European Partnership under Horizon Europe

Connected, Cooperative and Automated Mobility (CCAM)

[draft 13 March 2020]

WORKING DOCUMENT

The present document is a preliminary version of the document to be submitted to the European Commission to present the proposed European Partnership on CCAM. It is based on the input of the Working Group 1 of the CCAM Single Platform and will be used as a basis for consulting all relevant stakeholders.

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1 General information

1.1 Draft title of the European Partnership

European Partnership on Connected, Cooperative and Automated Mobility (CCAM)

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1.4 Summary (max 500 characters)

The proposed Partnership aims to harmonise European R&I efforts to accelerate the implementation of innovative CCAM technologies and services. It aims to unfold the full systemic benefits of new mobility solutions enabled by CCAM: increased safety, reduced environmental impacts, and inclusiveness. By gathering the actors of the complex cross-sectoral value chain, the Partnership will work on a shared, coherent and long-term R&I agenda. The Vision of the Partnership is: “European leadership in safe and sustainable road transport through automation”.

2 Context, objectives, expected impacts

2.1 Context and problem definition

- *Please explain the context in which the Partnership is considered: Why is this initiative being proposed now? What problems and/or strategic opportunities does the initiative aim to tackle? What are the causes ("drivers") of the problem and their relative importance?*
- *Include data and evidence on the state and scale of the problems and/or strategic opportunities currently (status quo), and possible results from foresight on how this is expected to evolve in the future. In establishing and analysing this, draw clear links with previous Framework Programme intervention and results in this priority area – both in the context of work programmes, as well as R&I partnerships, if applicable;*
- *Describe the underlying research, innovation, deployment or systemic bottlenecks and/or market failures that are to be addressed by the Partnership and how this serves both private and public interest and delivery of public goods, including dissemination and exploitation issues;*
- *Demonstrate how it will take into account and build on the experience and outcomes of previous R&I Partnerships and the results of evaluations and assessments, if relevant.*

Cooperative, Connected and Automated Mobility (CCAM) is expected to reshape mobility in Europe and globally. The goal is to create more user-centred, all-inclusive mobility, while increasing safety, reducing congestion and contributing to decarbonisation. This requires a system approach to innovation: including infrastructures, vehicles, operations and services.

This Partnership for research and innovation on CCAM focusses on road transport, but it takes into consideration relevant interfaces with other modes (for instance railway crossings, but also transfers and integration with public transport) in order to make sure that safety is increased, that efficiency and the optimal use of available infrastructure are improved and that new multi-modal services can be developed for the benefit of users and society as a whole. All connectivity aspects contributing to CCAM and to the value chain supporting CCAM should be considered.

To maximise the benefits from public funding and leverage private investments, the technological advancements need to reach society and change how we travel and transport goods. With full integration in the transport system, CCAM will contribute significantly to achieving the following societal objectives:

- **Safety**[1]: Reducing the number of road fatalities and accidents caused by human errors;
- **Environment**[2]: Reducing transport emissions and congestion by efficient use of transport capacity, smoothening traffic flows and removing unnecessary trips;
- **Inclusiveness**: Ensuring inclusive mobility for persons and goods by providing mobility access to excluded groups; and

[1] 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. (see https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/3rd-mobility-pack-factsheets-safety.pdf).

[2] *'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

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- **Competitiveness**: Strengthen competitiveness of European industries by technological leadership, ensuring long-term growth and jobs[3].

Opportunities

Mobility is crossing a new – digital – frontier with increasing connectivity, allowing vehicles to "talk" to each other, to the road infrastructure and to other road users. This will enable a coordination and cooperation at an entirely new level (e.g. warning messages not limited by line-of-sight or congestion management using real-time information). At the same time, automated vehicles can have a 360° vision of the surrounding environment and can reduce reaction times. Current road vehicles already provide ever more advanced assistance, and intervene when a dangerous situation is detected. Future systems will be able to control the vehicle for extended periods, and at some point, will no longer rely on a human back-up. Combining connectivity, cooperative systems and automation could go even further and allow automated and fully orchestrated manoeuvres, and bring us closer to Vision Zero. Furthermore, this combination 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, with the aim of making transport safer, greener and more accessible. By using its strengths in vehicle and system innovations for a push of socio-economic benefits and sustainable development, Europe has the unique opportunity to consolidate its leading role in cooperative, connected and automated mobility against a rising competition in global value chains and markets.

The development of CCAM solutions - sustainable, efficient and inclusive - shall finally provide all citizens with enhanced freedom of movement. Automated public transport services will give the opportunity to deliver profound changes not only in how people travel, but also in the way of living. 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, safer, more comfortable and integrated travel, delivering a much improved user experience. CCAM enabled shared mobility services will allow a much higher integration of new shared automated services with public transport and MaaS platforms. Therefore, people who cannot drive (disabled people, people without a driving license), or who no longer drive, will find a real interest to use the new services, when they become affordable.

In the meantime, in the freight and logistics domain, truck driver shortage, in particular for the long haul, is calling for better working conditions and for higher levels of automation that could support further transport productivity[4]. According to European Transport Workers Federation and the International Road Union there is a driver shortage of 21% across the freight transport sector[5]. In theory, fully automated driving could double existing average road infrastructure capacity[6] by smoothing traffic flow, but also enabling off-peak usage of infrastructure for freight. Moreover, CCAM coupled with innovative fleet management may allow to transport bigger amounts of freight compared to current operating practice and guarantee same transit time even at lower speeds (i.e. saving energy) in line with the Physical Internet concept.

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[3] GEAR 2030 final report

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

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

[6] 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

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

Challenges

Reaching the above-mentioned objectives however requires solving a multitude of challenges (defined as problem drivers in chapter 2.2) that need to be addressed at several levels: societal, human, technical, regulatory, economic and operational.

The society is not yet demanding or adopting a transition to CCAM enabled mobility. Potential implications and impacts (such as effects on safety or the environment) of integration of CCAM solutions into the mobility system are not well understood. There is a lack of awareness and acceptance by the expected users, the public opinion and policy makers. It is unclear whether the existing infrastructure is ready to support future CCAM solutions or if further investments are required.

Moreover, the technological capabilities due to the increased complexity for advanced CCAM solutions are not mature for market take up yet. Public R&I funding and private investments in CCAM technologies are fragmented and insufficient to maintain and extend EU industrial leadership. A well organised, large and complex, cross-sectorial value chain is required to build complete CCAM solutions, which currently is only in place for parts the value chain[8].

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, IoT, AI) and innovative business models (e.g. 'mobility as a service', Logistics as a Service/Physical Internet, 5G services) to really pay off. Moreover, the advent of automated vehicles opens important new challenges in relation to security and privacy topics.

CCAM enabled automated vehicle functions also pose a great challenge for future safety validation processes. Depending on the operational domain, many different driving situations and scenarios need to be tested and validated. Current available procedures[9] do not provide an efficient and cost-effective solution. Expending these domains with a high level of automation will drastically increase the need for testing and validation. The question remains how to integrate artificial intelligence and deep learning algorithms for automated driving into the functional safety assessment. Technical redundancies to manage hazardous events play an important role. Cost considerations and needed time for testing are of great relevance and the knowledge and data gathered from pilot tests across Europe can have a significant contribution to validate safe CCAM functioning.

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[7] https://www.volvotrucks.com/en-en/news/volvo-trucks-magazine/2019/jun/Veras-First-Assignment.html
[8] GEAR 2030 final report
[9] 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.

CCAM services will also need to be well integrated with urban planning and urban economics, with proper governance models to ensure the collaboration between stakeholders. The business models for automated and shared vehicles need to be researched, as well as interoperability and integration with public transport. In less dense areas, the main challenge will be to provide motorised shared, on-demand and personalised transportation available to all. Automated taxi/pods/shuttles/buses, shared vehicles in general, will be new options available to help fulfil this mission. Effective, profitable and transparent cooperation among local and regional authorities and the private sector is mandatory, to provide end-users with inclusive, equitable and accessible services for all, and to develop interoperable systems and operating conditions.

Needs

Despite the aforementioned expected benefits of CCAM enabled mobility, there is yet a fairly limited demand in society to implement these solutions. The order of magnitude of the benefits, but also further impacts and implications of implementing CCAM solutions are not well-understood. Therefore, users and investors are not ready for nor accepting a transition towards CCAM. A central, stakeholder-wide initiative in Europe will be a key driver to overcome this hurdle, while addressing these uncertainties on a **mobility system level**, rather than on an individual basis. This is essential in opening up the full potential of implementing CCAM enabled mobility, with integrated approaches including environment, safety and inclusivity.

Adjacent to this first hurdle, there is the issue that current, advanced CCAM solutions are not yet mature enough for a wide market uptake, not yet having positive effects beyond a limited set of scenarios for the individual vehicle. The latter is paramount when aiming to contribute to solving societal challenges, and is thus calling for an approach on a European scale. Only when doing so, R&I investments as well as other investments in relation to the deployment of CCAM technologies will allow the European mobility industry to maintain and extend its international leadership. Europe's knowledge base regarding these technologies, their validation, impact assessment and user validation can at the same time be pulled along to a similar level of international competitiveness. To really obtain this, it will be essential that the Research and Innovation efforts are taken beyond the current state of fragmentation, with a clear lack of cohesion. The R&I efforts should become aligned and jointly supported along the full value chain, and should be fit to a longer term vision in which societal benefits of CCAM enabled mobility are a core value.

To achieve this, a further hurdle needs to be taken; to build such a vision and consequently build complete CCAM solutions, a well organised, large and cross-sectoral value chain needs to be established. Such value chain and ecosystem could make use of existing parts of the value chain, whilst firm and coordinated actions are needed to bring them together, alongside with yet missing parts of the value chain.

At present, there is no actor in the stakeholder field who can break the barriers mentioned. This has to be dealt with in a joint, shared, international approach, engaging a wide variety of stakeholders. Furthermore, this needs to be taken up on the short term, and in an effective, powerful and explainable way. The only valid instrument, complying with all the boundary conditions and barriers, is a European Partnership.

Links with previous Framework Programme Interventions

Many Research and Innovation (R&I) actions as well as large-scale tests are already ongoing in Europe: at industry, local, national and EU level. Many of these are supported by the

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Commission through research funding programmes or deployment projects including cross-border demonstration and testing[10]:

For passenger cars, the **L3PILOT** project tests the viability of automated driving as a safe and efficient means of transportation on public roads. It will focus on large-scale piloting of SAE Level 3 functions, with additional assessment of some Level 4 functions. The functionality of the systems will be exposed to variable conditions with 1,000 drivers and 100 cars across ten European countries, including cross-border routes. The technologies being tested cover a wide range of driving situations, including parking, overtaking on highways and driving through urban intersections.

For shared mobility services the **AVENUE** project aims to validate the advantages that autonomous vehicles will offer to public transportation, linked with new innovative passenger service and guaranteeing road and passenger safety with demonstrators implemented for 4 years in 4 European cities (Copenhagen, Geneva, Luxembourg and Lyon).

For freight transport, the **ENSEMBLE** project will implement and demonstrate multi-brand truck platooning on European roads improving fuel economy, CO2 emissions, traffic safety and efficiency.

