potential adaptation of traffic rules.
- Advanced HMI solutions enabling the safe, efficient co-existence and interaction of Connected and Automated Vehicles in mixed traffic (VRUs included); reliable, seamless interfaces based on comprehensive knowledge and models of human behaviour/capabilities; monitoring systems and simulation models to assess/predict driver status; improved HMI functionalities to prepare the driver to take control (e.g. when the vehicle nears the ODD limit).
- Vehicle technologies and solutions which assess/optimise the on-board experience in terms of well-being, security and privacy, with improved design, ensuring inclusiveness and preventing dangerous/uncomfortable situations; training and information campaigns.

Timeline

All planned R&I actions of this cluster start early on. The actions advance during the CCAM Partnership timeline towards testing and implementation in Cluster 1. Expected outcomes will also support the Validation activities and facilitate the Integration of the vehicle in the transport ecosystem as well as defining requirements for key enabling technologies. Innovation Actions will follow and advance technical maturity and progress the state of the art after the first phase, delivering mature results ready for testing/implementation. The following image aims at making this progression process transparent.

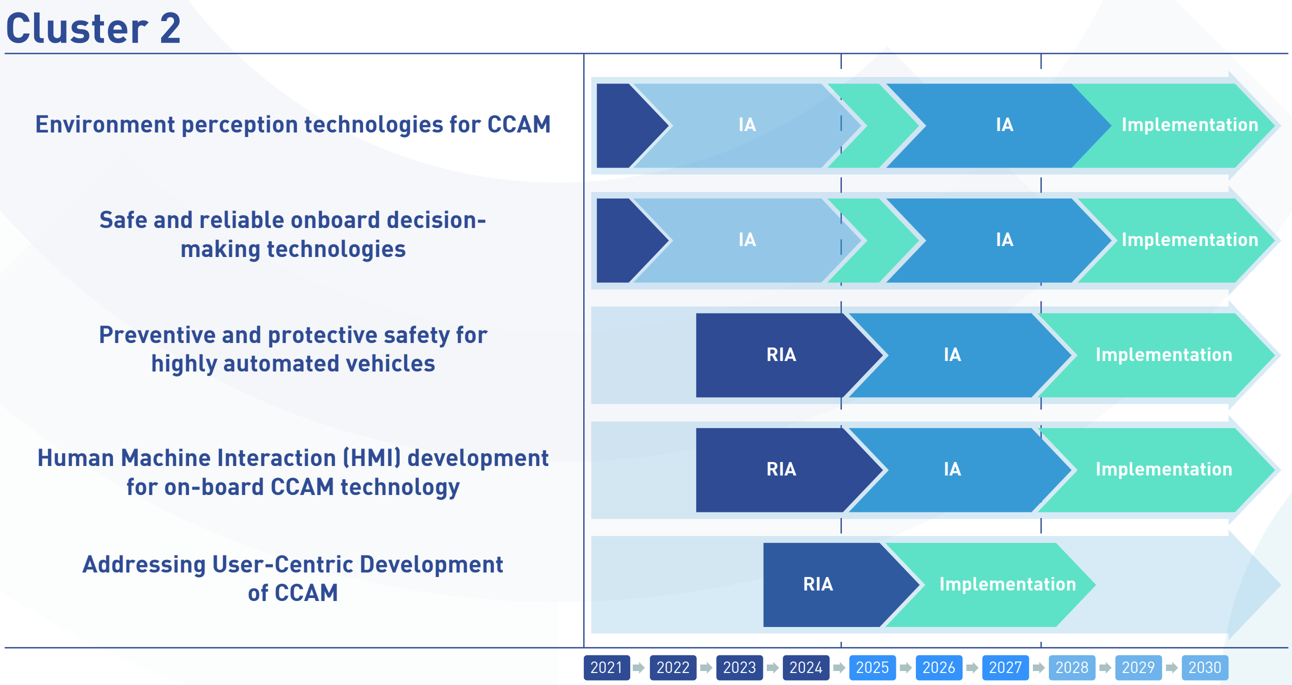
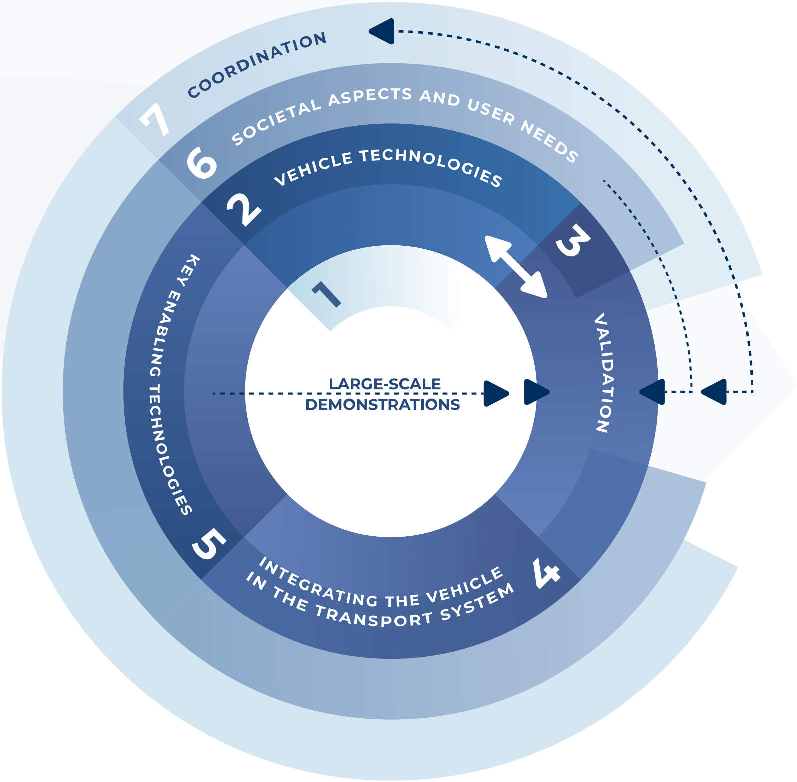


Figure 12: Cluster 2 R&I Actions over the Partnership Programme timeline.

7.3. Cluster 3: Validation

Introduction



The successful implementation of CCAM depends mainly on its acceptance and adoption in society. The decisive factor will be assuring the effective safety of CCAM. Therefore, the validation of the vehicles' automated driving functions and of their operation in the intended ODD is forming an important cluster in the portfolio of activities of the CCAM Partnership.

Cluster 3 will provide

- Validation methods applicable and recommendation of validation maturity necessary for FOTs and Living Labs, as described under "Large-scale demonstrations" above (to Cluster 1).
- Validation methodologies for application to vehicle technologies (to ensure the safe operation of CAVs and enable societal acceptance) (to Cluster 2).
- Requirements for validation methodology for cyber-security of CCAM (to Cluster 5).

Higher levels of automated driving require scenario-based validation methodologies following hybrid approaches with physical and virtual testing. This is necessary to reduce the high number of test kilometres needed for safety validation specifically with more complex ODDs. The key R&I action in this cluster, "Future-proof methodologies and tools for validation", addresses this need and also considers the possibility of updates of functions during the whole vehicle lifecycle as well as self-learning capabilities of future automated driving systems. Next to the safety of the intended functionality, this R&I action addresses the functional safety of such systems and will incorporate the results from cluster 5 with regard to the validation for cyber-security. It also includes the development of a commonly accepted and harmonised simulation environment for the virtual testing of CCAM functions and systems in their connectivity context.

A challenge for scenario-based validation will be identifying and considering all relevant critical scenarios with their probability of occurrence. This challenge is addressed by another R&I action in this cluster aiming at the establishment of an "EU wide database of relevant scenarios for validation". The scope of this R&I action covers the derivation, definition and collection of safety-critical scenarios for CCAM systems and their sharing as a basis for the verification, validation and assessment of CCAM systems in industrial development processes, in future type approval schemes and in consumer testing campaigns. The action will build upon the "Future-proof methodologies and tools for validation" and will also make use of the "Test data exchange framework" from cluster 7 as well as the "System architecture for data sharing" from cluster 5. At the same time, the EU wide database of relevant scenarios for validation will be linked to the "EU wide knowledge base" to be developed in cluster 7.

Validation will also need to take in into account human factors. This applies to human-technology interaction as well as to the understanding of human driving performance as a reference for the CCAM systems' performance in reducing the number of fatalities and crashes. A specific R&I action developing a "Human reference for automated driving" validated by real-world tests will serve the latter purpose. Such a reference model of the performance spectrum of human drivers will allow a direct comparison to an automated driving system in the simulation of a specific situation and thus support the deployment of the results from the R&I action "Future-proof methodologies and tools for validation". Together with results from cluster 6 on societal and user needs, it will also form the basis of developing a common understanding of the required safety and reliability level of CCAM and support the definition of an acceptable behaviour of automated driving functions in mixed traffic.

Since safe human-vehicle interaction is an important element of the safety of highly automated driving systems, there is also a need for harmonised HMI designs as well as harmonised HMI testing and validation, which is addressed by a fourth R&I action in this cluster on "Specific HMI testing and validation procedures, methods and tools for higher levels of automation". This applies both to driver-vehicle interaction and to the interaction with other road users, for which new intuitive interaction principles will be needed, when the human driver is not involved in the control-loop of the vehicle. This R&I action will profit from close cooperation with the "HMI development for CCAM" in cluster 2 and complement the results from the R&I action on "Future-proof methodologies and tools for validation".

Advancing the State of the Art

While different assessment methods have been worked on for automated driving functions, and a mix of different homologation methods has been proposed, to date no common standard methodologies exist that meet all the requirements for testing, validation and certification of all levels and Use Cases of automated driving. The discussion on this is on-going regarding EU type vehicle approval rules as well as in the framework of the UNECE (WP.1 and WP.29). The **HEADstart**[65] project is currently analysing existing approaches and developing harmonised scenario-based methodologies and tools for verification and validation with a specific focus on positioning and communication technologies as well as on cyber-security.

Several national and European projects have already started to collect relevant scenarios for verification and validation and store them in databases. Database structures and related methodologies have been defined and implemented on the national level. A sharing framework for aggregated test data and a common data format for EU wide application have also been developed, amongst others by the **L3Pilot** project. There is, however, no EU wide database of relevant scenarios nor an agreed database structure. Scenario descriptions also need to be harmonised. Moreover, there is the awareness that not all future critical scenarios are already known nor possible scenarios induced by automation, and processes and tools for their continuous collection need to be established.

Regarding the "Human reference for automated driving", statistical data is available on the number of road crashes, injuries and road fatalities in many countries, which can be related to the number of person kilometres travelled to get an idea of overall human driving, vehicle and infrastructure performance in terms of safety. Statistical evidence, however, is missing on the performance spectrum of human drivers in the variety of specific situations which might be critical for automated driving systems. Several software modules to simulate human driver behaviour do exist today, but they only cover specific aspects of human driving performance and do not cover the full spectrum of drivers with statistical data on the probability of certain behavioural patterns.

The HMI design of highly automated vehicles is the subject of several R&I projects at the moment, addressing challenges such as those arising from mode transition situations. Although there is

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[65] H2020 project funded under grant agreement ID 824309; https://www.headstart-project.eu/

an agreement on the need for harmonised HMI designs for such vehicles and safe human-vehicle interaction is an important element of driving safety, there are no commonly accepted HMI testing and validation procedures, methods and tools available yet for higher levels of automation.

R&I Actions and Expected Outcomes

The specific R&I actions relating to "Validation" are the following:

- **Future-proof methodologies and tools for validation**

  Common methodologies and tools (physical, virtual and hybrid) need to be developed to enable the verification and validation of CCAM systems in industrial development processes, in future type approval schemes and in consumer testing campaigns. This must consider maintenance, updates and upgrades during the whole vehicle lifecycle and includes the development of a commonly accepted and harmonised simulation environment for the virtual testing of CCAM functions and systems.

- **EU wide database of relevant scenarios for validation**

  Future methodologies for the validation of CCAM systems will make use of scenario-based approaches. The scope of this R&I action covers the definition and collection of safety-critical scenarios for CCAM systems, their sharing in an EU wide database and the derivation of test cases as a basis for the validation of CCAM systems in industrial development processes, in future type approval schemes and in consumer testing campaigns.

- **Human Reference for Automated Driving**

  A validated and robust reference model depicting the performance spectrum of human drivers in critical situations will allow a direct comparison to an automated driving system in simulation and form the basis of developing a common understanding of the required safety and reliability level of CCAM. By not only representing an average driver behaviour, but covering the full performance spectrum, it will be possible to quantify the performance of an automated driving system in a specific situation in comparison to the human driver population.

- **Specific HMI testing and validation procedures, methods and tools for higher levels of automation**

  Highly automated vehicles will need Human-Machine Interfaces (HMI) which allow intuitive and seamless transfer of control between the driver and the vehicle within short time as well as safe interaction with other road users. With the shared use of different vehicles becoming more common, and drivers having to adapt to the HMI of different vehicles, harmonisation of such HMI designs will be needed as well as their harmonised testing and validation.

On the basis of these R&I actions, the expected outcomes include:

- Common methodologies and tools defined, accepted and validated
  - by the CCAM value chain and its R&I partners for the efficient verification of CCAM systems in their R&I and product development processes,
  - by authorities and certification bodies for the validation of CCAM systems within type approval schemes and in future exemption procedures,
  - and by consumer testing campaigns for the safety rating of automated vehicles assisting users in identifying the safest choices for their needs.

- Verification, validation and rating procedures based on realistic and relevant test cases generated from an openly accessible EU wide database, providing the widest possible range of relevant scenarios which CCAM systems will potentially encounter on EU roads as a basis for robust system design.
- Extension of verification, validation and rating procedures to (self-)learning CCAM systems as well as to maintenance, (over-the-air) updates and upgrades of CCAM functions during the whole vehicle lifecycle.
- Inclusion of the connectivity context in the verification, validation and rating procedures for CCAM systems which rely on connectivity for safety-critical functions.
- A validated, robust and scalable reference model of human driving behaviour:
    - Replicating the full performance spectrum of human drivers, which allows comparing the performance of an automated driving system in a specific situation to the human driver population. This serves as a basis to define the required safety level of CCAM systems and to take decisions on validation requirements in type approval schemes. The model will also help to define fair assessment criteria in consumer testing campaigns relative to human-driven vehicles and for the safety verification of CCAM systems in industrial development processes.
    - Serving as a reference for the automotive industry and its R&I partners to design human-like and therefore easily predictable and acceptable behaviour of automated driving functions in mixed traffic.
    - Helping the automotive industry, its R&I partners, certification bodies and consumer testing organisations to realistically represent the behaviour of other human-driven vehicles in the (virtual) simulation of mixed traffic. Virtual testing shortens development cycles and accelerates the implementation of CCAM technologies.
- Harmonised methods and tools for the testing, verification and validation of the internal and external HMI of highly automated vehicles defined and accepted by the CCAM value chain and its R&I partners as well as by authorities and certification bodies.

Timeline

The first three R&I actions of this cluster are planned to start early on. The actions in Cluster 3 will advance during the CCAM Partnership timeline towards implementation, particularly in Cluster 1 and in Cluster 2.

While future-proof methodologies and tools for validation will already become available from a RIA in the first phase of the CCAM Partnership, another RIA is foreseen to follow and to extent methodologies and tools for validation to self-learning CCAM systems as well as to maintenance, over-the-air updates and upgrades of CCAM functions during the whole vehicle lifecycle. Moreover, the connectivity context will need to be included for future CCAM systems relying on connectivity for safety-critical functions.

Cluster 3

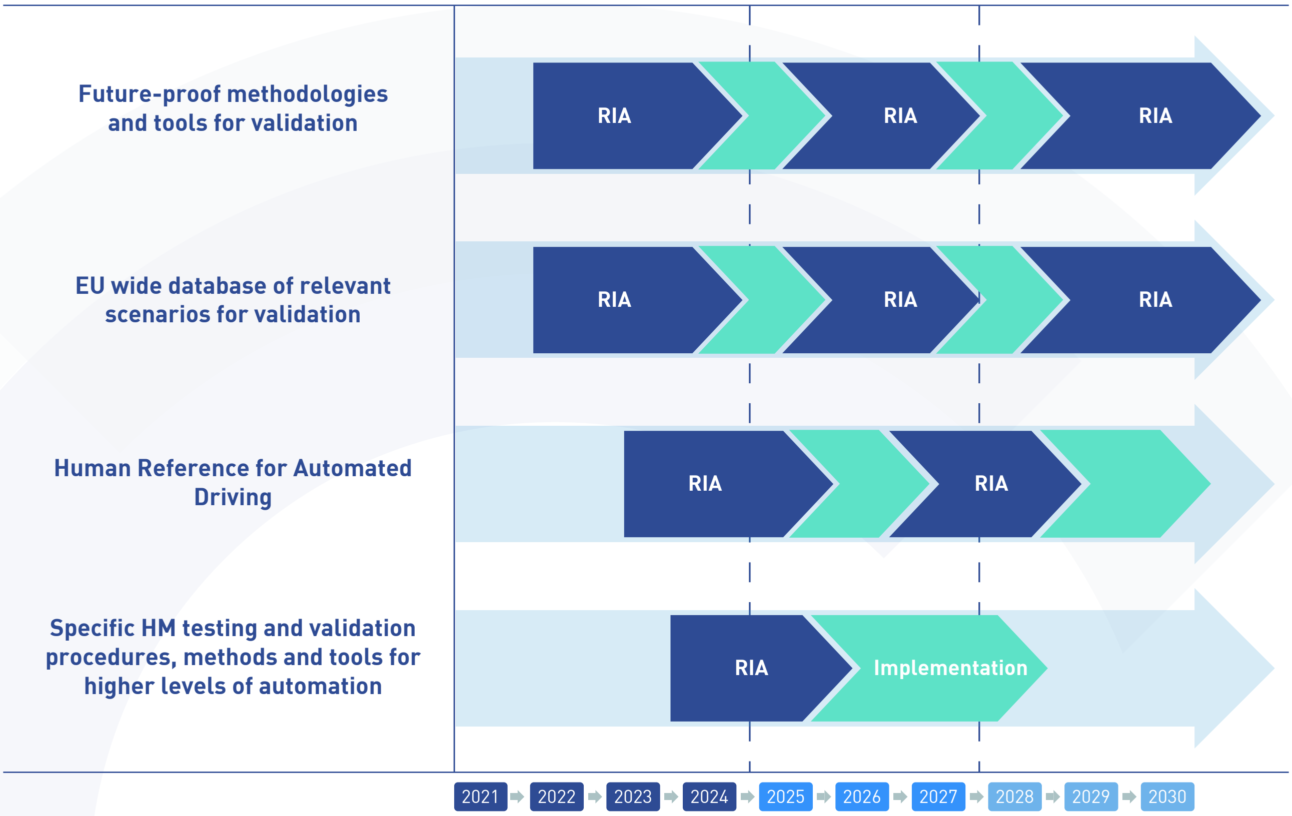


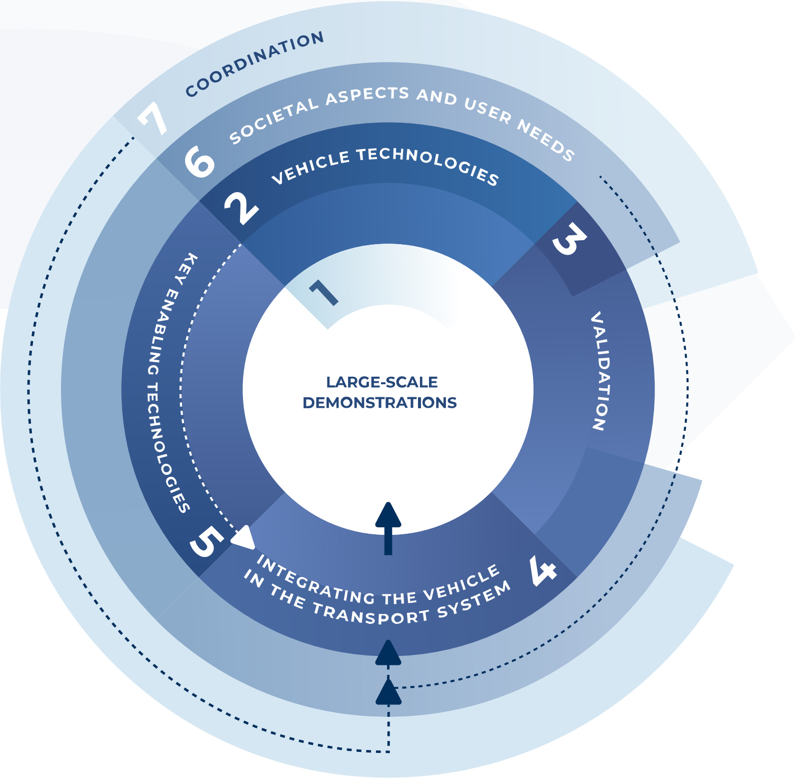
Figure 13: Cluster 3 R&I Actions over the Partnership Programme timeline.

The EU wide database of relevant scenarios will need to be updated and extended continuously according to extending ODDs and to the emergence of new traffic scenarios in the future road transport system.

The R&I action on a human reference for automated driving will also deliver valuable results in the first phase of the CCAM Partnership by providing a human behavioural model validated for selected fields of application. Expanding these fields towards a fully validated human reference model replicating the full performance spectrum of human drivers in all relevant situations, however, will definitively require another RIA building on the results from the first phase. See Figure 13: Cluster 3 R&I Actions over the Partnership Programme timeline. showing this progression process.

7.4. Cluster 4: Integrating the vehicle in the transport system

Introduction



The integration cluster plays a pivotal role with regard to the goal of the CCAM partnership – to create more user-centred, all-inclusive mobility, while increasing safety, reducing congestion and contributing to decarbonisation. Connected Automated Vehicles represent an integrated part of the future effective and efficient Mobility System, interacting with their environment, humans and other – old and new – transport means.

Cluster 4 will

- Provide digital information from all road transport operators and actors incl. private and commercially used individual vehicles to enable automated vehicles in mixed traffic (to Cluster 1).
- Develop connectivity and communication solutions to be integrated in vehicle technologies for sensor fusion, supporting on-board decision making, and enabling new HMI and active safety solutions (to Cluster 2).
- Deliver approaches and requirements regarding connectivity and communication towards cyber security or data sharing (to Cluster 5).
- Provide feedback on user needs and societal expectations (to Cluster 6) and further coordination needs (to Cluster 7).

Interaction with infrastructures, road and telecommunication infrastructure as well as automotive backend infrastructure, is crucial for the success of the system integration. Both elements of physical and digital infrastructure are important, in particular building a common understanding of what is required, how it can be achieved, and which roads should be prioritised with a view towards implementation. To prepare for the integration of maturing technologies, research in all clusters needs to encompass advances on methodologies, tools and applied safe and secure technologies, as well as governance and architecture issues. This is especially relevant for the societal dimension of the mobility system integration in cluster 6. With regard to longer investment cycles of road infrastructure and budgetary processes of public actors, there is a challenge to identify no-regret infrastructure investment in support of enlarging and optimising (e.g. robustness, predictability, uninterrupted coverage) Operational Design Domains (ODD) of CCAM vehicles. Moreover, all of these aspects call for harmonisation towards an EU definition of CCAM (incl. its system elements, i.e. vehicles, different infrastructures) and the CCAM ecosystem.

To better explain the integration process of vehicles in the transport system, the aspects of connectivity and interoperability need to be further highlighted. Connectivity represents an important capability of Connected and Automated Vehicles, expecting to increase the safety and efficiency performance of automation functions. Interoperability is key for providing seamless mobility, most notably at locations where handovers between infrastructure operators (e.g. urban – interurban road network, cross-border, Mobile Network Operators) are needed and between transport operators and service providers. Besides the connectivity aspect, cross-sector harmonised message sets based on standards are needed for communicating C-ITS information and also triggering actions of and between vehicles (e.g. cooperative manoeuvres, negotiation of intentions). Furthermore, Connected and Automated Vehicles may not necessarily be driven as an individual object in a swarm (traffic flow) but to an increasing extent becoming part of a managed fleet operated in the mobility system. Although differing in operational aspects, from an overall perspective, the task of fleet management and orchestration is independent from which actor takes this role (e.g. service provided by fleet management, individualised or semi-collective recommendations from traffic management) and whether a fleet is shared or mixed in modes. A specific element with regard to safe operation of Connected Automated Vehicles is remote operation and surveillance which forms also a part of this cluster.

Advancing the State of the Art

The R&I actions of this cluster, i.e. extending fleet and traffic management for CCAM, physical and digital infrastructure, connectivity and cooperative systems, can build on important achievements of research projects, related standardisation activities as well as regulatory and policy initiatives. The CCAM partnership proposal lists a number of the projects which have made important research contributions. In a generalised view the achievements on which the CCAM partnership builds on are as follows:

- The first generation of C-ITS services (Day 1 services) and their underlying message sets have been successfully developed, tested, standardised and profiled, piloted at large scale in Europe and have found their way into deployment.
- First concepts and messages for next generation services which go well beyond sharing information only, aiming at e.g. predictability of driving manoeuvres and transition of automation levels (incl. Transition of Control (ToC) aspects), have been studied and have been instrumental to standardisation work.
- Many of the CCAM services and Use Cases can benefit from 5G communication. A first set of projects and cross-border trials currently looks into validating advanced 5G features such as New Radio, Mobile Edge Computing, Network Slicing etc.
- It is commonly understood that road infrastructure support can benefit the sense-plan-act-process of CCAM enabled vehicles. Relevant elements of physical, digital and operational infrastructure have been collected. Concepts how infrastructure on a level-based approach can provide support to CCAM vehicles have been developed and studied.
- Mixed traffic, comprising automated and conventional vehicles as well as including the interaction with mobility users, poses several challenges towards suitable modelling tools, automation ready infrastructure and automation ready road authorities. Studies have found so far important contributions to the goal of the CCAM partnership while indicating conflicts in goal achievement which are attributable to the mixed traffic configuration.
- Improved collaboration within and across sectors also require shared knowledge, common tools and federation mechanisms to achieve superior performance on shared goals. Support actions have strongly enhanced the knowledge base, stimulated the collaboration tools and mapped out mechanisms which can serve as blueprints for the goal of the CCAM partnership.

- Many projects have delivered important inputs to the evolution of (multi-part) standards, e.g. DATEX II, TPEG, METR, cooperative ITS messages such as CAM, DENM, IVI.
- Moreover, the CCAM partnership is embedded in a policy and regulatory environment in favour of CCAM, mobility integration and data sharing, e.g. ITS Action Plan and ITS Directive, C-ITS Strategy, CCAM Strategy, Data Strategy.

R&I Actions and Expected Outcomes

The specific R&I actions relating to "Integrating the vehicle in the transport system", which have been identified and are described in detail in the SRIA development report June 2020, are:

- **Physical and Digital Infrastructure (PDI)**
  PDI improves CCAM services and increase the performance by extending the operational domains, increase functional safety and traffic efficiency. EU-wide and global harmonisation is key to define necessary infrastructure support for CCAM, enabling broad market uptake of services and guaranteeing coordinated deployment and a single market based on complementary Operational Design Domain (ODD) and infrastructure support levels.
- **Connectivity and Cooperative Systems**
  Hybrid communication approaches based on a technological neutral definition of connectivity and communication between vehicle and everything enables information exchange, realising collective perception and therefore enables cooperative automated mobility. In the expected mix of CCAM vehicles and conventional traffic this ensures the smooth and safe coexistence of connected cooperative automated vehicles and all other road users (specifically vulnerable road users) and enables better driving functions and increased traffic efficiency.
- **Fleet and traffic management in a CCAM eco-system**
  CCAM has to enable a system that orchestrates traffic management sub-systems, where people and goods will have to move within a continuous and cross-border framework of services that are interoperable (inter-modal interfaces should also be included). It is essential, that both fleets (commercial/logistics fleets, fleets operated by public or private transport operators) and individual vehicles (CCAM- or conventional vehicles) are well integrated in the entire traffic management system by planning, forecasting and managing the individual movements according to their specific needs.

On the basis of these R&I actions, the expected outcomes include:

- Common understanding of requirements and minimum set of infrastructure adaptations for the physical and digital infrastructure for CCAM systems and services, in mixed traffic with conventional vehicles and other road users and modes of transport.
- Description and development of service architectures of PDI for CCAM systems and services and agreed classification of infrastructure support levels stimulating EU-wide/global harmonisation for classification of infrastructure support.
- PDI support concepts of proven maturity (technically, functionally, etc.), developed in cooperation with road users and vehicle manufacturers to extend their Operational Design Domains (ODD), and ready for large-scale demonstration actions.
- Simulations and testing to investigate how PDI can support CCAM and which are the effects on traffic efficiency, traffic safety and traffic management (e.g. identification and performing of minimum risk maneuver).

- Business and financing models, policy options and ways to increase competencies and resources for road authorities (and/or operators) ensures aiming at physical and digital infrastructure remaining fit for purpose.
- Connectivity and cooperation enablers and needs for higher levels of automation identified and assessed, based on a detailed Use Case-approach for the CCAM mobility system.
- Requirements for availability (e.g. coverage, security) and performance of connectivity and cooperation enablers (e.g. data rates, latency, robustness and redundancy, quality of service, resilience against cyberattacks) specified per Use Case, meeting requirements of functional safety and safety-critical applications.
- Ensured quality of and trust in external data by common definitions (incl. quality indicators definition) meeting requirements of cross-border interoperability and continuity.
- Feasible and sustainable concepts for and provision of road infrastructure coverage (short- and long-range connectivity along the road network) developed to enable CCAM services, included in testing at living labs and ready for large scale demonstration.
- Integrated perspective and recommendation for actions on co-design, co-investment, co-existence, co-management and co-performance of connectivity and communication systems.
- Concepts of fleet and traffic management in the CCAM eco-system that go beyond digital twinning enabling optimised (and/or optimisable) systems for the mobility of people and goods and are well integrated with existing urban / regional mobility environments. The technological levers (What is possible with CCAM?) address and balance societal and user needs (What can and what should CCAM solve?).
- Interfaces that enable interoperability between traffic management systems (of different geographical locations and/or of CCAM vehicles and other modes of transport) considering integration beyond road transport in the overall multimodal transport system providing seamless mobility services.
- Advanced simulation models and tools that enable and help assessing new traffic management strategies (including dedicated lanes, priorities at intersections etc.) for CCAM.
- Optimised mobility network load balancing approaches through advanced traffic management guidance and information loops that can reach individual users as well as operational traffic and fleet management actors.
- Effective cooperation and governance models for operating CCAM services as part of real-life fleet and traffic management systems developed and tested.

Timeline

All planned R&I actions of cluster 4 start early. The actions advance during the CCAM Partnership timeline towards testing and implementation in Cluster 1. Expected outcomes of the first actions will allow for implementing specific elements after the first phase of the CCAM Partnership.

At the same time it is expected that R&I actions of the technology clusters (Cluster 2 and 5) will deliver important results on e.g. improved sensor and in-vehicle decision making capabilities as well as how cybersecurity can be best embraced in order to allow and achieve a transport system integration of vehicles, infrastructure, user and overarching entities. These inputs, including progressing the state-of-play on core R&I topics of Cluster 4 itself, will stimulate a second wave of Innovation Actions. This wave aims at advancing the technical maturity and putting more emphasis on the organisational implications of the proposed solutions, all to drive the integration of vehicles in the transport system. The second wave targets on delivering mature results ready for testing and implementation in the final third phase of the programme. The following image aims at making this progression process transparent.