These 3 projects advance and demonstrate the technical capabilities for shared mobility solutions, passenger cars and freight transport, paving the way towards the next challenges: with SAE Level 4 functions, with increasingly complex operational domains at a large scale.

In total from 2014 to 2020, around EUR 300 million from the EU's framework programme for research and innovation "Horizon 2020" have been allocated to support research and innovation on automated road transport. The majority of these projects[11] was funded under the H2020 ART calls, tackling different aspects of CCAM, advancing technologies and solutions towards market introduction and deployment in the following areas:

- **In-vehicle technologies:**
  - DENSE: Eliminating the inability of current systems to sense their surroundings under severe weather (snow, heavy rain or fog).
  - AUTODRIVE: Providing fail-aware, fail-safe, and fail-operational integrated electronic components, Electrical/Electronic (E/E) architectures as well as (deeply) embedded software systems for highly and fully automated driving.
  - PRYSTINE: Realizing fail-operational urban surround perception based on robust radar and LiDAR sensor fusion and control functions.
- **Integrating the vehicle in the transport system:**
  - INFRAMIX: Adapting the road infrastructure for future automated transport systems.
  - COEXIST: Integrating connected and automated vehicles on road networks.
  - ICT4CART: Designing, implementing and testing in real-life conditions an innovative ICT infrastructure that will support higher levels of automated driving.
  - INTERACT: Improving the communication and cooperation strategy between automated vehicles and other traffic participants.
  - TRANSAID: Allow a smooth integration of automated vehicles in traffic systems.
- **Human Factors:**

[10] See report by EC JRC "Research and Innovation in connected and automated transport in Europe", December 2019: https://trimis.ec.europa.eu/content/research-and-innovation-connected-and-automated-transport-europe

[11] https://ec.europa.eu/inea/en/horizon-2020/h2020-transport/projects-by-field/480

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- ADASANDME: Developing cooperative intelligent transport systems that compensate human errors, facilitate driving behavior, avoid collisions and increase safety on road.
- VI-DAS: Developing ADAS and navigation aids in societally acceptable and personalised manner, based on a reliable combination of the overall traffic scene understanding and essential consideration of the driver's physical, mental, demographic and behavioural state.

- **Demonstration activities towards larger scales:**
  - AVENUE: The project deploys, validates and integrates autonomous vehicles (mini-busses) in public transportation services.
  - L3PILOT: Operating 100 vehicles with 1000 drivers in the public transport system in order to test automated drive systems in conformity with Level 3 and Level 4 under real conditions and in a wide range of applications.
  - ENSEMBLE: Implementing and demonstrating multi-brand truck platooning on European roads.
- **Validation of CCAM systems:**
  - HEADSTART: Aims to define testing and validation procedures on specific functionalities of Connected and Automated Driving (CAD) functions, including key technologies such as communications, cyber-security and positioning.
- **Social aspects and user acceptance**:
  - BRAVE: Increasing society's confidence in automated vehicles.
  - LEVITATE: Will develop a wide-ranging evaluation framework to assess the impact of connected and automated transport (CAT) on all aspects of transport and individual mobility as well as at societal level.
- **Coordination activities:**
  - ARCADE: Building consensus across stakeholders from all sectors for a sound and harmonized deployment of Connected, Cooperative and Automated Driving (CAD) in Europe and beyond.

Although the above list is extensive, it is not exhaustive, and certainly not all the challenges and roadblocks of CCAM were addressed and solved in these H2020 projects. The challenges of these different thematic areas are under monitoring within the coordination and support action ARCADE[12]. Further collaborative research is needed to enable CCAM, especially in the areas identified as problems, listed in chapter 2.2, to bring together stakeholders and avoid fragmentation of efforts.

Many of the required steps towards CCAM therefore have to be planned consistently across sectors, and in cooperation with the Commission and the Member States, as they are highly interdependent. If not planned comprehensively, and matched with the proper framework conditions, e.g. in the regulatory domain, the innovation process may slow down or may not trigger the expected benefits. Resources and investments could be wasted and Europe may miss the opportunity to benefit from CCAM for its society and economy.

2.2 Common vision, objectives and expected impacts

Partnerships allow to pool additional private and public R&I investments on EU priorities (additionality) and align them towards common objectives (directionality), thus facilitating the achievement of impacts that cannot be realised by other Framework Programme actions or national action alone. This requires a common vision and a corresponding firm

[12] https://knowledge-base.connectedautomateddriving.eu/thematic-areas/

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commitment from partners from the beginning, with a clear idea of the impacts and objectives that need to be achieved, and the necessary resources, investments and activities. Since Partnerships are by definition only receiving financial support from the Framework Programme for a limited duration they have to also provide a clear concept on the expected time necessary to achieve the objectives, and the phasing out from the Union funding. The common vision is an important element demonstrating the envisaged benefits for the partners and the society at large stemming from the desired additionality and directionality of the public and private R&I investments.

- *Describe the general, specific and operational objectives of the proposed partnership, based on a clear intervention logic. In establishing the objectives, link them to broader policy objectives, in particular priorities set by the new Commission, including links with global strategies and agreements such has SDGs where EU has committed itself, where relevant. What is the expected timeframe to achieve the specific objectives?*
- *Outline the common vision and ambition of the Partnership that includes information and qualitative and quantitative data from socio-economic, environmental and industrial/technological studies, recent research results, policies and strategies, as well as data? on identifiable business/investment plans, as appropriate. In case of a predecessor Partnerships under H2020: please describe what will be different, reflecting notably the raised ambition to realise the economic, social and ecological systemic transitions that Europe needs;*
- *Describe links and/or collaboration opportunities identified at this stage with other Partnership candidates and Union programmes, in particular if co-financing of the Partnership by other programmes, or upstream use of other programmes is planned;*
- *Estimate how much R&I investments are overall necessary to achieve the specific objectives, which parts will be contributed by partners, and which by other sources, in order to justify the investment from the Framework Programme (additionality, possible quantitative direct and indirect leverage effects). Explain how reaching those investment targets could be monitored throughout the programme;*
- *Demonstrate how the proposed Partnership is expected to trigger relevant transformational changes in the broader research and innovation ecosystem (qualitative impacts) at national and/or sectorial level;*
- *Include a clear and realistic exit-strategy and measures for phasing-out from the Framework Programme funding.*

European Partnerships will be based on jointly developed Strategic (Research and) Innovation Agendas / roadmaps[13] *with clearly identified milestones and outcomes and their planned uptake. The development of such a strategy is a precondition for launching a European Partnership. To meet the requirements set in Horizon Europe, the strategy process needs to be comprehensive, notably by ensuring strong and broad stakeholder involvement and by making connections to ongoing policy and strategy debates. The Strategic Research and Innovation Agenda/roadmap needs to be agreed with the Commission services. It has to be sufficiently detailed to either build the basis for the drafting of work programmes, or otherwise clearly describe the process for further detailing the agenda of activities on an annual/multiannual basis. In the latter case, and depending on the area addressed and communities involved, it is appropriate to identify only high-level topics to be addressed, and describe the annual stakeholder consultation process in detail that translates this into the*

[13] identifies the foreseen portfolio of activities and measurable expected outcomes, deliverables and milestones within specific timeframes, as well as specific key scientific, economic and societal value for Europe.

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scope of annual activities. The level of detail should be agreed beforehand with the Commission Services.

- *Depending on the progress in the preparation of the proposed Partnership, please include an annex to the proposal that includes either:*
- *A description of the planned process for developing a Strategic Research and Innovation Agenda/roadmap; or*
- *A Strategic Research and Innovation Agenda/roadmap, including a description of the strategy process and evidence of the involvement of stakeholders in the identification of objectives.*

Vision

"European leadership in safe and sustainable road transport through automation"

In December 2019, the new European Commission announced a comprehensive and ambitious strategy package for Europe to become the world's first climate-neutral continent by 2050, "the European Green Deal"[14]. For the mobility sector, this will involve boosting the supply of renewable energy for transport of people and goods and leveraging the digitalisation of transport with smart and automated mobility systems.

In the Communication "On the road to automated mobility: An EU strategy for mobility of the future"[15] the European Commission lays down its vision, objectives and actions for an accelerated deployment of Connected, Cooperative and Automated Mobility (CCAM) with the ambition of making Europe a world leader in this domain. The communication highlights use cases of CCAM that will be particularly relevant from the public policy perspective in the next decade: passenger cars and trucks able to autonomously handle specific situations on the motorway (automation levels 3 and 4[16]), cars and trucks able to handle some low speed situations in cities, and public transport vehicles able to cope with a limited number of driving situations at low speed (automation level 4). 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 proposal.

The final report of the high-level group on the competitiveness and sustainable growth of the automotive industry in the European Union (GEAR 2030)[17] emphasise among others the medium and long-term recommendations for automated and connected vehicles.

The Declaration of Amsterdam[18] 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 the industry and the road users. Harmonised legislation and policies should enable cross-border mobility with automated and connected vehicles, for example for the platooning of trucks, which was the object of a demonstration during the signature event of the Declaration. It means that EU Member States countries 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. Exchanging views and

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[14] COM(2019) 640 final
[15] COM(2018)283
[16] Automation levels will be explained later in the chapter.
[17] https://ec.europa.eu/growth/content/high-level-group-gear-2030-report-on-automotive-competitiveness-and-sustainability_en
[18] Declaration of Amsterdam, "Cooperation in the field of connected and automated driving", 14-15 April 2016

working together between Member States on these subjects will contribute to an integrated approach to automated and connected driving across the EU.

In line with these strategic documents, the vision for the next 10 years is to make Europe a world leader in the development and deployment of connected and automated mobility services and systems, making a step-change in Europe's mobility system in reducing the number of road accidents significantly and bringing down the number of road fatalities towards zero, increasing traffic efficiency and enhancing traffic planning, fostering cooperation between different transport modes, reducing harmful emissions from transport and reducing travel time and congestion as well as increasing accessibility at lower population density areas and for impaired people.

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 allow for transferring more and more 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 will benefit from increased connectivity with other vehicles, the infrastructure and other road users. 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. With this integration, CCAM solutions will initiate a revolution in mobility. Shared, automated mobility and freight services will become widely available, providing seamless door-to-door mobility for people and goods, leading to healthier, safer, more accessible, greener, cost-effective, demand-responsive and more sustainable transport everywhere. To move towards this vision, the operational domains and use cases of these vehicles need to be extended to the point where they become economically viable and societal benefits are realised. As the associated challenges in this expansion grow exponentially, an unlimited operational domain seems unrealistic with the 2020 state of the art technologies[19].

[19] The capabilities of the CCAM systems envisioned here can be distinguished by referring to the concepts of automation levels and the Operational Design Domains (ODD) introduced by SAE. The ODD 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 4 the ODD is - by definition - limited. The boundaries are not only depending on the enabling technology of the vehicle itself but also on external factors, such as physical and digital infrastructure, traffic and weather conditions.
As SAE Level 5 is a theoretical description of ultimate automation, it merely gives a direction and not a realistic outcome: The general goal of the CCAM partnership is to enlarge the operational design domains (ODD) of automated driving systems, and thus related use cases, particularly of level 4 solutions to the point where they become economically viable and ready for (pre-) deployment. At the same time, this should not be seen as a limitation for enabling CCAM services with real societal impact. On the contrary, the most efficient and cost-effective solutions are likely those that are optimised for a specific ODD, and

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Objectives and expected impacts

CCAM is understood as a key element to further address societal challenges for clean, safe, efficient and smart transport. It will change our mobility and transport system and have a huge impact on all road-, traffic- and driving- situations. In the future, the transport system will accommodate vehicles with ever growing computing power, high speed connectivity, deep learning algorithms for artificial intelligence, fast processing and decentralised data handling. In addition, progressing digitalization, extreme growth in (big) data availability and need and increasing connectivity for users are shaping new business models in transport, modifying the future mobility needs and perceptions.

This development will lead to a paradigm shift and consequently, if fully integrated, the transport system becomes safer, more efficient, more resilient and more sustainable. Yet, this transformation is not happening, due to the hinderance by the following identified Problem Drivers:

- (PD1) Advanced CCAM solutions are not mature for market take up yet and current investment levels in CCAM R&I in the EU are insufficient to maintain and extend EU industrial leadership.
- (PD2) Current R&I efforts are fragmented with a lack of a coherent, longer term vision.
- (PD3) A well organised, large and complex, cross-sectorial value chain is required to build complete CCAM solutions, which currently is only in place for parts the value chain.
- (PD4) Insufficient demand as the society is not yet prepared or accepting a transition to CCAM enabled mobility. Potential implications and impacts of integration of CCAM solutions into the mobility system are not well understood.

The CCAM Partnership is needed to accelerate the implementation and realise the foreseen benefits for society. At the foundation of such a Partnership, there needs to be a consistent and coherent R&I strategy, developed and committed (PD2) by policy and industry stakeholders together:

- to create an innovation-friendly ecosystem for CCAM (PD3),
- to understand and assess, and raise awareness of the impacts of CCAM enabled solutions on society, and,
- to accelerate market-uptake (PD1).

The CCAM partnership shall contribute to achieving the following positive impacts for society:

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provided this is sufficiently large, it can be integrated into the overall transport system to provide door-to-door solutions.

One of the key challenges for CCAM solutions remains to ensure safety. This means to design and prove that a complex CCAM system of Level 3 or higher, without the human driver as major fallback role for the dynamic driving task (DDT), is functionally and operational safe. A larger ODD will have an exponential effect on dealing with this challenge.

1. Improving **safety** and **security** of the transport system drastically;
2. Meeting **societal needs** for **mobility** while **reducing environmental** impacts and strengthening our economy;
3. Maintain and extend industrial leadership for jobs and economic growth all over Europe;
4. **Strengthen** leadership in all technological and societal aspects of CCAM through targeted **knowledge** and **capacity building**

The following table shows the expected impact, the general objectives (where the CCAM partnership contributes) and the specific objectives of the partnership (i.e. the expected outcome by 2030).

Expected Impact	**General objectives (GO)**	**Specific objectives (SO)- expected outcomes by 2030**
Improving **safety** and **security** of the transport system drastically	• (GO1) Reduced number of fatalities and injuries in road transport • (GO2) Safe and efficient co-existence between automated and non-automated "conventional" traffic for a long transition period of mixed traffic	• (SO1) Secure and trustworthy interaction between road users, vehicles, infrastructure and services (link to PD4) • (SO2) Agreed safety standards for highly automated driving systems to operate and function on public roads (link to PD4) • (SO3) Validated functional safety for CCAM use cases (link to PD1)
Meeting **societal needs** for **mobility** while **reducing environmental** impacts and strengthening our economy	• (GO3) High public acceptance and adoption of CCAM with clear understanding of its benefits and limits • (GO4) Increased efficiency of transport flows (people and goods) leading to better use of infrastructure capacity and preservation of public space • (GO5) Reduced transport emissions and congestion	• (SO4) Demonstrate inclusive, user-oriented and well-integrated mobility concepts enabled by CCAM with a reduced carbon footprint (link to PD1 and PD4) • (SO5) Demonstrate new freight and logistics concepts and services enabled by CCAM with a reduced CO2 emission per tonne-km (link to PD3) • (SO6) Societal impacts (e.g. safety, efficiency, environment) and wider economic impacts are sufficiently assessed and accepted (link to PD4)
Maintain and **extend industrial leadership** for new jobs and economic growth all over Europe	• (GO6) Making Europe a world leader in the deployment of connected and automated mobility for people and goods • (GO7) More focused and long-term investments in R&I, development and pre-deployment of CCAM.	• (SO7) Long-term coordination framework for R&I and large-scale testing activities, involving all relevant public and private stakeholders from European, national and regional levels (link to PD1 and PD2) • (SO8) Improved synergies between public and private investment plans to advance vehicle and infrastructure technologies (link to PD2) • (SO9) Common evaluation framework for R&I results to foster exchange and reuse of results from CCAM projects in Europe (link to

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		PD2 and PD3)
Strengthen leadership in all technological and societal aspects of CCAM through targeted **knowledge** and **capacity building**	• (GO8) Support the creation, dissemination and capitalisation of knowledge to accelerate the development and improvement of CCAM enabled solutions	• (SO10) Inclusion of new and emerging knowledge fields addressing user needs and wide industrial application CCAM solutions (link to PD1, PD3 and PD4) • (SO11) Expand and disseminate the knowledge base on CCAM solutions, stakeholders, R&I programmes and projects, and testing activities.

In addition to the Impacts, General Objectives and Specific Objectives, the Partnership will monitor progress using the following Operational Objectives and associated performance indicators.

Operational objectives	**Performance indicators**
Establish a detailed Strategic Research and Innovation Agenda (SRIA) for CCAM with clear milestones for Specific Objectives.	• Delivery of SRIA document addressing the specific objectives of the partnership; • Level of milestone achievement from SRIA during programme • Annual review of the R&I priorities and updating SRIA following latest developments and project results • Industrial and public/MS commitment/involvement to the SRIA development/updating processes
Implement the R&I actions identified in the SRIA and undertake actions ensuring uptake and impact of the project results (e.g. dissemination, exploitation and facilitation actions, subsequent investments)	• Number and ambition of demonstrators, including large scale, with diverse use cases • Number and quality of patents & peer-reviewed publications. • Number of dissemination events and facilitation actions.
Create and continuously strengthen the synergies along the value chain, enabling and supporting the knowledge exchange and dialogue on results, needs and implementation potential	• Projects with cross-industry, cross-value chain involvement • Inclusion of new partners to the Partnership and projects with SMEs and start-ups
Demonstrate benefits of CCAM solutions for road safety, efficiency, environment and wider societal needs.	• Maintain and expand common integrated and central evidence base of CCAM R&I including results from demonstration activities and wider initiatives. • Number of R&I projects assessing the potential socio-economic impacts of CCAM.
Ensure open and transparent processes for consulting all constituent entities and relevant stakeholders on the identification of Partnership's priorities and the design of its activities. This includes appropriate governance structures, open membership policies and assistance to members.	• Number and diversity of actors engaged in the partnership and in the projects, including number of SMEs as well as attendance in dissemination and awareness raising activities.

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Operational objectives	Performance indicators
Ensure coordination and synergy with the other relevant European Partnerships and the relevant parts of Horizon Europe (including missions), as well as, where relevant, other Union programmes, Union bodies and national, international, and intergovernmental activities.	• Common calls, topics or demonstration projects with other relevant European Partnerships and the relevant parts of Horizon Europe. • Early identification and consideration of relevant standardisation, regulation and certification issues.

The Operational objectives (and the related Performance Indicators) will ensure the progress towards the specific objectives (SO) addressing the problem drivers (PD) in CCAM while fostering knowledge and capacity building all over Europe. The Partnership, its members, the represented value chain and the wider stakeholder community shall benefit from driving the transformational change with a positive impact on society.

Measures to end the partnership (exit strategy)

The partnership serves as a 'mean to an end' to achieve its objectives (as described in chapter 2.2.). The strategic research and innovation agenda for CCAM will describe a clear and comprehensive roadmap to deliver in the expected time frame. With reaching its objectives at the end (or earlier) will allow the CCAM stakeholders to move to the next investment phase (industrialization, competitive development and infrastructure deployment).
Other exit strategies are foreseen:

- in cases of very slow progress towards set objectives which would make a successful programme delivery very unlikely;
- radical technological progress in an area relevant for the CCAM partnership that would make further moving forward to achieving its targets obsolete.

In these cases, the constituent stakeholders can propose through the governing board the premature ending of the partnership.

Process to set up a Strategic Research and Innovation Agenda

The Strategic Research and Innovation Agenda of the CCAM Partnership will indicate what in terms of research and innovation needs to be done in order to achieve the objectives outlined in this proposal. It will set priorities and assess the content, timing, and responsibility for actions. The process will be open and transparent, involving public and private stakeholders from the entire value chain of CCAM. It builds on previous strategic R&I recommendations on CCAM, e.g. within Working Group 1 of the CCAM Platform, the Strategic Transport Research and Innovation Agenda (STRIA) Roadmap on Connected and Automated Transport, the Working Group Connectivity and Automated Driving of ERTRAC, the Transportation Working Group of EPoSS, and the results of the EU-funded Coordination and Support Actions CARTRE, ARCADE and SCOUT.

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2.3 Necessity for a European Partnership

European Partnerships are established for addressing European or global challenges only in cases where they will more effectively achieve objectives of Horizon Europe than the Union alone and when compared to other forms of support from the Framework programme. Therefore, the proposal needs to demonstrate convincingly that the envisaged Partnership will indeed be more effective in achieving the related objectives of the Programme. Depending on the intervention logic of the proposed Partnership, the proposal needs to address to different degrees the following aspects:

- *Demonstrate how the Partnership addresses the objectives of Horizon Europe and common political priorities of the EU and its Member States, with cooperation extending well beyond transnational joint calls and R&I projects, thus ensuring that structural and societal impacts contributing to the overarching policy objectives can be achieved;*
- *Demonstrate how the partnership will establish a meaningful collaboration with Member States /Associated Countries and relevant national/regional authorities and their respective commitments (e.g. by identifying and connecting with relevant national activities and programmes that allow addressing common challenged more effectively).*

In the Communication "On the road to automated mobility: An EU strategy for mobility of the future" the European Commission has laid down its vision for Connected, Cooperative and Automated Mobility (CCAM). Following the EU communication, a single platform was initiated, comprising primarily Member States and approximately 30 associations. In particular, the goal of Working Group 1 is to provide inputs for the EU agenda for research and pre-deployment, the definition of objectives, and scope of the future European partnership.

The work carried out within the platform has provided evidence that a partnership is needed for research and innovation efforts at EU level to address the challenges of the systemic innovation that CCAM implies at the level of technology and its socio-economic impact. Its key intention is to bring all stakeholders around a shared vision and define priorities together. The major challenge is to overcome traditional sectorial and stakeholder borders, e.g. between the automotive industry, infrastructure providers and traffic managers, which is hampering the deployment of solutions in the current arrangement. Also, research, innovation and demonstration activities have often been fragmented: Many projects have been launched by the European Commission and the private sector with a short life span and relatively small scales. There is insufficient exchange and reuse of the result from those projects. Their results should be better shared and evaluated against comprehensive objectives. Bringing together all the involved key players and strutting on previous results is crucial contribution of a partnership to make any progress in the development of CCAM and generate impact on EU-level.