Cluster 4

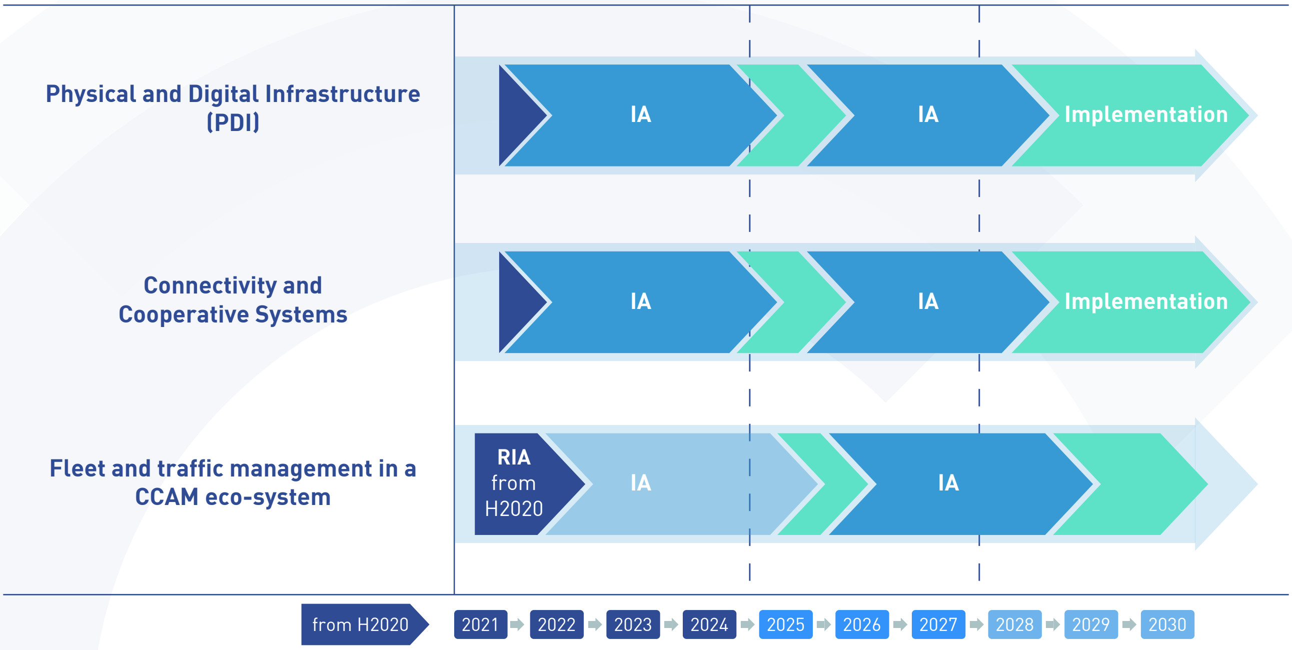


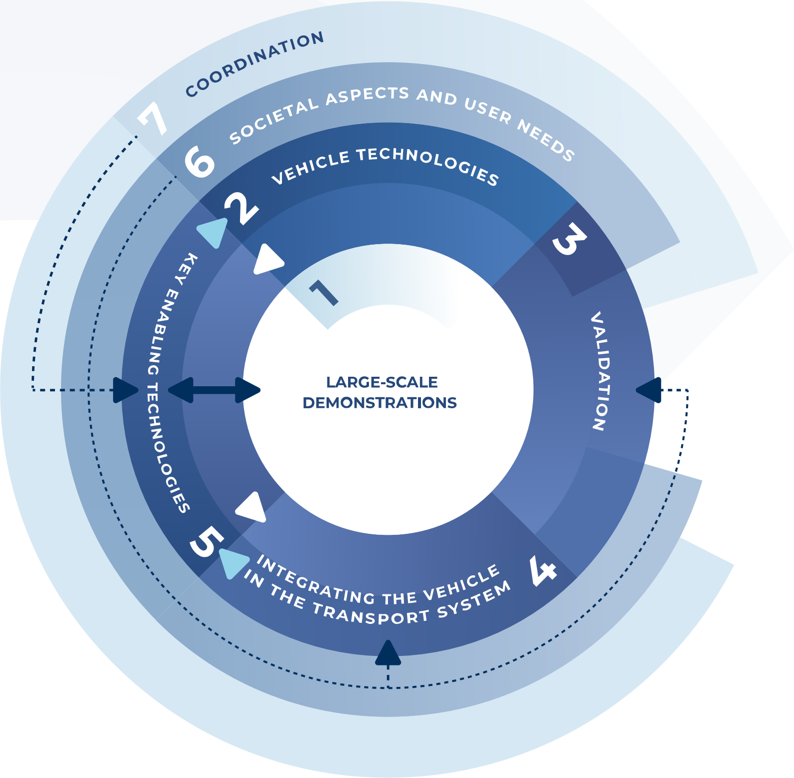
Figure 14: Cluster 4 R&I Actions over the Partnership Programme timeline.

7.5. Cluster 5: Key Enabling Technologies

Introduction

This Cluster focuses on CCAM R&I actions on enabling technologies, driven by digitalisation and extending the application of these technologies beyond the individual vehicle in a system's approach. In case of e.g. AI, it has the capacity to go way beyond on board decision making, based data from in-vehicle sensors. Data from other vehicles, infrastructure and back offices can be used in decision making in complex scenarios including safety critical situations, ranging up to traffic management, emission management, charging of vehicles and provision of many new and emerging mobility services.

Thus, the Cluster fosters cooperation amongst stakeholders from several technology areas and industries. Safe and secure operation of vehicles and mobility systems is key to develop trust and establish user adoption of CCAM solutions.



This Cluster 5 will

- Provide AI and cybersecurity solutions to be integrated in vehicle technologies (related to environment perception and on-board decision making) (to Cluster 2).
- Develop Harmonised procedures, methods and tools for the validation of cyber security for inclusion in conceptual description of an approval scheme of CCAM systems (to Cluster 3).
- Provide the basis for validation methods and tools for AI applications in CCAM for integration in validation procedures for CCAM systems (to Cluster 3).
- Develop and/or integrate Key enabling technologies (e.g. secure communication, robust and resilient connectivity) contributing to better performance of vehicle-transport system integration (to Cluster 4).

A harmonised approach to further develop these technologies can help to reduce market fragmentation, currently hindering EU companies to fully benefit and exploit new mobility business cases based on CCAM. For this, the extended domains are addressed with R&I actions for cybersecurity, data sharing and artificial intelligence (AI). Advancing CCAM solutions and developing a common understanding of CCAM under all circumstances will certainly benefit from harmonising approaches for data sharing, whilst on the other hand leading to maximised societal benefits of the technology application. Harmonised approaches for data sharing, leading to a system architecture for data sharing, should be developed for the full range of product development stages from development, testing, and validation up to implementation. It is important to include data security and cybersecurity requirements complying with European regulation regarding privacy, data security and cybersecurity. Fragmentation of data sharing approaches would lead to lack of seamless mobility possibilities, duplication of data storage and huge data inefficiencies, lack of coherence.

Extending the system domains beyond the vehicle through connectivity (short range or cellular) makes cybersecurity a fundamental building block for trusted (digital) interaction of road users with each other, the infrastructure and cloud-based solutions/services. Cybersecurity needs to be made an integral part of the development process, with common aims and objectives, frameworks/architectures, and designs (including normal operation, decision making and actuation as well as anomaly detection).

AI has a huge potential to change the (in-vehicle) decision making process as well as new services or safety solutions supported by AI. But, AI has to become a functional competitive and affordable CCAM technology first, in order to support safe autonomous driving in a more complex and dense traffic environments. Specific automotive requirements such as safety, security and real-time functionality demand a reinvention of AI for CCAM.

Implementing AI for situational awareness, in particular in CCAM, presents a variety of challenges, e.g. industrialisation, requirement-based development, continuous improvement of trained modules for application in safety critical domains. Verification of AI for situational awareness is essential for CCAM to operate in more complex urban traffic scenarios. The ambition is to move from reactive and/or adaptive system support to AI based predictive system state awareness, decision making and actuation.

Advancing the State of the Art

Data sharing approaches so far are merely limited to project or pilot base, or limited to specific use or Use Cases. For implementing connected, cooperative and automated mobility on a larger scale, including the essential further R&I activities, data sharing needs to be established on a wider scale and in an harmonised approach. Serving as a basis for next steps in R&I activities are the best practice examples for test data sharing as they have been developed and reported in the projects **L3Pilot** and **ARCADE**, as well as 5G-Mobix. Inputs from Cluster 7 are needed here. Cross project sharing will be an important first step; initially of data sharing frameworks and architectures, later on also on the actual data sharing and storage. An explicit cooperation will exist with activities within Cluster 1 on large-scale testing as well as with Cluster 4 especially on Connectivity and Cooperative Systems. The activities here should be seen in the light of e.g. Common European Data Spaces and the expected Data Act and take this to the contextual application.

Cyber security is often discussed and researched in a general approach. Explicit translation and implementation of results towards the specific CCAM domain needs to be achieved. Research can build upon previous work e.g. the CEN-CENELEC Cyber Security Focus Group. For CCAM, contextual definition is needed, including sector specific security features. This can build further on the recently developed ISO 21434 on a structured process to ensure that cyber security is included upfront in the system (vehicle or infrastructure) design. The ongoing work in the **SECREDAS ECSEL** project offers a referential starting point for more sector specific work, while looking at the operational security. Links are included also to Cluster 3 on e.g. validation of over the air updates and programming of vehicles, in a cyber secure approach. Alignment and cooperation is needed with Cluster 2, especially Safe and reliable on-board decision-making technologies, as well as for issues like over air updates of in-vehicle technologies.

Current state of the art within vehicle related AI has a primary focus on vehicle state, which was appropriate for the initial steps in CCAM related mobility. Now, a step needs to be made to incorporate information and predictions on not only vehicle state, but also human (driver) state and system state (environment around the vehicle). In current AI solutions, not much effort was put to trustworthy and reliable AI, simply because these items are emerging only now. Nevertheless, they will play a key role in supporting the public acceptance of AI based CCAM technologies and their market uptake, as well as in boosting the essential societal benefits (e.g. safety, emissions, inclusivity). Progressing beyond the current State of the Art should thus also firmly address the recommendations of the AI High Level Expert Group and their Guidelines for Trustworthy AI[66]. In addressing this, close interaction between Cluster 5 and Cluster 6 will be needed.

Current AI is merely reactive, based on data generated by smart phones and V2X communication. The Partnership aims to go beyond this by moving to adaptive system support and up to AI based predictive system state awareness, decision-making and actuation. Data fusion needs enrichment with also high precision localisation, end-user information, infrastructure (sensor) data as well as system state information, while balancing interactions. Major steps can be made in the broad implementation of CCAM solutions with AI components, for passenger vehicles, logistics providers, traffic management systems and new mobility service offerings, taking an explicit multimodal systems approach. The work within this context can build partially on projects within the framework of the proposed Partnership AI, Data and Robotics (the current PPP BDVA) and the EC funded project AI4EU. Within the proposed CCAM Partnership, close interactions are foreseen with Cluster 2 especially on environment perception technologies for CCAM, and safe and reliable on-board decision-making technologies.

R&I Actions and Expected Outcomes

The specific R&I actions relating to "Key Enabling Technologies" are the following:

- **Cybersecure components and systems**

  Systems for CCAM enabled mobility will have to be fail-operational and cyber-secure in their entire Operational Design Domains (ODD), to guarantee a safe and secure operation of vehicles and systems. Both safety and cyber-security need to be considered in a systems perspective, also as they are related to the interaction of vehicles as well as with the infrastructure, transport management systems and service systems. Joint definitions of the targeted levels of safety and security will be needed, as well as harmonised methods and protocols for its validation.

- **Robustness and resilience**

  Highly automated vehicles will need consolidated robustness and security measures. Threats, failures, problems as well as malicious and unintended interactions will have to be detected real-time and fed to a decision-making process on response actions. A tool suite of appropriate actions is needed to enable the component or system stepping back in real-time to a safe and secure situation.

- **Explainable concepts and training of AI for CCAM applications**

  There is a firm need for explainable, trustworthy[67] AI for CCAM applications and scalable solutions, including a clear vision on the capabilities and limitations of the AI systems.

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[66] Ethics guidelines for trustworthy AI, 8.04.2019, https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai

[67] Explainable and trustworthy AI: herewith, we mean systems which act in a for a human predictable and safe manner, which act according to clear and pre-defined ethical goal functions. The actions and decisions do follow an explainable logic, which is in line with or very close to the human decision making. As such, its actions are perceived safe, logic and comfortable; trustworthy. It will deliver technical solutions for CCAM implementation which can be easily accepted and boost its uptake in daily use, easing potential inclusivity hurdles and maximising societal benefits of such AI based CCAM solutions.

Concepts, techniques and models of AI for CCAM need to be developed and trained, with a first application in safety critical domains. Sufficient breadth and suitability of training data, solutions for data documentation (e.g. verifiability of data used for training), robustness and accuracy need to be incorporated. Major improvements are to be expected in addressing user acceptance and in increasing societal impact of AI based CCAM solutions, as well as market uptake.

- **AI for situational awareness**

  For meaningful (human) control of autonomous systems, hybrid AI approaches will be needed: combining system and domain knowledge, learning from data with knowledge-based AI techniques in order to improve the overall system performance, including, when needed, control handovers and handbacks. For increasing levels of automation, coordinated and comprehensive use of AI for situational awareness is essential to estimate and predict the system state, state of the human occupant or driver, and traffic state; the three parts that together determine the safety of a situation.

- System architecture for data sharing

  A joint and harmonised approach for data sharing and data storage will be essential to allow for seamless, continuous operation by many actors (both from the vehicle side and the infrastructure) at the same time. The required harmonised approach will need to incorporate items like data format, a common ontology for defining the terms, quality, speed, decisions on raw data vs data selections.

On the basis of these R&I actions, the expected outcomes include:

- Safe and secure operation of CCAM vehicles and mobility systems and services, enhancing trust and end user adoption of CCAM solutions.
- Cybersecurity requirements including data security and access control enabling harmonised approaches and tools for data sharing.
- Improved understanding of the new, emerging and specific CCAM related cyber security and resilience challenges, by using the contextual definition, including sector specific security features.
- Inclusion of cybersecurity and resilience as an integral part into the development process of CCAM solutions by OEMs, Tiers, telecom providers and service providers, with common aims and objectives, frameworks/architectures and designs
- Cybersecure data sharing approaches from pilot applications towards CCAM on a harmonised larger scale.
- A joint and harmonised approach for data sharing and data storage, allowing for seamless and continuous operation of CCAM systems and services.
- Concepts, techniques and models based on Artificial Intelligence (AI) used for situational awareness, prediction, decision making and triggering of actions for time critical and safety relevant CCAM applications as well as for cyber threat detection and mitigation.
- A clear understanding of the capabilities, limitations and potential conflicts of AI based systems for CCAM- for the entire CCAM stakeholder community including the end users.
- Increased user acceptance and societal benefit, from an early stage, based on explainable, trustworthy and human-centric AI. Interactions with AI using vehicles should be understandable, human-like and reflect human psychological capabilities.

- Accelerated AI development and training for CCAM enabled by a relevant set of real and synthetic traffic events and scenarios.
- AI based CCAM solutions will evolve from reactive and/or adaptive system support into predictive system state awareness (including driver state and user diversity), decision-making and actuation, enhancing road safety especially in near-critical situations.

Timeline

The Cluster 5 actions all follow a logic of a step-wise approach: moving from development on a component level (mostly in RIAs) to integration into system approaches and adjusting to needs of specific Use Cases or user groups (in IAs) ultimately to application and implementation.

The first two R&I actions within Cluster 5 are planned to have an early start, with the earliest planned implementation. The third and fourth R&I actions are planned to start in the second and third year, as these actions will advance based on inputs and needs from Cluster 2, 3 and 4, with a close link to Cluster 6 for especially the R&I action on Explainable AI. The last R&I action will have its start pending on results of projects within Cluster 7 on test data sharing.

Innovation Actions will follow and advance technical maturity and progress the state of the art after the first phase, delivering mature results ready for testing/implementation. The following image aims at making this progression process transparent. As the Actions in Cluster 5 concern fairly new technologies in the application domain, the sequence of RIAs, IAs and implementation is expected to run throughout the running time of the Partnership. Based on inputs and needs from Clusters 1, 2, 3, 4 and 6, detailed (R)IA needs and implementation paths can be defined. In the same way, new key enabling technologies can arise from other sectors, for inclusion and implementation here.

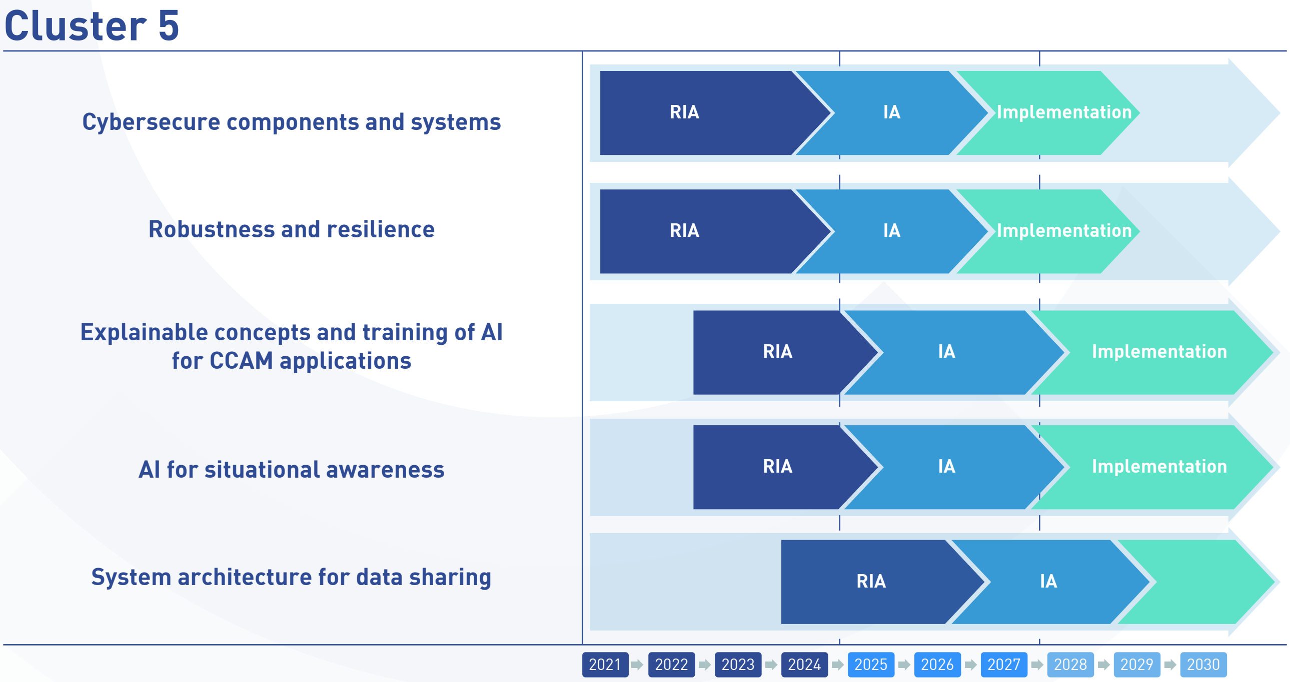
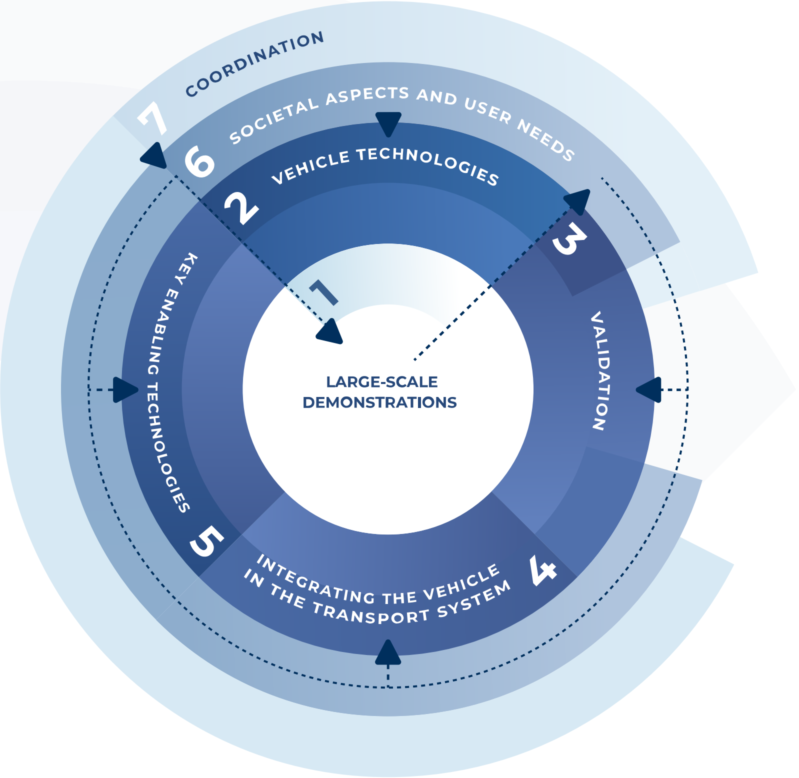


Figure 15: Cluster 5 R&I Actions over the Partnership Programme timeline.

7.6. Cluster 6: Societal aspects and user needs

Introduction



It is widely understood that the successful deployment of CCAM depends largely on the societal benefits it can generate and on uptake by individual users. To achieve the desired benefits, CCAM development, deployment and regulation have to be based on a well-founded and genuine understanding of specific needs, impacts (positive as well as negative) and costs. Taking into account user and societal aspects is a prerequisite for CCAM offers that are acceptable, appreciated and most appropriate for serving social, economic, and environmental needs and objectives.

Cluster 6 will:

- Provide input on user needs for the right setup of Large-scale Demonstrations, requirements on studies; what needs to be tested in FOTs to confirm user acceptance; and, in Living Labs to confirm societal expectations (to Cluster 1).
- Deliver user needs with a focus on HMI and user-centric technologies (to Cluster 2).
- Provide the user perspective and societal needs to develop and guide overall transport system integration (to Cluster 4).
- Provides user needs and concerns to be addressed while developing and adapting Key Enabling Technologies for CCAM (Cluster 5).
- Give feedback on societal/citizens aspects in co-creating Living Labs for evaluation methodologies (to Cluster 7).

Actions in this cluster will investigate, in the widest sense, the needs of future European CCAM users, citizens, and society at large. Methods and measures will be developed for capturing these demands as well as the expectations, desires and concerns towards CCAM, considering that they may evolve over time. Socio-economic and environmental impacts of CCAM will be assessed in order to understand how CCAM and associated services can be a positive contributor to societal targets in terms of safety, accessibility, equity, and environmental issues. Benefits of CCAM for different types of users as well as associated direct and indirect costs on the short, medium and long term are central questions that need to be understood, handled and transferred into the development process. Methods will be developed to adequately assess socio-economic impacts and address interdependencies of effects in different time frames. The CCAM developers, deployers and public authorities will be provided with tools to implement user-centred solutions that effectively contribute to the societal targets and the uptake of CCAM systems at regional level.

Furthermore, the impact of higher degrees of automation and digitalisation in CCAM road transport on the workforce will be analysed. Skills requirements will be identified, also regarding transport management, planning and policy making to ensure up to date knowledge for dialogue with CCAM providers concerning requirements, conditions and demands for CCAM development, deployment application and operation.

Advancing the State of the Art

The acceptance of CCAM technologies through the role of the "driver" (human or vehicle) is being addressed in several EU and national projects (examples: **TRUSTONOMY**[68], **DriveToTheFuture**[69], **PAsCAL**[70], **SUaaVE**[71]). These often focus on cars and their aims include preparing for future acceptance and use by looking into aspects such as HMI, safe hand-over, and vehicle interaction with other road users. Initial adoption considerations of level 3 technologies by drivers and other road users have been studied (**BrAVe**[72], **InterACT**[73], **TrustVehicle**[74]). However, needs and acceptance are often discussed in terms of making people use a new technology, with a strong focus on vehicles, and less on a broader identification of specific user needs and/or possible impacts of CCAM on a societal, socio-economic and environmental level.

Demonstrations with public or stakeholder involvement have been ongoing for some time (e.g. **Citymobil2**[75], **L3Pilot**[76], **ENSEMBLE**[77], **AVENUE**[78]; **C-Mobile**[79], national projects). Still a recent EuroBarometer study[80] has revealed that while many persons are aware of the existence of automated vehicles, their willingness to use them is low. There is thus a need to match user and societal needs with CCAM offers , using broader and more integrated methodologies, which can be empirical, that go beyond technical aspects.

Compared to these vehicle and technically oriented efforts, aspects related to inclusiveness and equity are far less common in CCAM design or R&I, and rarely go beyond considering persons with reduced mobility, gender, and age groups, or vulnerable road users (for a gender example, see the Horizon 2020-project **DIAMOND**[81]). Persons with different income levels or different digital experiences, and people living outside large city centres, are examples of user groups that need to be included to reach a more all-encompassing analysis of needs and expectations, whether at a micro or macro level.

Trust, privacy, ethics are considered important factors to foster user acceptance of CCAM. Unresolved or underexplored ethical considerations could hinder the public acceptance, and therefore deployment, of CCAM systems and services. Ethical-related issues have been discussed by a Commission Expert Group. Relevant recommendations from the report[82] will be considered for the implementation of the CCAM R&I agenda.

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[68] https://h2020-trustonomy.eu/

[69] http://www.drive2thefuture.eu/

[70] https://www.pascal-project.eu/partners/h2020

[71] https://www.suaave.eu/

[72] https://www.brave-project.eu/

[73] https://www.interact-roadautomation.eu/

[74] https://www.trustvehicle.eu/

[75] https://cordis.europa.eu/project/id/314190

[76] https://www.l3pilot.eu/

[77] https://platooningensemble.eu/

[78] https://h2020-avenue.eu/

[79] https://c-mobile-project.eu/

[80] Special Eurobarometer 496: Expectations and Concerns from a Connected and Automated Mobility; accessed via https://data.europa.eu/euodp/sv/data/dataset/S2231_92_1_496_ENG 2020-06-29.

[81] https://diamond-project.eu/

[82] European Commission, Directorate-General for Research and Innovation, Ethics of connected and automated vehicles : recommendations on road safety, privacy, fairness, explainability and responsibility, Publications Office, 2020, https://data.europa.eu/doi/10.2777/966923

Large scale participatory processes that include future users, citizens, and specific groups need to be enhanced in order to identify their needs and include them in subsequent design and development processes. This includes to elevate methodologies from surveying or interviewing into more extensive interactions in form of citizens' dialogues and workshops (collaboration with Cluster 7), and integration of developments in living labs (collaboration with Cluster 1).

Deployment of CCAM will generate impacts, positive as well as negative, which have to be known and handled. Optimising these effects can be seen as one societal need. Validated methodologies for impact measurement of existing technologies are in the works, and several frameworks and KPI's for impact assessment, as well as some support tools, are available. R&I activities in this field include the projects **LEVITATE**[83] and **SIMOD**[84] (impact assessments). The framework developed by the Trilateral Impact Assessment Sub-Group for ART (Automated Road Transportation)[85] with Europe, Japan and the US have developed a common set of recommendations for classifying automation implementations and determining impact areas to be assessed. The framework furthermore presents impact mechanisms through which automated driving is expected to impact life, covering both direct and indirect impacts.

However, current forecasting approaches typically focus on the detailed modelling of vehicle performances and the immediate effects on the microscopic level, e.g. energy savings and capacity gains due to efficient coordination of connected automated vehicles (CAV) at an intersection. Higher level impacts, such as for example meso- and macroscopic modelling of the effects on mode choice behavior and environmental impacts caused by the increased use of (more convenient and cheaper) CAV, are only addressed in some isolated approaches, sometimes combined with back-casting from societal/environmental/economic goals to define the contribution of CCAM to the transition towards multidimensional development goals. In addition, the maturity of analysis and assessment varies between impacts, where e.g. road safety risk assessments for CAVs are well established in comparison to wider health or equity impacts by CCAM. The broader implications and wider socio-economic effects (e.g. regarding public health, land use/infrastructure needs, accessibility, energy use, carbon emissions, employment, working conditions etc.) when CCAM solutions are integrated into the mobility systems are not well understood.

Fears of job losses through automation (for example for bus drivers) are contrasted by high expectations on job growth (e.g. in the field of ITS) through CCAM. Research on labour effects of mobility automation typically focus the transport labour force: its future working conditions and skills requirements are being researched, e.g. in the mapping of jobs that are disappearing, changing and emerging due to CCAM. **SKILLFUL**[86] is a project looking at changes in professions, and there are several projects addressing driver education. However, the full value chain of skills, educational, organisational and labour consequences also needs to be addressed, particularly for freight transport. Additionally, actionable analyses capturing a larger scope and systems level need to be developed to support realisation of job growth aspirations[87] .

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[83] https://levitate-project.eu/

[84] Krausea. J. et al: "Socio-Economic Impacts of Mobility Disruptive Trends" (2020)

[85] Trilateral Impact Assessment Framework for Automation in Road Transportation, 04.2018, https://connectedautomateddriving.eu/wp-content/uploads/2018/03/Trilateral_IA_Framework_April2018.pdf

[86] https://skillfulproject.eu/

[87] Mobility Package I, https://transport.ec.europa.eu/transport-modes/road/mobility-package-i_en

R&I Actions and Expected Outcomes

The specific R&I actions relating to "Societal aspects and user needs" are are the following:

- **Societal, citizen and user needs - for needs-based CCAM solution development and deployment**
- This action strives for a better understanding of needs, expectations and desires of future users, citizens, and society at large. This will be essential input to the design and development of CCAM solutions that can best serve these needs, without increasing equity gaps

- **Socio-economic and environmental impact analysis and target-based assessment of CCAM benefits**

  This action will lead to comprehensive impact assessment methods that cover the full range of effects of CCAM systems and services, taking into account under-researched fields and groups. The ambition is to provide tools for using desired impacts as a key input in CCAM development and deployment, and thereby reach expected effects.

- **Workforce development and knowledge enhancement**

  This action aims to define and assess opportunities to meet expectations on job growth through CCAM deployment. Activities might include the impact assessment of higher degrees of automation and digitalisation in road transport on the future workforce and an analysis of requirements for workforce skills along the value and educational chains.

On the basis of these R&I actions, the expected outcomes include:

- Methods and measures to engage with European citizens to capture their mobility needs in the context of economic, social and environmental objectives at national, regional and local levels. Guidance on how to engage with citizens on CCAM solutions aiming to address these needs. Evolution over time is taken into account.
- Detailed, robust and documented knowledge (e.g. knowledge maps) of users' and implementers' expectations, concerns and desires with regard to CCAM solutions for the mobility of persons and goods, with special attention to the needs of vulnerable users and under-researched groups, including women, disabled persons, and the elderly, but also ethnic minorities, persons from low income backgrounds, persons with varying digital literacy and skills, and those living in rural or peri-urban areas. This knowledge is to be integrated into the design and development of CCAM solutions to support these specific needs.
- Tools that support CCAM developers, deployers and public authorities in implementing user-centred solutions that effectively contribute to societal targets, including equity, and the uptake of CCAM systems at regional level.
- A well-founded understanding of effects and impacts (positive as well as negative), benefits and costs of CCAM systems and services (short, medium, long-term).
- Methods and indicators to assess the impacts of CCAM solutions on mobility and wider socio-economic effects (public health, land use/infrastructure need, environmental aspects such as energy use, accessibility, air quality, carbon emissions and impact on economy, employment, working conditions and required skills etc.).