In the European Green Deal, the Commission aspires to catalyse the shift to 'sustainable and smart mobility,' with a particular focus on transport and mobility. Several partnerships proposed under the Horizon Europe cluster *Energy, Climate and Transport* are addressing the objectives of the Green Deal. Automated and connected multimodal mobility will play an increasing role, together with smart traffic management systems enabled by digitalisation, for saving energy, and thus reduce CO_2-emissions. The EU transport system and infrastructure will be upgraded to support new sustainable mobility services that can reduce congestion and pollution, especially in urban areas.

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The Climate Pact, described as "bringing together regions, local communities, civil society, industry and schools" seems close to the ecosystem thinking that CCAM strongly advocates: a multi-actor collaboration that would lead to a joint commitment towards decarbonisation. These developments could be accelerated by working effectively within the quadruple helix model (research, industry, public authorities, and citizens) to develop and implement innovative solutions for decarbonisation together. Such an ecosystem approach is crucial to achieve the objectives outlined in the Clean Planet for All strategy.

The CCAM partnership will bear a great opportunity to bring the already existing initiatives to exploit the opportunities of CCAM for user-centric transport in terms of sustainability, inclusiveness and seamless services while decreasing the single occupancy cars on the road. European cities must reduce emissions while they are increasingly tackling the adverse effects of climate change. A perspective based on needs and that focuses on demand-driven solutions, placing the citizen in the centre, is increasing in importance. This is also highlighted in the Green Deal. In addition to involving citizen initiatives and community-driven innovation, a stronger relation should be created with cities and regions with their role, and responsibility, to engage with their community and move towards a new more collaborative research and innovation practice.

The ecological emergency requires innovative solutions and new collaboration urgently. Breaking sectorial borders between energy, climate and mobility areas is crucial to build sustainable low emissions regions and cities. To address the mobility challenges (air pollution, road congestion, travelling costs, accidents and noise pollution) it requires a strong regional eco systems of innovation, to test, to experiment, to exchange best practices and to scale it up. New governance models, strengthened public private cooperation, new regulatory frameworks to enhance the deployment of new/disruptive technologies and work on the governance of the innovation are significant enabling factors. Society needs to face the climate change. Local and regional actors have a significant role to play in the decarbonisation efforts in the European Union and beyond. The collaborative, inclusive aspect of a dedicated partnership will contribute to this vision.

Member States have a key role in the partnership. Beyond the question of adapting road infrastructure, Member States have skills and levers that are strategic for developing CCAM: the ability to fund strategic innovations of their industries, by helping the various actors to coordinate to solve complex problems; investment capacity; regulatory tools, particularly those related to taxation. A CCAM partnership can harness their potential creating an additional benefit beyond the reach of collaborative research.

A dedicated partnership on CCAM enables Member States across Europe to take a more active stance in supporting research and innovation for CCAM, in order to increase quality of life and economic prosperity. The Commission and public authorities ensure the alignment with transport policy objectives.

A co-programmed partnership setup offers a flexible and inclusive arrangement to support the dynamic of the fast-paced developments, emerging industrial uptake, developing SME-community and innovation in the sector while fostering further stakeholder commitment to this partnership. It drives an aligned and adaptable R&I roadmap from the stakeholder perspective allowing for synergy within the partnership and towards other EU-instruments. Europe cannot afford to lose the proposed global innovation race, especially when it comes to the digitalisation of road transport. With shorter innovation cycles and increasingly fast-acting competition from countries outside of Europe, we need to accelerate both research and the time-to-market. The co-programmed partnership will enable effective and timely research actions; the setup of an institutionalised partnership inherently would take longer time.

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Connected, cooperative and automated mobility is a complex ecosystem in which the vehicles, the physical and digital infrastructure, technologies and humans (drivers, passengers, motorcyclists, cyclists, pedestrians, traffic controllers) interact.

For this, Europe needs strategic planning, linking research towards (pre-)deployment, based on strategic roadmaps and societal needs. A qualified understanding of key challenges for CCAM is necessary for successful implementation and to maximise the impact.

Whereas, Horizon 2020 is a well-recognized programme to support and incentivise pre-competitive, collaborative research and innovation with significant impact. For quick evolving and multi-disciplinary technology area, such as CCAM, speed and agility are essential as well as a coherence of funding topics is crucial.

The research and innovation challenges need to be addressed in an integrated way, to achieve a systematic breakthrough in line with EU policy objectives. These include, among others, CCAM system validation, developing technologies at vehicle and infrastructure level and for data communication and processing. Personal data protection, cyber-security, ethics, social acceptance have to be addressed, as well as effects on labour and needed skills. Furthermore, it is important to assess impacts on road safety targets, emissions, land use and economy.

For the large-scale testing and validation of solutions addressing technical and non-technical challenges, a large number of actors (vehicle manufacturers, local and regional authorities, road operators, service providers, etc.) need to be involved. Coordination at EU level is needed in order to develop harmonised and interoperable solutions, avoiding fragmentation, duplication, inconsistencies and gaps.

For this reason, Europe needs a partnership for CCAM with clear objective setting and coordination across several research areas. The development of a long-term strategy, in close cooperation with all market players, will ensure that R&I projects support the competitiveness of the European industries.

To strengthen awareness, assess impacts and understand user and societal effects across many different Member States, Europe needs more large-scale demonstrations, pre-deployment projects and pilot initiatives involving all relevant stakeholders to accelerate implementation and remove barriers. These activities, due to the technical maturity and multi stakeholder involvement are highly cost intensive and require sufficient resources.

The CCAM partnership brings stakeholders together for a true system level approach. The European dimension enhances interoperability and ensures a critical mass of demand to allow industrialisation of innovation.

It is evident that digitalisation and particularly technologies such as electronic systems, AI, IoT and communication will form the most significant key enablers in CCAM. The observed *extreme returns to scale* in digital markets make CCAM a highly competitive topic. 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.

Increased agility and flexibility of research programme and projects are key. Due to increased demands on the industry's constantly evolving business environment, it is crucial to improve the agility and flexibility of R&I programme implementation in order to deliver results in time and with the available resources and funding.

To make efficient use of resources, there is a need to align public and private R&I investments engaging all relevant stakeholders to ensure capacity is built consistently in Europe. Consensus building and sharing is needed across stakeholders' groups to leverage the full potential of CCAM. Different perspectives beyond technology development need to be addressed to match use cases developed by industries with the needs of public authorities (including local and regional ones) delivering value to the user of the mobility and logistics

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system. The partnership will uniquely support both creating consensus and sharing at a larger scale and involving different stakeholders' groups.

Involvement of Member States

The involvement of Member States is of the highest importance to the success of the co-programmed partnership. This holds for both their individual involvement, as well as their harmonized contributions, to e.g. new policy frameworks, vehicle and infrastructure regulations. Member States are involved in the CCAM partnership in different top-level roles:

- They provide the policy framework for CCAM on national level and in coherence with the European Commission.
- In line with national automation and connectivity strategies they own, fund and manage research programs at Member State level, to some extent also transnational pooled funding (regional and/or sectoral cooperation). The program goals point well beyond the CCAM scope and include also e.g. the competitiveness of the domestic industry, supporting SMEs. While the European Commission is regularly informing the Member States on the drafting process of the regular and Partnership work programmes and collecting their inputs at the meeting of the Programme Committee for Transport, the CCAM Partnership aims to complement this by an additional forum bringing together Member State representatives and CCAM stakeholders for a direct exchange of ideas and assessments.
- They also manage and operate the mobility infrastructure whereby different settings are used in Member States (e.g. private concessionaires in parts of the road network, varying degrees of integration between high level and lower levels of the road network, split or integrated responsibility at the urban-interurban interface). The bundle of roles is typically allocated to National Road Authorities (NRAs) whereby operating the roads is an integrated or adjacent part of the overall tasks. The context of the CCAM partnership spans across all of NRAs' core business processes such as:
  - Operations and Services (operational infrastructure – traffic management incl. incidents and events, road maintenance incl. winter, crisis management, traffic information);
  - Planning and Building (new roads, road works planning, physical infrastructure);
  - ICT (ITS systems, digital infrastructure, enforcement, tolling).
- They provide guidance on societal needs and expectations. They support through their involved national road authorities and operators the definition, set-up and implementation of large scale demonstration projects.

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2.4 Partner composition and target group

- *Describe how the Partnership will build upon, strengthen and/or expand collaboration networks and initiatives that are currently existing at the EU level, beyond currently existing Partnerships;*
- *Justify the type and composition of partners (public, private, foundations etc.) considered necessary for this partnership and describe the ambition to include new types of partners (in particular end-users), and to ensure the necessary thematic and geographical coverage to meet the objectives;*
- *Describe the envisaged target groups / stakeholder community (beyond the members of the Partnership). Elaborate also on the international dimension and justify the EU-added value including international partners and stakeholders, and provide a justification when specific strategic needs at European level should restrict the international dimension.*

The Partnership needs stakeholder engagement from across the entire value chain of CCAM. It is obvious that to meet the overall objectives of the Partnership, active involvement is needed from different sectors, backgrounds and fields of expertise, including international ones when relevant and not hindering European competitiveness. This means that the European Partnership must be open to all those stakeholders representing industry, public authorities, research and users that are needed to work on the R&I challenges of all elements of the CCAM system (user, vehicle, its interaction with the surrounding environment, physical, digital and the bridge between the two, which is the operational infrastructure[20], interfaces between the individual transport modes) and all technical and non-technical enablers (see chapter **Error! Reference source not found.**). The types of actors to be included as members of the European partnership are shown in the figure below. Actors engaged in the Partnership will comprise private and public parties, together with European stakeholder associations representing overarching goals and expertise.

All stakeholder categories have a significant part to play in achieving the objectives of the European partnership and implementing the planned R&I actions. Private industry and research bodies will play a key role in the advancement of the technology, and together with authorities will facilitate demonstration activities in cities and regions, drive consistency and interoperability of common solutions whilst ensuring societal needs are met and suitable regulations are established. Mobility service providers will need to play a cross cutting role, with activities ranging from challenge definition based on their activity chain needs, via use case development to piloting. Research bodies will strengthen the evidence base for CCAM. Stakeholder associations, together with representative bodies, will ensure that key requirements and focus areas are addressed. They furthermore can play a critical role in bringing in the users' perspective and in creating user awareness and user acceptance, which will be critical for the overall deployment of CCAM solutions. In due time, during the evolution of the Partnership and of the technology field, new types of actors may arise as being relevant to the Partnership, which will remain open to new CCAM value chain partners to join.