- Definition of KPIs incorporating societal targets with individual mobility needs.
- Input for the design and evaluation of CCAM partnership activities, in particular for the large-scale demonstrators (ex-ante and ex-post), and for public engagement activities aimed at realistically informing users of CCAM capabilities and expectations.
- Recommendations for large-scale demonstration projects to include user and societal aspects taking into account location-specific characteristics of the implementation area, such as local policy targets, population density, and cultural matters.
- Framework for building CCAM related awareness, knowledge and competence at all levels of society – from school curricula, training of drivers and future road users, planners, decision makers in public and private contexts. Definition of short and long-term demands for updated skills and enhanced knowledge for the range of professions involved with CCAM.
- Methods and tools for CCAM developers and manufacturers, authorities, municipalities and citizens, enabling design and decision making based on a sound understanding of all its possible short, medium and long-term impacts, thereby avoiding negative rebound effects, such as discrimination or bias towards certain user groups, like women, the elderly, and disabled persons, but also ethnic minorities, persons from low income backgrounds, persons with varying digital literacy and skills, and those living in rural or peri-urban areas.
- Knowledge and understanding of the policy environment fostering CCAM business and labour market dynamism with incentives for increased investment from companies in human capital, supporting mobility and on the job training.
- All the above expected outcomes should support the uptake of CCAM solutions (including acceptance and adoption).

Cluster 6 "Societal aspects and user needs" lays the foundation for understanding citizens' needs and the expected impacts of CCAM and interacts therefore with all other clusters. It provides input in terms of emphasising topics that need to be investigated in more detail to maximize the benefits to society. It also sets boundaries and informs the other clusters about potential unintended effects.

Timeline

Early starts of the two R&I actions for Needs and Impact will deliver to all clusters up-to-date and relevant input for the second and third phases of the Programme: future users' needs to be taken into account, and socio-economic impacts for use in pro-active planning of clusters' actions.

Output from other clusters will create a wider view of needs and impacts through e.g. experiences from large scale demos and user centric HMIs (Clusters 1,2) and Cluster 4. Furthermore, new key enabling technologies (Cluster 5) and Cluster 7 activities will create new opportunities to understand and assess needs and impacts. The consecutive Cluster 6 RIAs on Needs and Impact will capture and handle both these inputs and the dynamic nature of CCAM, the increased deployment, updated set of stakeholders and their needs, societal evolution etc. Additionally, there is the accelerated technology development, which influences CCAM but also the methods and tools that can be used and developed. The late Impact RIAs will provide foundation for the CCAM SRIA update for the Partnership's final societal impact assessment from Cluster 1 results. (ex-post impact assessment).

The Workforce R&I action will start in the third year and build on work carried out in primarily Cluster 1, 4, 5 as well as the two other cluster 6 actions. It will build the base for addressing consequences of CCAM deployment on the workforce and educational value chains. A second action in the third phase, following an implementation period, will advance the basis for realising expectations on job growth through CCAM.

Cluster 6

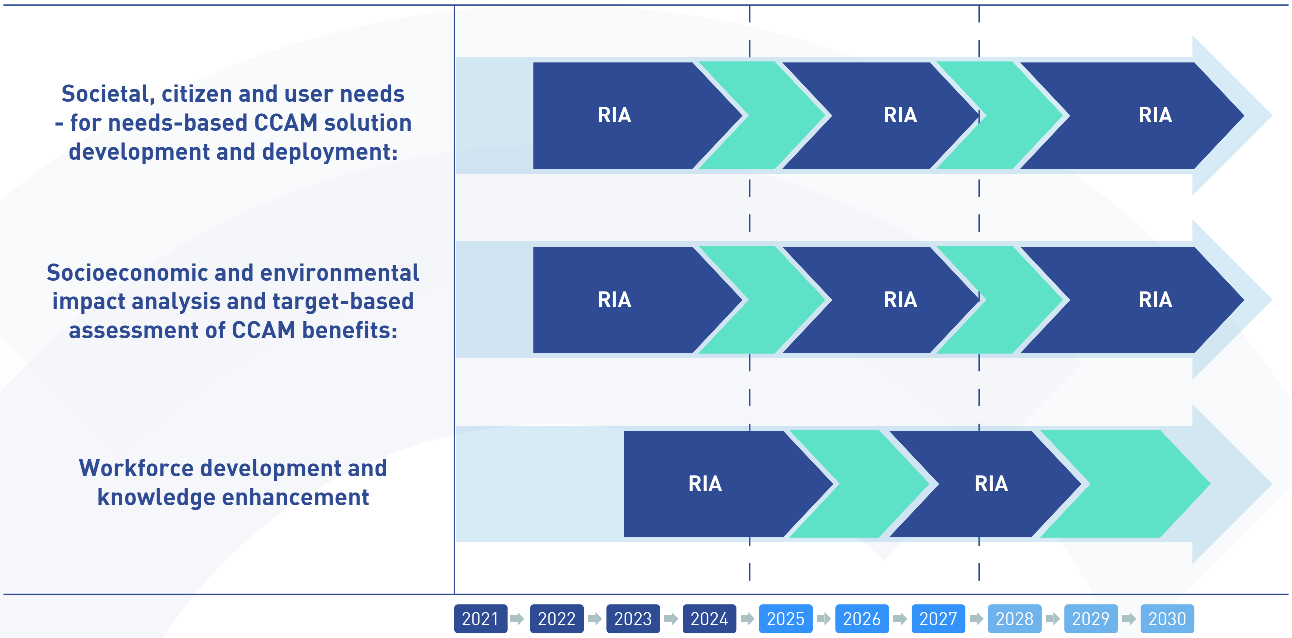
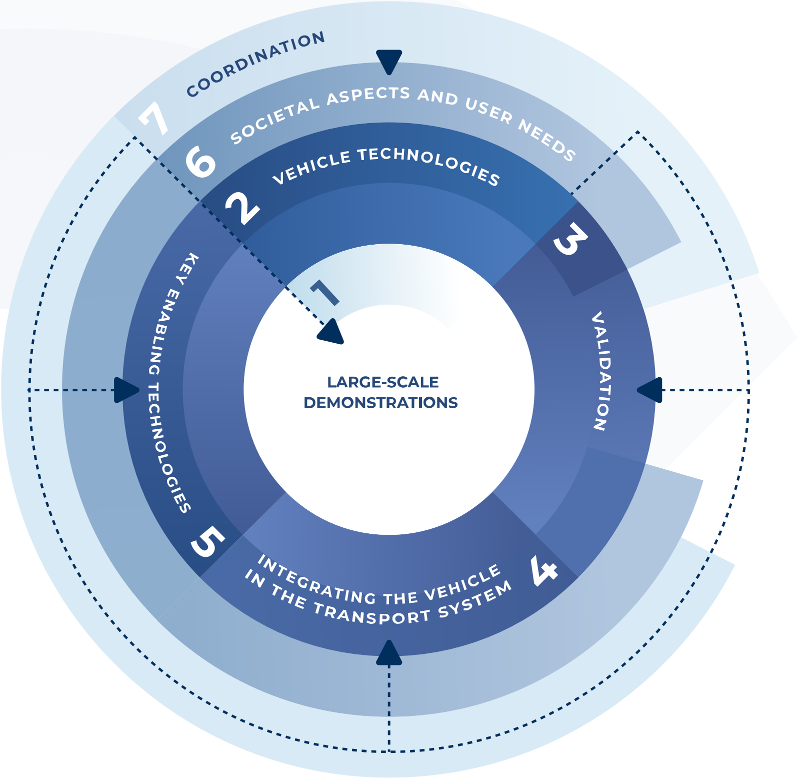


Figure 16: Cluster 6 R&I Actions over the Partnership Programme timeline.

7.7. Cluster 7: Coordination

Introduction



Coordination of R&I and testing activities across Europe is required to address the current fragmentation of R&I efforts and the lack of a coherent, longer-term vision and strategy as identified in PD3.

Harmonised approaches, common methodologies and tools to facilitate the exchange of best practices and lessons learned will support the collaboration across the complex cross-sectorial value chain needed for the organisation of Large-scale Demonstration and future scale-up to the impacts of complete CCAM solutions.

Cluster 7 will

- Provide the Common evaluation methodology to be applied in Large-scale Demonstrations (to Cluster 1).
- Deliver a Common test data exchange framework for sharing lessons learnt and best practices on test data exchange to Cluster 2,Cluster 5, and Cluster 3 (to additionally ease sharing of scenario descriptions).
- Provide knowledge base and guidance on shared/individual functionalities to traffic managers and fleet managers (e.g. on connectivity and cooperation) (to Cluster 4).
- Coordinate the CCAM Stakeholder forum to consult for expectations and feedback for all Clusters.

The necessity of cross-sector collaboration in Europe for the development, testing and deployment of Connected Automated Driving (CAD) has been highlighted in the Declaration of Amsterdam, the GEAR 2030 final report and the Communication from the European Commission "On the road to automated mobility". The objective of this cluster is to develop harmonised approaches and European frameworks for the assessment of impacts of CCAM technologies, systems and services, testing on public roads and sharing of Test data, building on the work carried out by EU-funded Coordination and Support Actions since FOT-Net and by Working Group 2 of the CCAM Platform in 2019-2020. The cluster will also create a stakeholder forum to improve collaboration and will maintain and extend the EU-wide Knowledge Base that will publish and disseminate R&I and piloting activities and their results, as well as methodologies and definitions of common scenarios enabling the exchange of knowledge, experiences and lessons learned as well as the development of open-source tools for these scenarios. The different activities of the cluster will support the coordination and cooperation of R&I, testing activities and living labs across Europe, facilitating the collaboration between stakeholders from all sectors and create the fundaments to move from testing and piloting towards the harmonised deployment and operations of CCAM with consensus on how it supports the societal goals.

A common evaluation methodology for large-scale demonstration pilots, including but not limited to user evaluation and socio-economic impact assessment will allow comparability of results, complementing evaluations and meta-analysis over multiple evaluation studies. Similarly, a European framework for testing on public roads will help streamlining the different national and local processes for obtaining testing permissions; facilitate mutual recognition of procedures across Member States, ultimately resulting in unified testing approaches for a better data analysis, verification and validation of systems and services. The effectiveness of large scale testing in Europe can be largely increased by a more systematic exchange of experience, test results, and test data.

Member States will have an active role in this cluster and in the related R&I and Coordination and Support Actions. A strong link will be required with the Member States Advisory board of the Partnership as well as with the national/local clusters and ecosystem for the operational aspects, in particular regarding testing conditions and regulations and associated harmonisation aspects.

Advancing the State of the Art

The initiatives of this cluster are building on a strong legacy of EU-funded projects as well as ongoing European, national and international harmonisation activities. The successive projects **VRA**[88], three **FOT-Net Projects**[89], **CARTRE**[90], **SCOUT**[91] and **ARCADE**[92] have federated large networks of stakeholders and driven consensus building across stakeholders on challenges, needs and requirements for CAD and Field Operational Tests. These actions allow building harmonised views and contribute to the development of European R&I agendas. The **ARCADE** project recently developed an online Knowledge Base gathering up-to-date information on CCAM-related R&I projects and pilot activities in Europe and beyond, regulations and policies, standards, and impact assessment and data sharing methodologies. This is complementing the **CORDIS** and **TRIMIS**[93] online databases maintained by the European Commission, the latter aiming at supporting the development and monitoring of the Strategic Transport Research and Innovation Agenda[94] (STRIA). JRC regularly carries out a foresight and horizon scanning with a similar objective. Similarly, some Member States have set up knowledge and cooperation platforms (e.g. Finland with **TransDigi**[95], and The Netherlands with the Knowledge Agenda Automated Driving). The **STAPLES**[96] project financed by CEDR[97] is looking into the test facilities across Europe but a wider scope of living labs on mobility (and a classification of them) is needed.

Several instruments and evaluation methodologies have been developed and are being used by EU-funded projects or international initiatives. These include the FESTA[98] Handbook, the Trilateral Impact Assessment Framework for Automation in Road Transportation (EU–US–Japan cooperation), the C-Roads Evaluation and Assessment Plan, the **LEVITATE**[99] Policy Support Tool (PST) as well as the

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[88] https://trimis.ec.europa.eu/project/support-action-vehicle-and-road-automation-network

[89] https://wiki.fot-net.eu/index.php/FOT-Net

[90] https://trimis.ec.europa.eu/project/coordination-automated-road-transport-deployment-europe

[91] https://trimis.ec.europa.eu/project/safe-and-connected-automation-road-transport

[92] https://connectedautomateddriving.eu/about/arcade-project/

[93] Transport Research and Innovation Monitoring and Information System (https://trimis.ec.europa.eu/)

[94] https://ec.europa.eu/research/transport/pdf/stria/stria-roadmap_on_connected_and_automated_transport2019-TRIMIS_website.pdf

[95] http://www.transdigi.fi/en/transdigi

[96] https://www.stapleproject.eu/about

[97] Conference of European Directors of Roads (https://www.cedr.eu/)

[98] https://wiki.fot-net.eu/index.php/FESTA_Handbook

[99] https://levitate-project.eu/

methodologies of **L3Pilot**[100], **AUTOPILOT**[101], **AVENUE**[102], **EU EIP**[103], **ENSEMBLE**[104], **MANTRA**[105], **SAM and SHOW**[106] projects. Collaborations between some of these projects on harmonised methodologies have started and the different approaches are being collected and made available in the **ARCADE** Knowledge base. The EU project **SHOW** and the French **SAM** project are preparing the frameworks for data collection and evaluation methodologies of multiple-FOT projects, gathering various Use Cases, vehicles, systems and services.

Similarly, initiatives in Europe have defined common formats or have set up data catalogues to facilitate the exchange of test data, e.g. **L3Pilot** Common Data Format, **FOT-Net Wiki**, Catalogues and Data Sharing Framework. Common formats for CCAM are also being specified by standardisation bodies like ISO TC204 & CEN TC278.

Some initiatives have been collecting information about testing regulations across Members States in Europe, collecting best practices or developing guidelines and recommendations to facilitate the organisation of cross-border testing. The **ARCADE** Knowledge base is gathering content on Regulation & Policies with a focus on testing exemption procedures. **L3Pilot** is developing a Code of Practice and the **SHOW** project is looking into the issues and solutions for cross European test permits.

The 4th High Level Meeting on **CAD**[107], organised by the Finnish Ministry of Transport in October 2020, highlighted the need to develop means towards mutual recognition of testing authorisations to facilitate experimental testing. **ENSEMBLE** started discussions on the requirements for mutual recognition of exemption procedures for platooning. Preparatory work is also being carried out on a framework for mutual recognition of exemption authorisations as part of the DE-FR-LU cross-border testbed. Working Group 4, on Safety Validation, of the CCAM platform set up by the European Commission is working on "Guidelines for testing of automated and connected vehicles" and preparing recommendations for mutual recognition. The EU project **HEADSTART**[108] and German project **VV Methods**[109], which have continued the work of the German project **PEGASUS**[110], are looking into harmonised safety validation approaches. Euro NCAP has defined a roadmap for definition and introduction of CAD safety assessment protocols.

Beyond Europe, initiatives have been launched to gather data about testing activities to evaluate the readiness of AVs for public use, increase transparency and raise public awareness. The AV TEST Initiative from US DOT (NHTSA) provides an online platform for sharing automated driving system on-road testing activities and other pertinent information with the public. Similarly, the Autonomous Vehicle Monitoring and Evaluation System (OLIVE) from Singapore’s Land Transport Authority gathers data from Automated Vehicles and CCTV systems for evaluation purposes.