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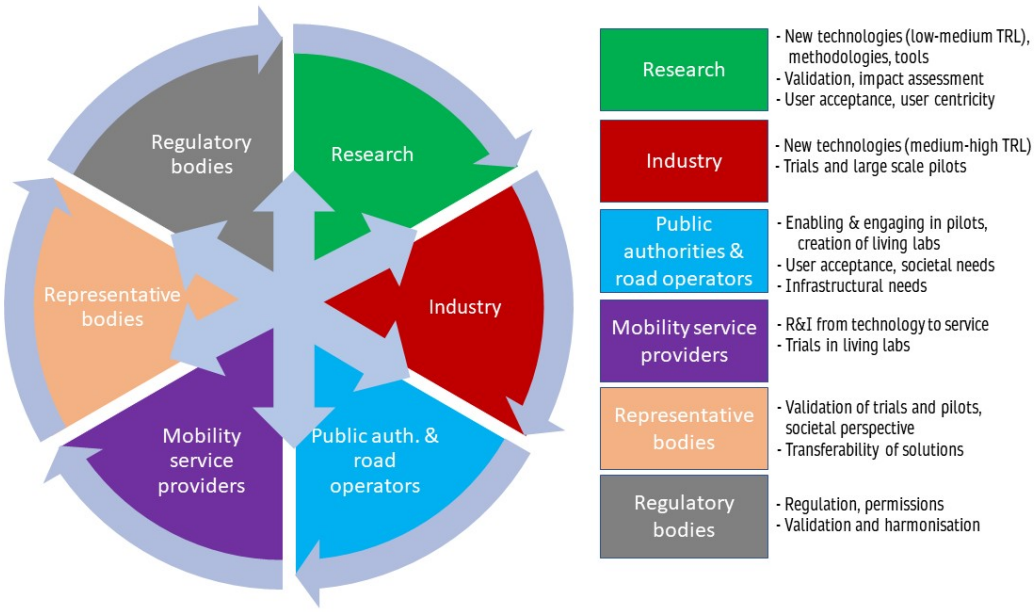
[20] In terms of definitions: Physical road infrastructure means the road, road signs, road markings, communication infrastructure and so on that form part of the physical world where vehicles operate. Digital road infrastructure includes static and dynamic digital representations of the physical world with which CCAM vehicles interact. Operational road infrastructure means traffic-management functions which facilitate the traffic flow by providing information or guidance. For example: speed sign (physical), speed – digital message via I2V (digital), speed limit (operational).



The types of organisations mentioned above are supported at European level by their respective European association, who gathered them into single representation bodies, ensuring their representation towards the European institutions. These associations organise an important bi-directional flow of information from single entities to the EU level and from the EU level to single organisations. They are therefore crucial in the information effort and to ensure that the activities of the Partnership are spread to a large number of actors within each sector, and reach widely the different regions of Europe, including EU-13 countries. Efforts to ensure this wide geographical coverage will be described in chapter 3.3 and 3.4 about the governance and the openness of the Partnership.

The following European sector associations are already supporting the CCAM Partnership by contributing to the drafting of this Proposal: EUCAR (automotive OEMs), CEDR (national road authorities), ERTICO (ITS Europe), POLIS (cities and regions), CLEPA (automotive supply industry), EARPA (automotive research providers), ECTRI (transport research institutes), UITP (public transport stakeholders), FIA (mobility users), ALICE (logistics), EPoSS (smart systems). The intention is to involve more organisations in the course of the proposal drafting.

In addition to these European sectorial associations, the Partnership Proposal is built on already existing collaboration networks using a multi-stakeholders approach:

- The CCAM Single Platform, as already mentioned, is a key initial source of content for this Proposal. The Platform gathers all private and public actors involved in CCAM in order to provide advice to the European institutions on research and development, innovation, pre-deployment and regulatory issues. In particular the CCAM Platform Working Group 1 has provided a major input to this Proposal through its list of objectives and research and innovation areas.

- The stakeholders network currently managed by the European support action ARCADE, provides a large basis of experts from companies, research institutes and public authorities, working on research challenges and developing in detail R&I topics. The network has contributed in defining the future R&I actions for the Strategic Transport Research and Innovation Agenda (STRIA) on Connected and Automated Road Transport from the

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European Commission, as well as contributed to the ERTRAC roadmap on Connected Automated Driving. The project manages the knowledge base on https://connectedautomateddriving.eu, gathering up-to-date information on CCAM-related R&I projects and pilot activities in Europe and beyond, regulations and policies, standards, and evaluation and data sharing methodologies, thus providing a means of exchanging knowledge and best practices on CCAM and supporting the commitments from the Declaration of Amsterdam. ARCADE is also responsible for supporting the European Commission in organising the European contribution to the Trilateral EU-US-Japan Working Group on Automation in Road Transport and for the organisation of the EU CAD Conference and EU CAD Symposium, taking place once per two years.

- The European Technology Platform for road transport ERTRAC, and in particular its Working Group on "Connectivity and Automated Driving" is also gathering experts from the industry, research community and public authorities, and has issued a Roadmap on "Connected Automated Driving" providing a view on how automation of road vehicles can be progressively developed, and which are the research and development challenges that need to be addressed. This Roadmap is updated every two years in order to provide an updated view of the sector on current challenges and the development paths expected for CAD systems. Other Working Groups of ERTRAC have also provided research recommendations linked to connectivity and automation, since they hold a key potential to bring substantial benefits within their fields: Road Safety, Urban Mobility, and Long Distance Freight Transport.

- The European Technology Platform for logistics ALICE is also working with the topics of connectivity and automation, as they are enablers for a more efficient freight transport system and towards the vision of a Physical Internet. CCAM is an enabler for increased multi-modality and towards the creation of a truly integrated transport system for sustainable and efficient logistics. Different application and use cases are proposed to be explored and socio-economic impact and benefits are well assessed: autonomous end to end (intermodal) transport chains, last mile rail to warehouse autonomous transport, port and terminal autonomous transport operations, infrastructure usage off-peak and or at night, reduced transport speed, urban freight transport automation.

- The European Technology Platform EPoSS defines R&D and innovation needs as well as policy requirements related to Smart Systems Integration and integrated Micro- and Nanosystems. The role of these technologies for enabling CCAM has been described in much detail in the EPoSS roadmap "Smart Systems for Automated Driving". Being a founding member of the Joint Undertaking "Electronic Components and Systems for European Leadership" (ECSEL) and its successor in Horizon Europe, EPoSS can help to identify opportunities for alignment of the partnerships along the value chain.

The collaboration networks mentioned above address different stakeholder groups from various sectors often resulting in fragmented approaches in identifying needs and requirements for CCAM. While bilateral exchanges or common initiatives between the networks often take place, the CCAM Platform has brought all these organisations and initiatives together. One example is the EU-wide *Knowledge base on CCAM*, developed and maintained by the ARCADE project. The CCAM Platform extended the network of stakeholders contributing to the gathered knowledge and lessons learned significantly.

The European CCAM Partnership will further leverage existing collaboration networks and stakeholder organisations by combining and coordinating efforts of Member States and the entire value chain of CCAM, complemented by user groups, research and academia. Consistency and coherence will be guaranteed through the joint definition of the Strategic Research and Innovation Agenda.

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International dimension

The CCAM partnership shall explore opportunities for complementing its activities in collaboration with partners and stakeholders at international level. For an assessment of what to aim for and how to best create added value in a collaboration, the EU's High Level Clusters for International Collaborations will be explored: strengthening of the EU competitiveness, addressing market access issues, contribution to addressing global challenges, and identification of global players and programmes.

International cooperation and dissemination is essential to ensure that Europe effectively contributes to worldwide harmonisation efforts and to raise awareness about European technologies as well as current development, testing and deployment activities in the region. Essential ongoing initiatives for international collaboration and exchanges on CCAM activities are the Trilateral EU-US-Japan Working Group on Automation in Road Transport and the regular concertation sessions and workshops organised in the frame of international conferences taking place annually in the three region and supported from the European side by the ARCADE project (EUCAD conferences, Automated Vehicle Symposium and SIP-adus conferences and workshops). The partnership will further support the development and maintenance of strategic partnerships and close cooperation with other regions of the world to exchange knowledge, expertise, lessons learned and best practice, as well as to work towards a global framework and international standards for connectivity and automation technologies.

While, the exchange of information with the U.S. and Japan shall be continued in the context of the Trilateral Working Group on Automated Road Transport, new relations, networks and collaborations shall be established with other relevant regions on the world as well, e.g. the Republic of Korea and Australia which have joined the Trilateral Working Group as observers recently, and China and Singapore: Korea is a major auto making country, thus establishing collaborations on CCAM may provide insight into technical requirements for the automotive supply industry in Europe. Australia, despite not being a vehicle manufacturing country, has become an important living lab for CCAM in recent years where experiences with the adoption of regulation can be gathered. Singapore is very innovative in introducing CCAM in the city state's transport system and may provide best practice examples for urban transport planning in Europe in this regard, while the Chinese government has established ambitious goals for the network and AI-support of CCAM that deserve close monitoring, as these may not match prospects from a European perspective, thus Chinese attempts for worldwide standards in this domain needed to be anticipated and responded to.

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3 Planned Implementation

3.1 Activities

The Partnership should deploy the necessary broad range of activities including calls for R&I proposals, from concept to demonstration and validation, as well as joint activities beyond joint calls that effectively support achieving its objectives. Where appropriate, the Partnership should take into account relevant standardisation, regulation and certification issues to maximise the impact of its actions and ensure market, regulatory or policy uptake.

- *Describe the envisaged portfolio of activities to support the full and effective achievement of the objectives and expected impacts of the proposed Partnership (to be elaborated in detail in the SRIA);*

- *Describe the mechanisms which will ensure the complementarity of activities and help avoid unnecessary duplications with other relevant initiatives of Horizon Europe, including with other relevant European Partnerships, missions and EU actions / initiatives beyond Horizon Europe;*
- *Demonstrate how the Partnership will ensure coherence and synergies in relation to major national (sectorial) policies, programmes and activities;*

This Partnership includes R&I actions addressing all elements of the CCAM system (user, vehicle, its interaction with the surrounding environment, physical, digital and operational infrastructure, interfaces between the individual transport modes) and all technical and non-technical enablers.

CCAM mobility systems and services for 2030

This Partnership for research and innovation addresses all development paths of CCAM for the next decade that are relevant from a public policy perspective, a road operator, a user / consumer perspective and from an industry perspective. It will focus on those co-operative and automated mobility systems and services that can bring gains in terms of safety, efficiency and sustainability of the overall transport system.

The aim is to support the development and pre-deployment of innovative (shared) mobility and logistics services using fully connected and highly automated vehicles (SAE level 4) for passengers and freight. The EU agenda will follow an iterative approach based on experience gained during testing with the objective to continuously expand the operational design domain of highly automated vehicles. The table below shows the application areas for 2030 CCAM systems and services that will be targeted in the EU agenda for research, innovation and testing. Differences in terms of type and maturity of CCAM systems and services in the different geographical areas are to be expected. However, our overall goal and long-term ambition level for CCAM is the same for passengers and freight and in all application areas. Further detailing the CCAM systems and services, determining milestones, deliverables and specific timeframes is part of the preparation of the Partnership. The selection of use cases has to be impact driven. The ones most relevant to achieve the objectives identified in section 2.2 and with great potential for deployment in the short to medium term (market readiness, industrialisation) should be favoured. At the same time, it is important to remain open to consider other possible new mobility services / use cases being developed in the coming years.

	Urban	Highway / nat. roads	Rural
Pax	Innovative, user-centric, inclusive (shared) mobility services using fully connected and highly automated vehicles (SAE level 4[21])		
Freight	Innovative, (shared) freight transportation and delivery services using fully connected and highly automated vehicles (SAE level 4) in real logistics operations		

Table 1: application areas for 2030 CCAM systems and services.

[21] This does not exclude lower SAE levels from this roadmap, it means that our goal is to reach SAE level 4 as quickly as possible and priority should be given to activities that help achieve this objective.

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	Urban	Highway / nat. roads	Rural
Pax	• Inclusive, cost effective public or shared transport, Shared automated shuttles / pods / busses / taxi services (possibly mixed passengers / freight, first on dedicated roads, later in mixed traffic)	• Highway pilot / chauffeur / convoy / platooning supported by digital infrastructure • Shared automated transport • Driverless maintenance and road works vehicles	• Inclusive, cost effective public or shared transport: shared automated shuttles / pods / buses / taxi services (first in specific small segments with suitable operational domains, later in mixed traffic)
Freight	• Delivery robots, automated freight vehicles (possibly mixed passengers/freight confined areas - dedicated roads - mixed traffic, defined periods) • Logistic Services, first & last mile • Waste collection, urban utility / cleaning / maintenance vehicles	• Highly automated (freight) vehicles • Driverless maintenance and road works / maintenance vehicles on highways	• Automation for shared vans • Delivery robots, shared deliveries (& drones) • Logistic Services, last mile delivery in secluded/cut off rural areas • Waste collection

Table 3: examples of application areas with most probable step-by-step approaches for evolutionary research and pre-deployment

The long-term ambition level and detailed EU agenda developed in the CCAM platform shall also be the basis for the definition of concrete R&I actions of a future European Partnership on CCAM.

Type of R&I actions

We will address R&I actions of two types: pre-competitive research at lower TRL levels and demonstration actions in operational environments. The EU agenda for research, innovation and testing will focus on large-scale demonstrations to test the performance and demonstrate the safety of innovative highly automated driving systems for passenger and freight, in all environments. These large-scale demonstrations should prepare the way for the deployment of CCAM systems and services. The Connecting Europe Facility or European Investment Bank can support pre-deployment. Interaction with the mobility system, development of associated services and potential to create positive impact and business cases are examples of aspects that need to be accounted for in high-TRL actions.

Actions to provide inputs for standardisation and harmonisation of technologies and methodologies will also be included as well as the development of assessment and validation methods. 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 towards a fully integrated European mobility system.

The EU agenda for research and pre-deployment (and European partnership) will also include a number of actions to support the strategic planning, coordination and cooperation between EU and national R&I projects and programmes (following-up on the ongoing work of the CCAM Platform, e.g. well maintained and searchable knowledge base, data sharing framework, common scenario databases, etc.)

The CCAM Partnership reinforces the need for cooperation on multiple layers. On the example of NRAs, this cooperation comprises multi-layered needs:

- internal: harmonise all in-house departments and implementation of their work into relevant (digitalisation, automation, decarbonisation, etc.) national programs;

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- between each other: follow up by coordinating the individual NRAs' approaches in international platforms, sector umbrella organisations (e.g. CEDR, PIARC, UNECE) on governance and working group level, as well as national representation at the CCAM platform;
- with other actors: liaise with other sectors (policy makers, industry, etc.), via high level representatives and a unified NRA position.

For most types of R&I actions addressed, cross-sector collaboration is very important from early stages of research on CCAM elements (roads, services and vehicles) onwards to enable seamless deployment and maintenance over the entire life cycle of the assets placed to the market.

- Prospective deployment partners need to be key actors already in the early phases, together with cross-sector research and innovation partners, in order to develop CCAM on the Technology Readiness Levels (TRL) up to some pre-deployment (Horizon Europe scope).
- When industry is turning to the next and competitive phase, i.e. development to market, infrastructure actors do not compete, but collaborate for preparing coherent and harmonised deployment. Since different investment planning cycles represent a significant challenge (e.g. sufficient lead time for planning and deployment budgets), there are strong merits of better cycle synchronisation 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 programs like Connecting Europe Facility (CEF 2).

R&I action areas

Based on the action plan of the STRIA Roadmap on Connected and Automated Transport and the stakeholder discussions in WG1 of the CCAM platform, the following R&I action areas can be considered as priority areas for the EU agenda and for the European partnership (see the earlier table for the link between the R&I action areas and the strategic objectives).

R&I action area	Description
Environment perception	Robust and accurate environment perception is essential for highly automated vehicles. To date systems are ready for partially automated driving in standard situations but not for complex driving conditions and demanding Operational Design Domains (ODDs). This will imply the need for: increased performance of perception systems (sensors), enhanced cognition using machine learning (AI), more powerful embedded in-vehicle systems, integration with infrastructure based perception systems to complete data fusion where internal systems are out of reach, and highly accurate and dependable localization systems. An incremental progress for highly automated driving in agreed ODDs to achieve less false detections for improved driver comfort and trust from all partners and road users of CCAM.
Cyber-secure Electronics	Systems for CCAM should be fail-operational and cyber-secure in their entire Operational Design Domains (ODD). In case of failure in subsystems or components, the CCAM system needs to remain safe, which requires advanced redundancy measures. Concepts are needed to identify tampering attempts and automated plausibility checks as part of the inherent safety concept along the entire lifetime and value chain, from production to operation to maintenance or

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R&I action area	Description
	repair (e.g. software updates, replacement of single components in a workshop).
Passive and active safety for CCAM	Active safety functions need to be adapted and advanced so that automated vehicles safely navigate in both, expected and un-expected scenarios. Therefore, systems need to be developed to anticipate and minimize risks, avoiding collisions where possible and reducing the consequences of unavoidable crashes. Advanced passive safety systems protecting passengers in new, non-traditional seating positions will be a focal point of research as well as conditions for the use of such systems, e.g. in public shared automated vehicles. The development of automated driving functions will lead to new interior concepts that can significantly increase the comfort of the occupants and transform driving time into leisure or work time. As automated driving evolves, we can assume that crashes will continue to occur. Consistent methods and assessment tools are required to fully understand the safety impact of automated vehicles in mixed traffic and to derive safety requirements. Needs and potentials for the (conditional) adaptation of traffic rules should also be derived in this context. Progress in accidentology based on naturalistic driving data will be used to gain new insights on vehicle interaction with and for the protection of vulnerable road users. Moreover, research is needed on required reliability levels of in-vehicle systems and components as an element of active safety.
On-board decision making	On-board safe, unambiguous, real-time decision-making for CCAM using complex in-vehicle systems-of-systems with advanced sensors, extensive computational power, reliable, dynamic high-definition digital maps. Focus on harsh and complex conditions where advanced capabilities such as pattern recognition, big data analysis and self-learning require high performance computing on- and off-board. Definition and EU-wide harmonisation of ODDs to ensure real-time decision-making for safe and secure CCAM for all types of traffic situations and roads.
Validation of CCAM systems	Higher level of automation, in particular in mixed traffic situations requires scenario-based validation and verification of the vehicle and its operation in the intended ODD to ensure safety, reliability and security. Within this context virtual, physical and hybrid approaches are needed allowing a cost-effective, reproducible and interchangeable validation of individual components and software as well as of the vehicle automation functions, including the underlying safety concept. Common methodologies and tools are needed to define the validation and verification requirements as well as the orchestration of the required tests including the derivation of representative scenarios and tests. This includes the development of a standardised, virtual simulation environment, dedicated hardware and physical infrastructure for testing. Attention needs to be given to the validation of self-learning systems as well, as their properties are principally dynamic and will change with time and with increasing experience on the road. Recommendations for a common framework for harmonisation, standardisation and homologation need to be elaborated on the basis of a common understanding of the required safety, reliability and security of CCAM.
Human-Machine interaction and interface design	Continue research and international standardization work on design strategies for in-vehicle input, in-vehicle interface with driver, output devices and actuators as well as on how to interact with surrounding road users (VRU, people in adjacent vehicles, police, etc). Consider different design strategies depending on road type, ODD, vehicle type etc. Ensure wider range of user groups (e.g. children, elderly, disabled people) especially when designing for mobility services. Ensure continued research and proof of concepts (PoC) on

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R&I action area	Description
	driver state assessment methods and technologies. Develop solutions to handle humans unfit to resume control. Develop training and information campaigns for users and general public which can complement intuitive vehicle designs. Continue work on developing proper HMI testing procedures, methods and tools which include both strict experimental set-ups as well as more naturalistic ones.
Remote operation and surveillance	When a CCAM vehicle is not able to continue operation without human intervention, remote operation and monitoring of related telematics can be useful to re-initiate safe operation (in dedicated environments remote operation of vehicles can also be considered for a continuous start-to-end remotely operated vehicles). In this specific situation safety, security and cybersecurity are critical. In addition, remote surveillance or user monitoring can be useful for safe system operation. This facilitates management of emergency situations, remote assistance for passengers, and supervision of the Quality Of Service. While enabling this functionality through connectivity, it is important not to change the safe system functioning and ensure minimal risk for users and other traffic participants. Therefore, the remote operation or surveillance should only be possible through the specific mode foreseen for this purpose by the manufacturer. This mode of operation should not alter any legal provisions and liability.
Physical and digital infrastructure (PDI)	Research and innovation on physical infrastructure (markings, road signs, layout, etc.) and digital infrastructure (digitised spatial network and regulations, communication technology, road-side sensors, HD maps integrating static and dynamic data, etc.) and operational (traffic management of the mobility network etc.) to support CCAM and ways to ensure how the transition can be made in the most efficient and cost-effective manner. Research on business and financing models, policy options and ways to increase competencies and resources for road authorities (and/or operators) to ensure, that the physical, digital and operational infrastructure remains fit for purpose. Achieve common understanding of the role of PDI for CCAM and specifications of required infrastructure.
Connectivity / cooperative systems	The main objective is to secure effective connectivity for the needs of CCAM. Ensure robustness and redundancy, availability of communication channels (network coverage) and a minimum quality of service (QoS) especially for higher levels of automation. For safety critical applications of CCAM, the performance and resilience of connectivity is essential. Create trust among the different entities exchanging information. Assess the performance from an end-to-end perspective in real-world driving conditions and in hybrid communication environments, safeguard fail-safe operation, appropriate degradation, privacy protection and end-to-end security. Ensure interoperability between all involved actors (vehicles, infrastructure, road users, road/fleet operators, public authorities, etc.), develop standardised C-ITS messages and message sets (e.g. for manoeuvres) and test EU-wide interoperability and compatibility.
Artificial Intelligence (AI)	Develop explainable concepts, techniques and models of Artificial Intelligence (AI) for CCAM. Huge amounts of in-vehicle and infrastructure-based sensor data together with other data sources will be used to 'train' AI algorithms. This development process is accelerated and supported through harmonization, availability, quality assurance, interoperability and exploitation of relevant data. However, a variety of challenges must be tackled: e.g. industrialisation, requirement-based development, continuous improvement of trained modules for application in safety critical domains and the verification and certification of AI for automated driving functions.