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[100] https://l3pilot.eu/about/

[101] https://autopilot-project.eu/

[102] https://h2020-avenue.eu/

[103] https://www.its-platform.eu/

[104] https://platooningensemble.eu/

[105] https://www.mantra-research.eu/

[106] https://show-project.eu/

[107] https://www.lvm.fi/en/-/high-level-meeting-on-connected-and-automated-driving-aims-at-strengthening-cooperation-1234725

[108] https://www.headstart-project.eu/

[109] https://www.ika.rwth-aachen.de/en/research/projects/automated-driving/3120-vv-methods.html

[110] https://www.pegasusprojekt.de/en/

R&I Actions and expected outcome

The specific R&I actions relating to "Coordination" are the following:

EU-wide knowledge base and stakeholder forum on CCAM

Continue and extend the existing EU-wide Knowledge Base[111] on CCAM as the "one-stop shop" for the exchange of knowledge and experiences on CCAM in Europe and beyond and to promote existing and valuable datasets. The action should also establish a network of experts and provide a forum to facilitate their interaction.

- **Common Evaluation Methodology**

  Establish a well-structured overview of European evaluation methodologies for impact assessment and their testing instances (test sites, living labs, simulations, open road) and develop a common evaluation framework and methodology with common indicators for large-scale demonstration pilots.

- **Test Data Exchange Framework**

  Develop a test data exchange framework, which addresses legal and administrative aspects as well as technical aspects such as data provision, access, protection of user data, and labelling of data and proper description of the data format.

- **European Framework for Testing on Public Roads**

  Establish a European framework for testing on public roads based on criteria for mutual recognition of procedures to facilitate the development of both cross-border testing and support authorities, and in particular cities, in organising piloting projects.

On the basis of all the above R&I actions, the expected outcomes include:

- Comprehensive analysis of all demonstrated CCAM Use Cases and agreed strategy and harmonised approaches for implementing future large-scale demonstrations in Europe.
- Common framework for large-scale demonstration pilots in Europe including the identification of common Use Cases and Operational Design Domains (ODDs) as well as the definition of a common taxonomy and tools for scenario assessment.
- Common evaluation methodology which will allow comparability of results, complementing evaluations and meta-analysis over multiple evaluation studies (building on the outcome and recommendations from working group 2 of the CCAM Platform.
- Test data exchange framework with a collection of best practices and guidelines, including specifications for data labelling and common data formats as well as tools and documentation to use them, a common openly accessible data exchange platform safeguarding ethical usage of test data in a trusted and transparent manner to improve cooperation across projects and stakeholders. A reference platform building on existing solutions should constitute an intermediary step towards the common platform.
- Develop protocols and governance models for a unified European shared and publicly available database on incidents and other events related to safety of automated vehicles.
- Harmonised conditions and processes for tests of CCAM systems on public roads, including criteria for a mutual recognition of procedures (building on the outcome and recommendations from working group 4 of the CCAM Platform).

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[111] The existing Knowledge Base (https://knowledge-base.connectedautomateddriving.eu) has been established as the one-stop shop for CCAM knowledge in Europe, which is used by an increasing number of stakeholders from Europe and other regions of the world. It features a number of essential elements for the identification of future R&I needs, supporting the harmonisation of procedures and the transferability of best practices. These elements include past and present R&I projects (both on a European and national level), information on related regulation and national policies, strategies and action plans, guidelines and evaluation methodologies, data sharing, relevant terms, related events (including materials from past events).

- Common basis for CCAM Knowledge in the EU through an up-to-date and continuously maintained Knowledge Base on CCAM[112] adapted to the needs of the potential members of the European Partnership on CCAM and all relevant stakeholders.
- Efficient and sustainable governance structure for the collection of CCAM Knowledge in Europe and globally, thus facilitating the engagement and contribution of stakeholders from all sectors and in particular exchanges and cooperation with and amongst Member States.
- Network and forum of experts in the different thematic fields of R&I on CCAM with adequate tools and processes to enable the exchange of experiences and practices, stimulate collaboration and cooperation between all CCAM stakeholders and reach consensus on challenges and future R&I needs.

Timeline

Cluster 7 coordinates and supports the partnership and all planned R&I actions of this cluster start early on. The actions advance during the CCAM Partnership timeline to support testing, implementation and evaluation in Cluster 1. Expected outcomes of the first actions will allow for the use of common and harmonised methodologies and lessons learned by projects and testing activities after the first phase of the CCAM Partnership. Coordination and Support Actions will follow to continuously maintain and update the knowledge base and methodologies after the first phase, supporting and collaborating with actions from all Clusters and ensuring harmonised and coordinated approaches that are updated with experience and lessons learned. Once the CEM is developed in the first RIA, a follow-up CSA is needed to reflect the feedback of the first project and try it out in practice. The idea is to keep the CEM as a living document like the FESTA Handbook which has been regularly updated to reflect the latest lessons learned and good practices. Similarly, the data sharing landscape will evolve over time and an IA should follow upon the initial RIA.

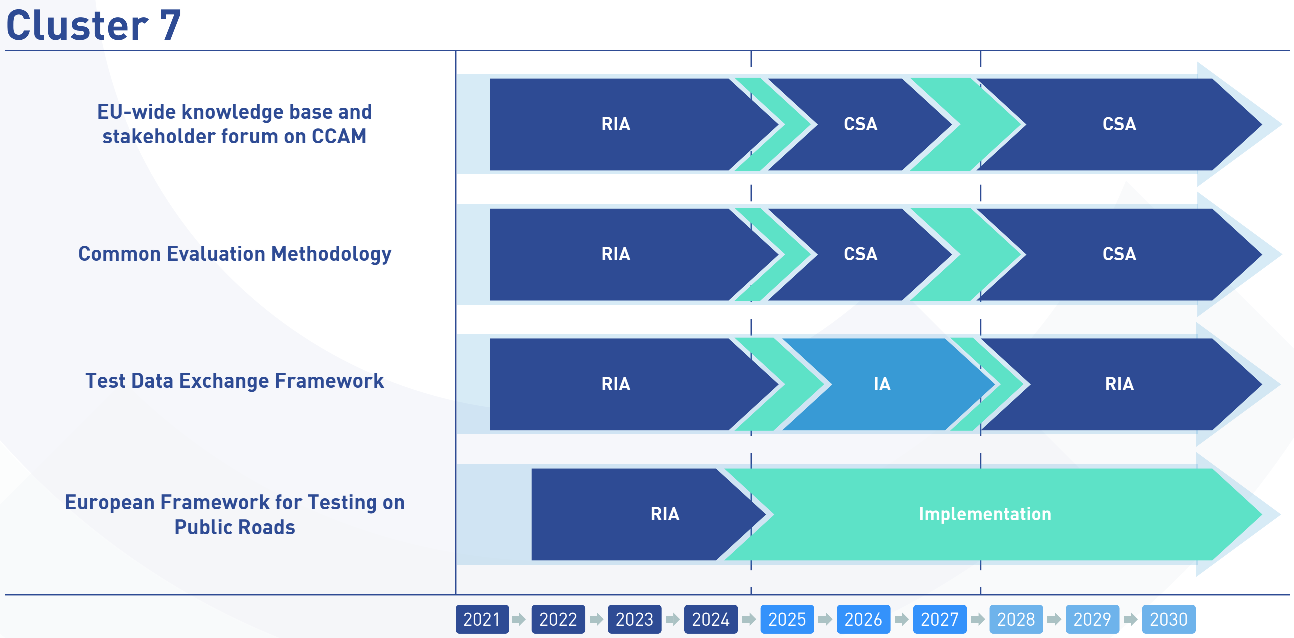

Figure 17: Cluster 7 R&I Actions over the Partnership Programme timeline.

The data environment is constantly updated and will be different than today in 4-5 years. A RIA would be necessary afterwards to keep up with the ever changing landscape.

The following image aims at making this progression process transparent.

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[112] https://knowledge-base.connectedautomateddriving.eu/

8. SRIA Implementation

The Partnership will be implemented through collaborative R&I projects funded by the Horizon Europe programme and by additional activities provided in kind by the partners. A number of activities, such as coordination and dissemination efforts, support to harmonisation and standardisation, international cooperation, etc. will be covered both by EU funding in the different types of EU projects and complemented by in-kind additional activities.

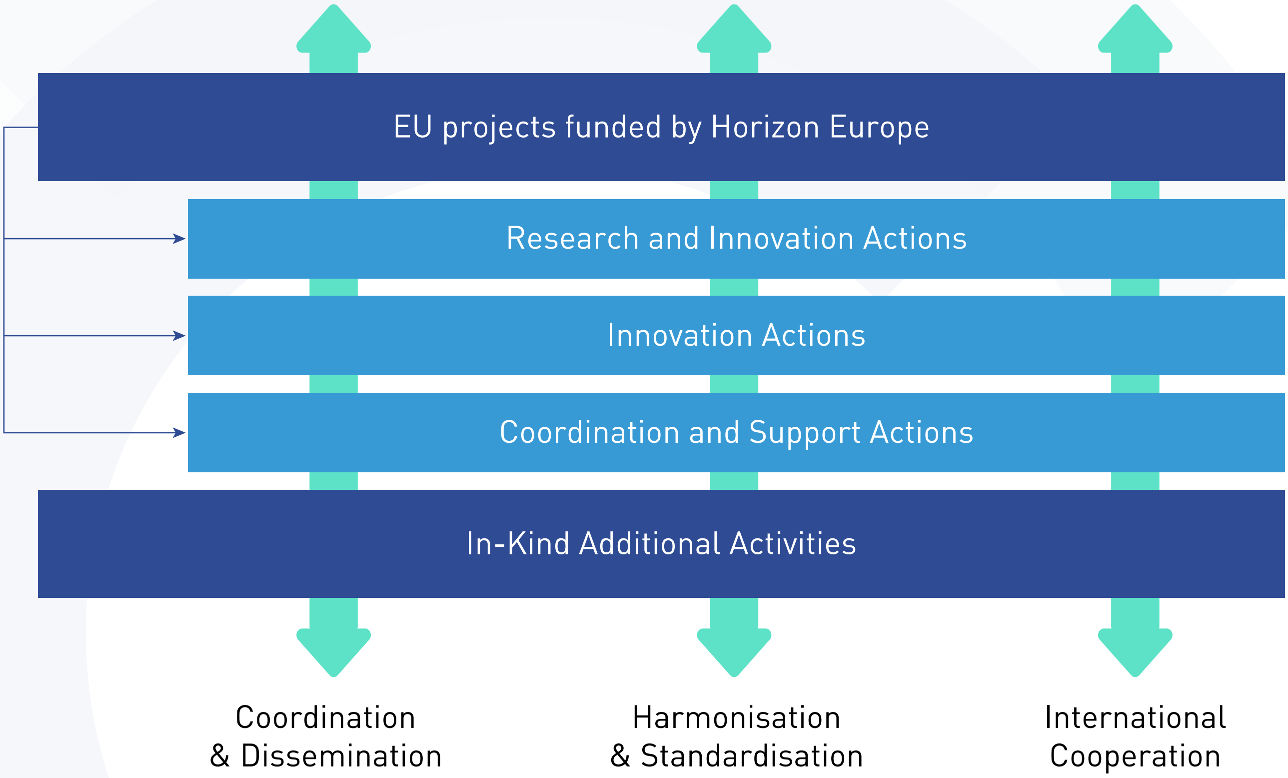

Figure 18: SRIA Implementation activities

8.1. CCAM calls for projects under Horizon Europe

The SRIA describes the R&I Actions necessary to advance toward the Deployment Readiness of CCAM. An increasing maturity of technologies (TRL) and successful delivery of enabling activities will be needed. The implementation of the SRIA will mostly be done through the different types of European collaborative projects that are described in the following sections. The members of the CCAM Partnership have expressed their willingness to contribute to these activities.

Research and Innovation Actions

Research and Innovation Actions (aiming at TRL: 3-5[113].) are the basis for all developments towards cooperative, connected and automated mobility. The Research and Innovation actions developed in the seven CCAM Clusters will be aiming at delivering new knowledge, and/or be exploring the feasibility of improved or new technologies. Instruments of Research and Innovation Actions can include e.g. desk research, feasibility studies, technology development, HMI studies including user tests, laboratory testing, model development, cost-benefit analysis, risk assessment and simulations. Some examples of topics for RIAs expected:

- The development of reliable occupant protection technologies and HMI solutions to ensure the safety of highly automated vehicles. This will require a mix of research activities including

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[113] Section G on TRL definitions: https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-ga_en.pdf

modelling and simulation in addition to testing solutions in the laboratory in order to provide significant advances with respect to the state-of-the-art.

- The development of explainable and trustworthy Artificial Intelligence (AI) concepts, techniques and models for CCAM, including the development of decision making (i.e. planning and acting) based on robust and reliable detection and perception, as well as unbiased AI training approaches.
- The development of technologies for cyber secure and resilient CCAM for safe and secure operation. This will require development and validation of methods and tools, as well as specific security building blocks, with a systems approach and harmonised interfaces and protocols to enable integration of vehicles, infrastructure, back-offices and mobility service centres
- The development of methodology and indicators to assess the impacts of CCAM solutions on mobility and wider socio-economic effects. This requires a multidisciplinary approach encompassing aspects such as public health, land use/infrastructure need, environmental aspects such as energy use, accessibility, air quality, carbon emissions and impact on economy, employment, working conditions and required skills etc.

Innovation Actions

On the basis of the results of amongst others the Research and Innovation Actions, further development shall be carried out in the Innovation Actions (aiming at TRL: 6-8). The Innovation Actions will be developing e.g. designs for new, altered or improved products and/or services. Activities may include prototyping, testing, demonstrating, piloting, large-scale technology and application validation including validation of the economic viability. Two examples of topics for RIAs expected:

- The development of more powerful and reliable on-board perception and decision-making technologies – activities need to include also the testing of prototype solutions on vehicles in realistic conditions in order to ensure that complex environmental conditions can be tackled accordingly.
- The central element of the CCAM Partnership is the large-scale demonstration activities (see Chapter 7) in Cluster 1. While demonstrations with Pilots and FOTs focus on the technical usability, living labs will be a key instrument to evaluate the usability of CCAM within society by including citizens in testing and demonstration.

Coordination and Support Actions

Coordination and Support Actions will be required beyond Research and Innovation Actions or innovation Actions to pave the way towards deployment in cases where building of consensus is required among stakeholders for harmonised approaches and to ensure that common methodologies are promoted and regularly updated to reflect lessons learned and best practices. Coordination and Support Actions have been defined in the Horizon 2020 Framework programme[114] as “Actions consisting primarily of accompanying measures such as standardisation, dissemination, awareness-raising and communication, networking, coordination or support services, policy dialogues and mutual learning exercises and studies, including design studies for new infrastructure and may also include complementary activities of strategic planning, networking and coordination between programmes in different countries”.

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[114] HORIZON 2020 – WORK PROGRAMME 2018-2020 General Annexes, https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-d-csa_en.pdf

In the case of CCAM, CSAs are in particular expected to

- Support the development of harmonised methodologies and framework for testing, evaluation and piloting of CCAM solutions and services
- Support reaching consensus among stakeholders on challenges and solutions related to the development and deployment of CCAM solutions and services
- Contribute to raising awareness about CCAM solutions and foster the exchanges of best practices and lessons learned.
- Organise contributions to policy dialogues and support the definition of policy and R&I agendas.

The following activities will be cross-cutting, covered by the different types of EU projects described in 8.1, and complemented by in-kind additional activities listed in 8.2.