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R&I action area	Description
Fleet and (mixed) Traffic Management	Integrate (shared) automated vehicle systems in existing traffic, with conventional vehicles and on existing roads. Integrate (shared) automated services in fleet and traffic management systems. This requires to reach agreements on targets and roles within the mobility system among multiple stakeholders, as well as research on a multitude of aspects, e.g. simulation and big data analysis, impacts on operations and users, total system effects, infrastructure savings and needs, etc. Test new options and governance models to operate shared automated mobility systems as part of real-life fleet and traffic management systems. Guidance for authorities (e.g. local, regional, national, port, EU-wide) to prepare and plan for CCAM services.
Develop and demonstrate shared and integrated automated mobility solutions	Understand user acceptance and requirements of smart, shared, automated mobility solutions and foster the development of technologies and business models, in particular to encourage shared mobility fully integrated with public transport and soft modes, and logistics solutions, including proven and tested stimulation methods (like incentives, regulations and taxation schemes). This may include the design of a code of behaviour in CCAM vehicles as well as widely acceptable access regulations. Provide appropriate living-labs to analyse public acceptance of CCAM in real-world conditions while offering stakeholders with the opportunity to innovate, propose, test, and improve high value mobility and logistics services for the benefit of the end-users and the overall community. Large-scale demonstrations shall increase the scalability of demonstrations of advanced shared automated mobility and logistics solutions, including automated door-to-door goods delivery solutions, to pre-deployment in more complex ODDs in urban, peri-urban and rural environments. Demonstrations will show efficient ways to integrate shared mobility solutions using CCAM vehicles into the transport system. Demonstrations will facilitate the uptake of new business and operational models which positive societal impacts. They will demonstrate inclusive shared automated mobility solutions complementing mass transit, in particular for users with special needs (such as disabled, elderly) and for Mobility White Spots, where other public transport is not economically viable.
Large-scale demonstration of highly automated passenger vehicles	Large-scale pilots and field operational trials (FOT) will ensure safety, provide valuable insights in the abilities of automated driving systems (ADS) and their current limitations. Large-scale pilots with prototype vehicles provide data for verifying and validating ADS ensuring safety and reliability before market introduction. Demonstrations with small series production passenger vehicles (i.e. FOTs) will raise user awareness, help assess the impact on society and accelerate implementation. For these FOTs, “Living Labs” provide the infrastructure (including connectivity), mixed dynamic traffic environments and user communities. The coordination of Living Labs for ADS is important to foster harmonization and interoperability and support cross-border functionality all over Europe. The network of large-scale pilots will boost knowledge acquisition through harmonised data/scenario exchange. Improvements of operation efficiency in urban, sub-urban environment and smaller villages and for human-machine interaction will be assessed. Public and private stakeholder collaboration will be fostered to achieve common objectives and assess societal impact.
Large-scale demonstration pilots of automated commercial / freight vehicles	Large-scale demonstration pilots and pre-deployment (e.g. FOTs) activities will deliver evidence for quantifiable freight transport objectives such as increased freight transport efficiency, improved road infrastructure utilization, reduced energy consumption, increased safety, and improved working environment. Large-scale demonstration pilots will also prepare for deployment of connected automated commercial freight vehicles in mixed traffic with different type of vehicles of various automation levels, and

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R&I action area	Description
	different ODDs in urban, peri-urban and rural environments. Early involvement of different freight logistics stakeholders such as; shippers, port, terminal, road infrastructure authorities, forwarders, truck OEMs, trailer and load-carrier manufacturers will identify opportunities and obstacles. New operational and business-models will be developed, tested and evaluated through logistics operational pilots in a "European logistics living lab" for integration into a global logistics context and to strengthen European competitiveness to pave the way for innovative concepts and new products and services.
Societal needs analysis	Analyse user requirements, expectations and concerns related to the use of connected, cooperative and automated driving technologies and systems in their broadest sense (e.g. interaction with the system, trust, liability, ethical issues, privacy concerns, security, minimum safety and performance standards, etc.). Particular attention will be given to the requirements of users in need of special attention (e.g. disabled, elderly people, children). Assess the impacts of higher degrees of automation and digitalisation in road transport on qualifications and licencing of the different actors involved in the mobility system. Examples include that vehicle drivers may turn more into operators, and traffic management may include more control tower elements. Analyse requirements for new competences and qualification principles. Develop updated education and licencing procedures and requirements, and define principles for their interaction with the new and fast changing framework conditions and technological evolutions of CCAM.
Socio-economic and environmental impact analysis	Assess the short, medium and long term impacts, benefits and costs of connected, cooperative and highly automated driving systems (in all areas) considering the full range of impacts including, but not limited to, driver behaviour, mobility behaviour, accessibility, safety, traffic efficiency, emissions, energy consumption, use of resources, impact on transport market, impact on employment and working conditions, required skills, infrastructure wear and land use. Conduct comprehensive cost / benefit analyses and projections of the overall investment requirements, vehicle equipment costs, operating costs and environmental costs (including life cycle analyses of the systems) of large-scale CCAM deployment, in exchange for expected targets for road-safety, traffic efficiency, health and pollution, affordability for users, and inclusiveness, so as to direct development policies towards the most appropriate economic, social and environmental needs. Identify and develop specific use cases with a positive socio-economic impact, defining the policy framework and specific use cases and roll-out plans.
Strategic European agenda for R&I and large-scale testing	Develop and continuously update a clear long-term European agenda for research & innovation and large-scale testing activities, making sure that investments at European, national and local levels, both of public and private nature, are complementing each other towards systemic and interoperable solutions for a fully integrated European mobility system.
European frame-work for testing on public roads	Beyond validation and verification of the vehicle functions in confined areas, large scale testing on European level is needed to better understand the road user and driver behaviour as well as the ODD, including connectivity. Both are needed, on the one hand as input to the scenario-based vehicle validation, and on the other hand for evaluating the impact of CCAM in mix traffic scenarios (e.g. safety and energy consumption, reduction of congestions, environmental impact, etc.). To foster and enable such testing, a European framework to allow testing on public roads is needed, including different road categories, cross-border traffic and addressing all types of vehicles. It should allow to analyse and to demonstrate the performance, reliability, safety, security and robustness

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R&I action area	Description
	of CCAM including the fail-safe and fault-tolerant functioning in varying mixed traffic scenarios. Within the framework for testing, obligations on a common methodology for conducting and evaluating those field operational tests needs to be included as well as on a harmonised ontology for data handling and storage (taking privacy and cyber security aspects in account). The framework must ensure safe testing, before a comprehensive vehicle validation procedure is in place.
Data exchange framework	The effectiveness of large-scale testing in Europe can be largely increased by a more systematic exchange of experiences, test results and test data. Based on the work of the CCAM platform, the European partnership will establish a data exchange framework and a common evaluation methodology to improve cooperation and make better use of the results of all testing activities in Europe. Key objectives will be to ensure provision of high quality and well documented datasets, co-operate on a technical reference platform with other data sharing initiatives, encourage data re-use and establish win-win situations and keep the balance between privacy / IPR and availability.
EU-wide knowledge base, including common scenario database	Establish and maintain the existing web-based Knowledge Base centralising information about stakeholders, R&I programmes and projects and testing activities in the field of CCAM in Europe and worldwide. Extend the Knowledge Base by providing more information about national, international CCAM activities, standards, testing methodologies, common scenario database, lessons learned.
Common evaluation framework	Develop and support coordinated and harmonised approaches to assess impacts of CCAM technologies and systems. Common evaluation framework for large-scale demonstration pilots in Europe to allow comparability of results, complementing evaluations and meta-analysis over multiple evaluation studies.
Data storage and sharing	Develop a harmonised approach for data sharing based on open and interoperable programming interfaces (APIs) and access control by defined user rights. Focus on the data value chains, data storage and formats, standards and related infrastructure. Provide a complete and secure system architecture that complies with privacy, data security and cybersecurity requirements while allowing access to in-vehicle real-time data and resources, on-board and remotely, as needed, for all relevant service and application providers. This will foster cross-industry interoperability, choice by and portability of services for the user, price affordability, and competitiveness (for example, to support the maintenance, repair, and improvement of vehicles throughout their lifecycle).
Workforce development	Assess the impacts of higher degrees of automation and digitalisation in road transport on the future workforce (including job location, working environment, working times, needs for new skills, education and training). Analyse requirements for new workforce competences. Define policies for labour market incentives and ways to adapt workforce development and value chains to new and fast changing framework conditions and technological evolutions of CCAM.

Table 2: R&I action areas

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3.2 Resources

A partnership will only be successful if all partners are and remain committed. Binding commitments to their contributions will be necessary to achieve the objectives.

- *Please specify which types and levels of contributions from partners are necessary to achieve the objectives and impacts (financial contributions, in-kind contributions, activities/resources linked to market, regulatory, societal or policy uptake, broader investments) and provide qualitative and quantitative information on these;*
- *Please specify which other investments or framework conditions are envisaged / relevant for the deployment.*

CCAM will have a remarkable economic impact and therefore play a decisive role in global competitiveness and EU's industrial strategy. According to a 2016 PWC study[22], connected car technologies generate around 45 billion $ in customer spending in 2016. Safety and automated driving technologies are the largest categories, accounting for about 61% of the total. It is expected that the revenue from connected car technologies will grow to 156 billion $ in 2022. Another study estimates that car manufacturers have an additional revenue potential of 30% in 2030 driven by connectivity services and new business models. According to Boston Consulting Group, the autonomous car market could be a $42 billion market by 2025, which could be around 12-13% of the total auto market. And the global market for components like cameras or sensors is estimated up to €35 billion and for advanced software and related services up €18 billion by 2030[23].

The ambition 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 objectives will not be reached by research and innovation actions alone.

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 realize the expected impacts. Connectivity and automated driving bear great opportunities for the industry in terms of mass manufacturing as well as new business models or new mobility services. The technological evolution must meet market needs and customers' expectations.

These require a scale up phase, after the projects and programme finish, with investments in the range of 5 to 10 times the scale of the overall partnership budget (public and private side contributions). These comprises technology development in high TRL level (8-9), 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 in this domain and hence untap otherwise unused synergies, e.g.:

- 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
- Public transport providers use their fleet and operations to test CCAM services
- Transport industry supports CCAM with their expertise in heterogeneous and complex system landscapes

[22] Connected Car Study 2016, PwC

[23] Bernhart, W. et al., think act - Autonomous Driving, Roland Berger Strategy Consultants GmbH, 2014

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This broad contribution leads to a significant larger proportion of in-kind contributions and a strong leverage effect towards market uptake.

The members of the CCAM partnership commit to a common and coherent R&I strategy and the joint objectives (see chapter 2.2). This commitment includes the financial and in-kind contributions for the administration and execution of the work programme as well as the necessary actions to support:

- creating an innovation-friendly ecosystem for CCAM;
- removing barriers to implementation; and
- accelerating market-uptake.