Coordination & Dissemination

The Partnership will undertake coordination activities in order to facilitate networking and contribute to the building of the stakeholders community: it will facilitate new and improved connections between the various actors, including academic, industry, civil society and policy. Also the local level need to be involved e.g. users representatives, local authorities, providers of local mobility services, etc. This community building between researchers and stakeholders should help to exploit the results from research: raising awareness for technological development and innovation activities, encouraging the uptake of new solutions into new services, and leveraging the policy objectives impact. Cluster 7 will be in the lead here, following up the results already established in projects like **ARCADE**[115]. All Partnership members will be invited to contribute to these activities developed by the cluster 7 projects.

Regarding dissemination, the ambition is to spread the information, results and impacts delivered by the Partnership activities among the stakeholders. The dissemination and communication should also support the long-term ambitions of the Partnership to include a large variety of stakeholders, including start-ups and SMEs. The large-scale demonstrations especially in living labs provide opportunities to involve the civil society and enhance public awareness, which will be also studied and promoted through the activities of the cluster 6. The dissemination and communication strategy should include information sharing through website and newsletters, knowledge sharing among partners, coordinated outreach activities and jointly organised conferences and events together with the European institutions and various stakeholders including civil society representatives.

Harmonisation & Standardisation

To ensure that technologies and methods developed within CCAM can be rolled out in Europe and to avoid cross-border and cross-supplier conflicts, the Partnership will contribute to the harmonisation of CCAM enabled mobility solutions and development of technical standards from the very beginning. The members of the Partnership Association will cooperate with European standardisation bodies addressing interoperability of new technologies for cooperative, connected and automated mobility, which will also lay a foundation for involvement with international standardisation organisations further enhancing European competitiveness. Concretely, the Partnership projects will be required to include this objective of promoting standardisation in their activities where relevant. They should plan upfront the dissemination of their results towards the standardisation bodies, providing support from their research results to the standardisation processes.

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[115] ARCADE Grant agreement ID: 824251, https://cordis.europa.eu/project/id/824251

The Partnership Association itself will support this process by disseminating and promoting the projects activities and results, e.g. through targeted events with the involved stakeholders. It will however not act itself within standardisation bodies.

International Cooperation

One specific action will be the setup of a States Representatives Group in which national authorities of countries participating to the Horizon Europe programme will be invited in order to exchange information and promote coordination between the EU activities and the activities organised at the national level, as well as among the countries themselves. The meetings of this States Representatives Group will be convened by the Partnership Board and the matters it may cover are described in the Memorandum of Understanding. Moreover, the objective of international cooperation will not stop at the European borders and targeted events will be organised with other world regions, in continuity of the efforts done during the last years e.g. the EU-US-Japan trilateral meetings. The exchange of information is at the core of this activity, so the European activities are made known across the world, while we get to know the activities done elsewhere. But beyond the task of exchanging information, such international cooperation should provide awareness about the key research topics and the strategic orientations followed by international counterparts: this knowledge should bring insight and support the refining and update of the European strategy, which must take into account the trends taking place at international level. The Cluster 7 will also be in the lead for this activity.

8.2. In-Kind Additional Activities

In addition to the actions funded by the Horizon Europe programme, a number of in-kind Additional Activities will be done by the Partnership in order to support its objectives. These contributions demonstrate the commitment of the partners to work together towards the common objectives, and they are an added value of setting such a European Partnership. The Memorandum of Understanding of CCAM provides the list of in-kind additional activities that may be covered by the members:

i. Coordination and development of projects, dissemination of results and achievements of the partnership, including identification of success stories. Support to knowledge building and sharing by contributing to a joint database.

ii. Activities to involve and raise awareness of users and communities at national, regional and local levels. Specific dissemination of Partnership results towards decision-makers.

iii. Support to relevant standardisation, certification and regulatory activities.

iv. Organisation and participation in conferences, expert webinars on specific topics, and stakeholders networking events.

v. Support R&I strategy alignment and synergies by building common roadmaps.

vi. Actions to develop synergies with other European, transnational and national R&I initiatives. Including coordination with other related partnerships at EU level.

vii. Complementary projects at national, regional, local and private level: projects covering lower or higher TRL activities in the field of the partnership, or projects occurring in parallel to the partnership activities e.g. other trials and field tests.

viii. Education, training and skills development: employees benefiting from upskilling and training schemes. Adaptation of academic schemes.

The definition, planning and reporting of these in-kind additional activities will be organised by the Partnership Board as part of the work process described in chapter 9, in consultation with the stakeholders.

8.3. Commitments and contributions of partners

The ambition of the Partnership is to make Europe a world leader in the deployment of connected and automated mobility, and making a step-change in Europe in bringing down the number of road fatalities as well as reducing harmful emissions from transport and reducing congestion. These very ambitious objectives will not be reached by the research and innovation actions alone, and this is why the Additional Activities are of high importance, and the involvement of as many stakeholders as possible is key.

After developing, testing and successfully demonstrating mobility services based on automated driving technologies and cooperative systems, the production and market penetration is the actual key to realise the expected impacts. The technological evolution must meet market needs and customers' expectations to leverage the great opportunities for the industry in terms of mass manufacturing as well as new business models or new mobility services provided by CCAM.

This requires a scale up phase, with investments in the range of 5 to 10 times the scale of the overall Partnership budget. These comprise technology development in high TRL levels (8-9) and the deployment of technologies, systems and services, ramping up manufacturing capabilities and pilot lines, infrastructure investments, and investments in new jobs and skills required. The Partnership will foster the collaboration of stakeholders to support this process, by encouraging synergies and the mobilisation of additional investments, for example in regard to further testing:

- OEMs and suppliers will contribute with their fleets of test vehicles and equipment.
- Research sector contributes with know-how, innovation and assessment capabilities.
- Cities, regions and infrastructure operators provide the foundation for living lab environments to implement large scale testing and demos and the link to users and citizens.
- Public transport providers use their fleet and operations to test CCAM services.
- Mobile network operators will address (5G) connectivity needs to enable seamless mobility services.
- Transport industry supports CCAM with their expertise in heterogeneous and complex system landscapes.
- Cross-sector collaboration leading to joint investments is also very important for the entire lifecycle of CCAM elements (roads, services and vehicles) from early stages of research up to deployment and maintenance over the entire life cycle of the assets placed to the market.
- All actors necessary for the deployment need to be involved already in the first phases, together with cross-sector research and innovation partners, in order to contribute jointly to develop CCAM on the Technology Readiness Levels (TRL) up to some pre-deployment (Horizon Europe scope).
- When industry is entering competitive phase, i.e. development towards market, collaboration with infrastructure actors is needed for preparing coherent and harmonised deployment. Since different investment planning cycles represent a significant challenge (e.g. sufficient lead time for planning deployment budgets), there are strong merits of better cycle synchronisation identified earlier through the partnership in order to deliver value for all partners also at intermediate steps (aligned releases, updates, etc.).
- Deploying and/or adapting physical, digital and operational infrastructure in support of CCAM is costly and the return on investment is to a significant extent contributing to societal goals (safety, traffic efficiency, decarbonisation). Hence, deploying CCAM needs support from infrastructure deployment focused co-funding programmes like the Connecting Europe

Facility (CEF 2) at the European level, or else will rely very much on investments by national programmes.

Following the setup of the Co-Programmed Partnership instrument in Horizon Europe, the contributions provided by the partnership members will be:

a. In-kind contributions to the projects funded by the EU (on the basis of non-reimbursed eligible costs);

b. In-kind contribution to the Additional Activities: these in-kind additional activities are those activities which contribute to achieving the objectives of the Partnership, including R&I at higher TRL and/or to ensure demonstration, market, regulatory and societal uptake, which are in the scope of the SRIA but are not covered by Union funding. These in-kind Additional Activities are defined by the Memorandum of Understanding and listed in chapter 8.2.

Contributions to **a.** will be quantified through the standard EU projects reporting procedure. Contributions to **b.** will be assessed through a harmonised reporting methodology.

In addition, the members of the Partnership will contribute to its leverage when making investments in operational activities: investments going beyond the work foreseen in the SRIA but contributing to achieve the objectives of the Partnership. These investments in operational activities will not be included in the calculation of the contributions provided by the Partners but will count as leverage of the Partnership. Depending on the stakeholders, these investments could take very various forms. The Memorandum of Understanding of CCAM provides the list that may be covered by the members:

i. Investments in infrastructures to support testing and deployment.

ii. Investments in start-ups or spin-offs.

iii. Investments in development to prepare market introduction.

iv. Investments in production capacity.

v. Training programmes for workforce.

These investments by both private and public stakeholders are expected to trigger a leverage effect of at least 5 times the initial EU funding and hence maximise the impact of the Partnership. It is however expected that most of these investments will come rather towards the end of the partnership lifetime and beyond its timeframe.

8.4. Alignment, exchanges and joint actions with other Horizon Europe Partnerships and EU programmes

Strengthening coherence in research, technological development and innovation in Europe is one objective addressing the Problem Driver 3: Current R&I efforts are fragmented and lack a coherent, longer-term vision and strategy for targeting systemic solutions. Public and private stakeholders can develop synergetic effects for their investment plans to advance vehicle and infrastructure technologies.

The CCAM Partnership is seeking interaction and coordination with other complementary Partnerships (2ZERO, DUT, Transforming Europe's rail system) or Partnerships addressing enabling technologies for CCAM (KDT, AI, SNS, HPC, Photonics). This coordination will be facilitated through e.g.:

- alignment groups or institutional meetings,

- joint expert workshops,
- joint conferences.

The CCAM partnership can also support the objectives of the Mission on "Climate-neutral and Smart Cities" by implementing large-scale demonstrations of automated mobility systems and services within cities.

Synergetic effects in the long-term could facilitate and accelerate deployment thanks to links with other European programmes and funding instruments (e.g. Connecting Europe Facility 2, IPCEI).

In the following paragraphs the coordination opportunities with other relevant European Partnerships is described.

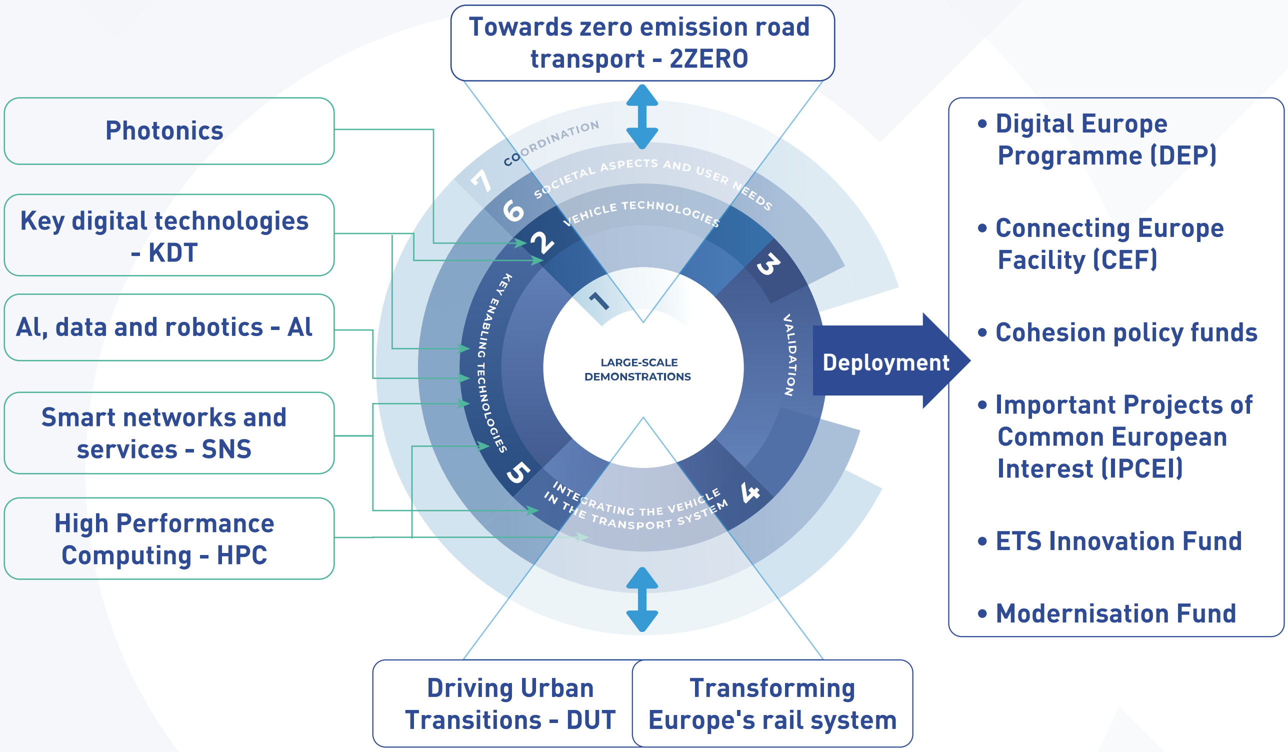

Figure 19: Interfaces between CCAM partnership and other European partnerships and synergetic effects with EU Programmes/Funds supporting deployment.

Cooperation between the CCAM Partnership and the 2ZERO Partnership

2Zero - Towards zero emission road transport - is a candidate Co-Programmed Partnership in Horizon Europe. It is the follow-up of the EGVI - European Green Vehicles Initiative - Public-Private Partnership implemented in Horizon 2020. Its core objective is the acceleration of the introduction of zero emission vehicles in a system approach. The purpose of linking 2Zero with the CCAM Partnership is to seek the integration of the decarbonisation and digitalisation challenges, opening additional opportunities to improve the efficiency, both at vehicle level and at mobility system level. Zero emission powertrains combined with connectivity and automation will enable innovative climate neutral mobility services and logistics operations.

Potential fields for cooperation

- Develop and demonstrate innovative mobility services that combine automation and zero emission technologies.
- Environmental impact analysis: potential effects of CCAM solutions should be integrated within

the climate-neutrality objective pursued by the 2Zero Partnership.

- Fleet and traffic management including environmental aspects such as emissions reduction
- Vehicle technologies for emissions reduction leveraging CCAM technologies.

Cooperation between the CCAM Partnership and DUT Partnership

DUT - Driving Urban Transitions - is a candidate Co-funded Partnership in Horizon Europe, addressing urban transitions with a cross-sectoral and integrated approach. It includes the transformation of the urban mobility system as one of three pillars in sustainable urban development. Connecting the two initiatives CCAM and DUT allows to build a European approach for the implementation of CCAM, ensuring that its technologies, infrastructures, services and systems are developed with a sound understanding of their implications on the wider urban context. Urban-related results and issues developed and identified in the CCAM Partnership could be considered and taken up within the DUT Partnership, to investigate the wider consequences and potentials of CCAM solutions for urban planning and management. On the other hand, the DUT programme could also support CCAM in mobilising a wider set of actors in the participating countries, contributing to experimentation in cities and urban areas with different local conditions, covering some aspects related to governance, the role of CCAM in integrated mobility systems, behavioural issues and needs, as well as relationships to other sectors and systems (e.g. energy).

Potential fields for cooperation:

- CCAM-related infrastructure demands, solutions and their impacts on other urban infrastructures.
- Fleet and traffic management concepts developed in CCAM could be picked up in DUT to investigate relationships with other mobility modes.
- Aspects of governance and management, urban planning issues, user behaviour and societal needs.
- Large scale demonstrations on urban logistics or last-mile delivery could be connected
- Opportunities to assess CCAM solutions and approaches in a wider context, e.g. for other sectors and stakeholder groups.
- Knowledge sharing and learning to support capacity building and joint dissemination and outreach.

Cooperation between the CCAM Partnership and KDT Partnership

KDT – Key Digital Technologies – is a Partnership succeeding the ECSEL Joint Undertaking of Horizon 2020 in the next framework programme. Its focus is on Electronic Components and Systems as enabling technologies for multiple application fields including mobility. Therein, enabling affordable, automated and connected road mobility is a high-priority R&D&I area. Moreover, KDT shall support the validation and certification through digital innovation for safety, security and comfort of (artificial) intelligence embedded in vehicles. The focus topics of KDT is mostly on providing the components, building blocks while their customised integration, verification and optimisation is within the CCAM Partnership.

Potential fields for cooperation

- Reliable and precise sensor systems for environment detection and localisation as well as machine learning and AI-based cognition methods.
- Performance requirements of a sensor suite in terms of resolution, contrast and speed should be defined for relevant ODDs within CCAM.
- Sensors, communication devices, actuators, controllers and algorithms or AI, their adaption to the requirements of e.g. a certain automation level or ODD, is part of CCAM. Testing and validation of such control systems (methods, tools, platforms), and particularly their self-learning parts, in view of relevant traffic scenarios, whether in real world or virtually, is a matter of CCAM.
- Hard- and software-based methods of shielding, tamper proofing and encryption ensuring cybersecurity between vehicles, the digital infrastructure and communication networks is part of KDT and adapted to and applied to the specific Use Case of CCAM is part of the CCAM Partnership.
- Active safety and assistance systems supporting CCAM with sensors, actuators and controls are to be developed within KDT. Reliability levels of the components required for accident avoidance should be assessed in CCAM with a feedback loop to KDT.

Cooperation between the CCAM Partnership and The Smart Networks and Services - Partnership

The SNS - Smart Networks and Services - Partnership proposal has as one of its objectives to enable the full digitisation of vertical industries. CCAM was identified as one of the main vertical domains (besides other domains like healthcare, media, smart manufacturing, energy, smart cities). The 5G Infrastructure Association (5G IA), currently the lead contact partner for the SNS Partnership, has already ongoing collaboration on the CCAM field with stakeholder associations such as ERTICO, GSMA and 5GAA which are also involved in the CCAM Partnership proposal. The SNS research agenda will further investigate innovative solutions to provide network and device enhancements necessary to support the development and deployment of CCAM enabled mobility solutions. For CCAM systems which rely on connectivity for safety-critical functions, the connectivity context will have to be included in the validation methodologies.

Potential fields for cooperation:

- Specifications, requirements and enabling technologies for the digital infrastructure to enable safe and secure operation of CCAM systems.
- Mutual exchange and alignment on interfaces, service and business requirement definition.
- Secure effective connectivity needed for CCAM and build further on SNS results to allow for early adoption of new connectivity innovations. Jointly define robustness and redundancy, availability of communication channels and a minimum quality of service for Cloud Edge computing.
- Define clear targets and roles for stakeholders engaging in the mobility system and fleet and traffic management with secure communication, in contextual application. Creating a (cyber) secure overall system with distributed tasks and shared responsibilities enabling (real time) data handling, data sharing, including cross border issues and smart protocols related to connectivity.

- Exchange of demonstration activities, on both CCAM technologies and SNS technologies, best-practice information and collecting and interpreting results.
- Joint validation scenarios based on real world scenarios for CCAM systems relying on connectivity for safety-critical functions, the connectivity context is to be included in validation methodologies.

Cooperation between the CCAM Partnership and the Partnership on AI, data and robotics

Increased computing power, the availability of large amounts of data and progress in algorithms, smart devices and smart robots, are shaping Artificial Intelligence (AI) as one of the most strategic technologies of the 21st century. The SRIDA of the Partnership on AI, Data and Robotics mentions several topics linked to CCAM and more widely to mobility. Based on this and on discussions with representatives of the Partnership, potential fields for collaboration are identified and incorporated. The Partnership on AI, Data and Robotics can be seen as a horizontal Partnership, rather sector-agnostic, whereas the CCAM Partnership is a vertical one. The fields of collaborations are at their intersections, and will concern the development of sector-agnostic innovations into Use Case and sector specific innovations.

The development of CCAM solutions builds upon the progress and directions taken in a number of key technologies addressed by the AI, Data and Robotics Partnership. These are linked to the CCAM Cluster 2 **Vehicle Technologies**, and to Cluster 5 **Key Enabling Technologies**. The CCAM Partnership aims at a fast application and uptake of new and emerging knowledge fields identified and developed within the AI, Data and Robotics activities.

Potential fields for cooperation

- Machine Decision Making: autonomous actions by an AI-based system; hybrid decision making, combining human efforts and AI technologies as well as the physical and human interaction.
- Applying AI for situational awareness and predictive perception, and eventually also actuation. Improving integration of the perception systems with AI and decision making control systems in the vehicles.
- Develop explainable, robust and trustworthy concepts, techniques and models of Artificial Intelligence for CCAM.
- Increase the acceptance and uptake of AI-based technologies through a better understanding of societal, socio-economic and environmental needs, by developing knowledge-based solutions grounded in social innovation.
- Data quality, combining data from multiple sources, privacy and protection and interaction on handling, sharing and storing data in a harmonised approach and in a multi-sectoral alignment to foster uptake.

Cooperation between the CCAM Partnership and Photonics21 Partnership

The European Technology Platform Photonics21 represents the photonics community of industry and research organisations. Photonics21 activities, addressing developments of key enabling photonics technologies, would benefit from cooperation with CCAM projects focusing on system integration, development of sensor-fusion solutions for environment perception, validation and other pre-deployment activities:

- Photonic sensing capabilities efficiently integrated in automotive platforms, and fully performant under real-world environmental conditions. Validation of sensor fusion with graceful degradation when exposed to adverse weather conditions.
- Higher levels of automation and new ways for in-vehicle sensing enable new ways humans interact with the vehicle. New strategies will be required for monitoring the driver to sense their distraction and readiness to resume control of driving when required.

Cooperation between the CCAM Partnership and the Transforming Europe's Rail System Partnership

Transforming Europe's Rail System is a candidate institutionalised public-private partnership (iPPP) in Horizon Europe. It is the follow-up of the Shift2Rail Initiative implemented in Horizon 2020. The objective of the new rail partnership is to enable the European rail network to be a crucial part of the Green Deal policy towards an environmentally friendly and energy-efficient mobility. Dependability, resilience and service quality will be key objectives to fulfil the goal of being a core part of a competitive and resource-efficient multi-modal European transport network.

Even though the partnerships CCAM and Transforming Europe's Rail System do focus on different transport modes, they have points of contact in various topics. On the one hand, to enable a multi-modal transport chain, the future rail system needs to be interoperable with the mobility services developed in CCAM. Especially in the urban environment, where trams and LRT share the same space with automated vehicles. On the other hand, both partnerships share, due to the main objectives of digitalisation and automatisation, a variety of action areas such as cybersecurity or data architecture. Since product life-cycles in the rail sector differs significantly from those of the road transport and particular future CCAM system, specific requirements and constraints will lead to totally different solutions despite commonalities in defined R&I actions. As such, cooperation should focus on exchanging and transferring knowledge by e.g. interchange groups for similar action areas in both partnerships. The organisation of joined dissemination activities such as interdisciplinary publications or joined events could expand the interested public and show the connectivity of the European partnerships.

Potential fields for cooperation

- Exchange of findings and cooperation in common research fields including Artificial Intelligence, Data Storage and sharing, System architecture, Fleet and (mixed) Traffic Management, Cyber-Security, Environment Perception, Robustness and resilience, Physical and digital infrastructure and Validation.
- Cooperation and possible alignment of methodology for the approach to evaluate societal aspects and user needs.
- Joined dissemination to reach a wider interested public.

Cooperation between the CCAM Partnership and the Clean Aviation Partnership

Clean Aviation is a candidate institutionalised public-private partnership (iPPP) in Horizon Europe. It is the follow-up of the Clean Sky Initiatives implemented in FP7 and continued in Horizon 2020. Clean Aviation's goal is to enable climate-neutral aviation by 2050 through zero- and low-emission technologies. Hereby, Clean Aviation will contribute to the EU policy priorities, especially the Green Deal. Following the draft Clean Aviation SRIA, Clean Aviation will target regional and short-range flights as well as medium and long-range flights by suitable propulsion solutions and aircraft designs.

The purpose of linking CCAM and Clean Aviation is to gain from experience and findings in similar research fields. In several fields CCAM and Clean Aviation have to face the same challenges. Besides the planning of large demonstrations, both partnerships will use the opportunities of digitalisation and thus have to address also its challenges.

Potential fields for cooperation

The requirements and constraints of aviation differs significantly from those of CCAM, so that joint research and innovation activities are not deemed efficient. However, both Partnerships should exchange and discuss insights and solutions on common research fields like AI, digitisation, safety or social impact to foster synergies. Following measures are feasible:

- Interchange groups for similar action areas in both partnerships could be established. An exchange of findings in such groups could be used to gain from the experience in the other transport mode.
- The organisation of joined dissemination activities such as interdisciplinary publications or joined events could expand the interested public and show the connectivity of the European Partnerships.
- Exchange of findings and cooperation in common research fields including Artificial Intelligence, Data Storage and sharing, System architecture, Fleet and (mixed) Traffic Management, Cyber-Security, Environment Perception, Robustness and resilience, Physical and digital infrastructure and Validation.

Cooperation between the CCAM Partnership and the Integrated air traffic management (ATM) Partnership

Integrated ATM is a candidate institutionalised public-private partnership (iPPP) in Horizon Europe. It is the follow-up of the SESAR Joint Undertaking implemented in FP7 and continued in Horizon 2020. The goal of the European Partnership on European Partnership for Integrated ATM is to achieve a digital transformation of air traffic management in order to make the European airspace the most efficient and environmentally friendly in the world. This will support the competitiveness and recovery of the European aviation sector in a post-coronavirus crisis Europe. Focusing on e.g. improving connectivity, air-ground integration and automation, increasing flexibility and scalability of airspace management and safe integration of drones there are several fields in which CCAM and Integrated ATM have to face the same challenges.

Potential fields for cooperation

- Interchange groups for similar action areas in both partnerships could be established. An exchange of findings in such groups could be used to gain from the experience in the other transport mode.
- The organisation of joined dissemination activities such as interdisciplinary publications or joined events could expand the interested public and show the connectivity of the European partnerships.
- AI is foreseen to be used in main areas of Integrated ATM, in particular addressing advanced aircraft energy management by optimised flight paths.
- In Integrated ATM, research will be carried out to find ways to ensure the stable connectivity and environment perception while designing the entire air traffic management system and its technical components safer and energy efficient.

- As for all innovations triggered by digitalisation, cyber-security is an important part of the developments in Integrated ATM.
- By using digital twins, continuity and traceability of aircraft information e.g. certifications will allow a smooth handling.
- Digitalisation to accelerate validation processes, with increased cost-efficiency.

9. Annual planning and work process

9.1. Approach of stakeholder involvement and activities planning

To deliver on the objectives of the Partnership, it will be necessary to assess and update on a regular basis the priorities and planned activities. The SRIA was developed in a comprehensive process engaging with all relevant stakeholders, as described in chapter 2. Broad stakeholder involvement via the Partnership association will be the basis for identifying priorities and defining the activities with all constituent entities, including Member States representatives. This consultation process will be the basis for the work: setting up each year a number of activities and meetings to support the assessment, setup and monitoring of the Partnership activities and objectives. All relevant stakeholders will be involved through an open membership approach of the Partnership association, with a proactive strategy to encourage further membership.

The development of the SRIA was based on a co-creation approach engaging the multi-sectoral stakeholder community. Even though the SRIA R&I actions are defined on a long-term basis, they are based on technological and socio-economic realities that will continue to evolve, making it imperative that its expected results and impacts are monitored continuously: this assessment will feed the definition of the next research priorities and additional activities.

9.2. Process, content and timing for the annual workplans

The objectives of the SRIA will be translated into annual workplans to be discussed and agreed in the Partnership Board, by the delegates of the stakeholders together with the European Commission services. The governance of the Partnership Board is defined in the Memorandum of Understanding signed between the European Commission and the Partnership Association, completed by rules for procedures. The governance of the Partnership association is defined by its own Statutes, setting up the nomination process and work principles for the delegates representing the association in the Partnership Board. Important principles have been set to guarantee representativeness and openness: delegates will be elected from all the different member categories, and will act not to represent only their own organisation but to represent their stakeholder category and the association as a whole.

The annual workplan will propose actions for the following year: including the preparation of research recommendations for the Work Programme, and also the identification of additional activities to be done beyond EU projects. These additional activities, as defined in the Memorandum of Understanding, will contribute to achieve the objectives of the Partnership e.g. further testing and demonstration, support to standardisation or harmonisation, dissemination and support to societal uptake, etc., as explained in chapter 8. Furthermore, outcomes and results of ongoing R&I projects should be collected on a regular basis to feed the process with latest news: information from projects will be collected, with the common knowledge base being the key instrument and source for this assessment.

The annual workplans will therefore include the following activities:

On a regular basis: inputs from the running CCAM projects to build the State of the Art and lessons learned. This process should be conducted with the support of the coordination projects from Cluster 7, which are essential tools for the collection of knowledge, State of the Art and methodologies.

When requested by the European Commission and at least every two years: discuss the next R&I priorities for CCAM, including expected impacts and objectives, by providing detailed recommendations for topics to be included in the Horizon Europe Work Programmes. Each of the 7 CCAM Clusters will prepare content for these topics, to be discussed also in the General Assembly meetings, with all members invited to participate in this process. Member States organisations will be involved in this process directly through their membership in the association. Recommendations will also be presented in the States Representatives Group. These R&I priorities for the next Work Programmes will be developed together with the European Commission services within the Partnership Board: the delegates of the association will present to the Partnership Board the input prepared within the association, to discuss with the EC services with the goal of reaching a common understanding. The text of the R&I topics will be finalised and processed by the European Commission into the Horizon Europe Work Programmes.

On an annual or bi-annual basis, according to the reporting methodology described in the Memorandum of Understanding:

a) Assess the progress done towards the Partnership objectives, using the Key Performance Indicators (KPIs) described in chapter 6.

b) Report on the functioning of the Partnership, including on openness, transparency, collaboration and synergies with other European Partnerships and initiatives.

c) Plan and report the additional activities done beyond EU projects (as described in chapter 8.2 and in the MoU): develop every year a plan of which upcoming additional activities can support the objectives of the Partnership, and then report annually which of these additional activities have been done, including qualitative assessment and quantitative data whenever possible.

d) Provide information on investments in operational activities (as described in the MoU): investments spent beyond the work foreseen in the SRIA, including public and private investments mobilised to exploit or scale-up CCAM. This is used to calculate the leverage effect of the Partnership.

e) Develop "impact case studies": success stories that can be used to highlight prominent results or lessons learned from specific projects/activities, or highlight follow-up using other instruments.

The planning and reporting of additional activities and investments in operational activities will respect confidentiality and competition requirements.

9.3. Process and timing for updating the SRIA

The SRIA provides the strategic framework for preparing future activities within the Partnership. In order to consider recent developments and rapid technological progress (i.e. of disruptive nature), the SRIA will be updated during the lifetime of the Partnership to reflect any major technological advancement, new emerging challenges, or evolving societal needs. So, even though the SRIA at hand is covering the full duration of the Partnership, an evaluation during the Partnership lifetime will be necessary.

This review and updating process will be done in full openness, involving all the members of the Partnership, again in a co-creation approach. The coordination activities from Cluster 7 will provide the knowledge on latest project results and achievements, and all Clusters will support the evaluation by providing relevant expertise on the different R&I fields. The European Commission services will participate to the evaluation. Member States Representatives will be involved through the States Representatives Group. All members of the Partnership will be consulted in the drafting of the updated SRIA version, and a public consultation will be organised, to allow also non-members to provide their views. The updated SRIA will be presented to the General Assembly of the Partnership association for endorsement by the stakeholders, and to the Partnership Board for agreement with the European Commission.

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EUROPEAN PARTNERSHIP

CCAM
CONNECTED, COOPERATIVE
& AUTOMATED MOBILITY

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