As all the partners in this partnership commit to the general and specific targets, their contribution to the association (membership fees) will be used to finance and facilitate these. Besides the R&I work programme for CCAM, this will involve

- actions to raise awareness with users, communities, regional and national level, and European level (EUCAD conference, TRA Conference, Digital Transport Days);
- dissemination addressing all relevant stakeholders across Europe (with special focus on EU13);
- accelerating implementation with specific dissemination towards high level decision makers for transport policies;
- guidance to education developments for (software) engineers in the area of CCAM; supporting re- and up-skilling of work force in related industries

Financial commitment, both from public and private side, will need to be assessed according to the final scope and objectives of the partnership.

Based on the final version of this document, a more precise assessment of the respective financial commitment will be drafted.

3.3 Governance

- *Outline the governance and management of the Partnership, including advisory structures and mechanism to be established. Demonstrate how the governance and management of the Partnership helps to achieve the defined vision and objectives. Describe how it will contribute to ensuring coherence and synergies with the EU research and innovation landscape and demonstrate, as well as transparency and openness during the Partnership as regards the identification of its objectives, priorities, vision, Strategic Research and Innovation Agenda (SRIA) and work programmes.*
- *Provide, with the support of the Commission services supporting the preparation, a description of the involvement of the Commission in the preparation and implementation of the Partnership. In particular, describe the mechanisms for defining and defending the EU public interest in the framework of the Partnership.*

The objective of the Partnership is to bring all the relevant stakeholders together around a shared vision, and to define together the objectives and the priorities. Research and demonstration efforts are often fragmented and there is a strong need for more exchange of information about activities and reuse of results achieved by projects. If we want to increase the impact of investments and make an efficient use of funds available in Horizon Europe, we need a better coordination between research and innovation agendas from the local, regional, national, and European level, across the public and private sectors. The governance of the

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Partnership shall enable this coordination, and do it in an efficient, open, transparent, timely and lean way.

The governance shall both organise the representation of the stakeholders of the Partnership and set up the process for exchanging with the European Commission services. The rules of a Co-Programmed Partnership operating under the Horizon Europe programme will be followed.

All stakeholders of the Partnership shall be gathered within a non-profit association to be created for this purpose. For full openness, all stakeholders willing to contribute to the Partnership shall have the opportunity to join this association. Membership to the association will be open to all types of organisations listed in chapter **Error! Reference source not found.**. European associations will also be entitled to join the association.

All members will be gathered in the **General Assembly** of the association, which will be responsible for endorsing documents and decisions, ensuring information to all and the transparency of the activities.

The General Assembly will elect its **Board**, composed of a Chair and Vice-Chairs, who will be responsible for the daily management of the association, to chair the meetings, and to represent the association towards the European institutions, and for any other external representation required for the operations of the association. The detailed nomination rules for this Board will be governed by the Statutes of the association. Its composition shall reflect the different stakeholders represented in the association membership.

Out of the members of the General Assembly will be selected a precise number of representatives to act as a Delegation of the association responsible to meet in the Partnership Board, the body where the stakeholders of the Partnership meet with the European Commission services to discuss future research priorities and draft recommendations for the annual Work Programmes.

The **Delegation** will include representatives of the different sectors involved in the Partnership, ensuring a balanced representation of the different stakeholders. Its members will be selected from the General Assembly. The detailed nomination rules shall be governed by the Statutes of the association. Proposals for research topics to be funded by the Partnership will be collected from all members of the General Assembly, to guarantee openness, and the role of the Delegation will be to bring these proposals to the Partnership Board in order to discuss them with the EC services. The Delegation will report back to the General Assembly about the discussions and outcome of the Partnership Board meetings, in order to provide information to all stakeholders and guarantee the transparency of the process.

The **Partnership Board** will be the body formed by the Delegation of the association and representatives of the European Commission services. It will discuss the research priorities and provide recommendations for topics to be implemented by the annual Work Programmes. This exchange shall ensure that topics to be funded contribute to achieve the vision and the objectives of the Partnership. The Delegation will bring its expertise and knowledge of the latest R&D activities happening within their organisations and at national or local level where they are also active, while the European Commission services will ensure that the topics are in line with the latest European policies and strategies, and that there is coherence with the overall EU research framework. All partners should also look for complementarity and good coordination with other parts of the Horizon Europe programme, both within the Energy, Climate Change and Mobility cluster and with other clusters, especially with other Partnerships addressing related topics, as identified in chapter **Error! Reference source not found.**.

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The meetings of the Partnership Board will take place at European Commission premises, and will be called by the European Commission services according to the planning of the Work Programmes definition, to allow a timely consultation and drafting work.

In addition to the meetings of its bodies and the process of identifying research priorities, the association will organise public events, open to non-members of the association, in order to publicise the activities of the Partnership, disseminate its results, and promote further collaboration with additional actors. Such public events could take the format of a conference or of thematic workshops, and could include external invitees and be open to international participants, as judged relevant. Such events will contribute to the openness and the transparency of the Partnership.

Joint activities could also be organised together with other Partnerships operating under Horizon Europe, in order to address common topics and promote coordination and collaboration across several research fields. Such joint activities will be decided and prepared in cooperation with the respective European Commission services.

Specific activities could also be organised towards the EU-13 countries, in order to disseminate information and promote participation. Through its openness, the association will welcome stakeholders from these countries within its membership. Existing networks (listed in chapter 2.4) already aim at involving them and will support this effort. In particular the European associations that are supporting this Partnership proposal have a wide geographic coverage in their membership, with many members from the EU-13 countries: they will provide information to them and encourage them to join the activities. Also the associations representing public authorities will help to reach that wide geographic coverage of the European Union, through their members in all countries. This includes the national level (such as road authorities represented in CEDR) but also the local and regional authorities, which are involved in networks such as POLIS and Eurocities. Authorities from southern and eastern Europe are active in these associations and will get informed and encouraged to join. The same goes for associations representing the researchers, such as ECTRI, FEHRL and EARPA: their membership include research institutes and universities from all over Europe, who will be informed thanks to their communication channels. Beyond this role of information sharing, it is by networking that a wide participation can be promoted: it is thanks to participation in the association meetings and public events that the different stakeholders will meet with each other and will identify potential partners to build collaborative research activities.

Involvement of Member States

The different portfolios of Member States roles in CCAM require different levels (i.e. categories) of involvement with a range of activities tailored to the needs and preferences of individual Member States. The specific involvement of every Member State is open in the following categories:

- Continuous involvement **as partner** in key processes (comprising the full range from strategy to operational tasks, also including performing research activities) within the CCAM partnership.
- Interaction and dialogue on CCAM on an annual basis (information provision from CCAM partnership to Member States, advise from Member States) as member of a national Member States 'Advisory Board'.

Infrastructure managers and local authorities have a direct role to play as member of the Partnership, because of their ability to mobilise actors in the local innovation ecosystem, including public and private actors. They can integrate projects and provide expertise on how to integrate technology to the local mobility needs and constraints, providing opportunities for testing and demonstration activities.

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For partners: the key interest of Member States also comprises – amongst others – *validation and verification of CCAM functions* and the *European framework for testing on public roads*. On both objectives, the competent authorities within the Member States (top-level governance) can coordinate their efforts, supported by appropriate Horizon Europe funding instruments (e.g. Coordinating and Support Actions (CSA)).

For advisory board members: the feedback loop between the partnership and the Member States advisory board shall ensure coherent European, national and transnational R&I programmes for CCAM. The alignment with the CCAM partnership on goals and scope and/or on exchange and cross-fertilisation of results is an essential interest of Member States in this advisory body.

Member States also provide guidance on societal needs and expectations with regard to CCAM and large-scale demonstration projects. Existing formats of exchange, e.g. High Level Dialogue on Connected and Automated Driving, and the CCAM Platform, may provide important contributions but are not necessarily institutionalised for the full expected duration of the CCAM partnership. Hence, to provide room for a high-level Member States Advisory Board complementing the actions described above would be a significant contribution to the success of the partnership.

3.4 Openness and transparency

A Partnership will maximise its impacts by involving all relevant partners and stakeholders beyond the narrow composition of core partners and by remaining open during its lifetime. Consequently, there should be a high level of openness and transparency regarding the identification of common vision, and the involvement of partners and stakeholders from different sectors, including international ones when relevant. Also, the Partnership should seek to remove barriers that hinder newcomers from entering and participating in the Partnership or its activities. The implementation of the Partnership should include regular activities that allow new players to enter, participate in and benefit from its activities, and add value to the Partnership without compromising the ownership and commitment from the partners.

- *Demonstrate that the proposed Partnership will be established in a transparent way with no unjustified restriction in participation and with a broad, open and transparent approach towards different sectors and geographical areas including international partners when relevant. Justify any restrictions for the openness of the Partnership where it is deemed absolutely necessary;*
- *Describe the strategies and plans throughout the lifetime of the Partnership to ensure easy and non-discriminatory access to information about the initiative and dissemination of and access to results (in line with Horizon Europe provisions), and to stimulate the participation of new partners and actors in the definition of common priorities and their participation in the partnerships itself or its activities (including eligibility for funding);*
- *Describe how the proposed Partnership will establish a proactive recruitment policy which is dynamic and agile to allow a membership constituency responding to the evolution of the sector and the needs of the partnerships throughout its lifetime, across the Union and, where relevant beyond;*
- *Describe the process, during the implementation phase of the SRIA/roadmap, for establishing annual work programmes, and define measures to ensure and open and transparent methodology for consulting all constituent entities and relevant stakeholders for the identification of its priorities and the design of its activities.*

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This Partnership has the objective to involve all the stakeholders involved in the development of CCAM technologies and services, so by nature such a partnership cannot have a narrow composition of partners but in the opposite aims at bringing together the various actors that play a role in CCAM development and testing. Because connectivity and automation are complex technologies and services requesting a joint effort from different industry actors together with several levels of public actors. It is the main objective of such a partnership to enable this collaboration of players, and its multi-stakeholders nature represents its key added value compared to a standard R&D funding. Therefore, the governance will be designed as very open and lean, in order to enable a wide participation of all the needed stakeholders.

And since the field of connectivity and automation is evolving very fast and new unforeseen developments could happen in the coming years, the governance will provide the openness to allow additional stakeholders to join the Partnership during its lifetime. So the membership will not be fixed at the start but will stay open, so there will be no barrier to the involvement of newcomers.

The membership of the association will therefore be opened to all stakeholders willing to contribute to the Partnership. Since the aim of the EU R&I Framework Programme is to provide benefits to European citizens, the participation shall however be restricted to organisations performing activities in the European Union, or in countries associated to the Horizon Europe programme. So the members of the association shall respect the following basic criteria:

- share the common vision and objectives of the Partnership;

- demonstrate research activities within Europe (EU MS and Associated Countries to HE);

- show willingness to invest in collaborative research activities at European level.

Membership to the association will be open to all the types of organisations listed in chapter 2.4. European associations will be entitled to join the association. So the association will take as members both associations and single organisations.

The association will aim at a very wide membership mixing researchers, industry and public authorities. This Partnership proposal is already supported by all the major European associations involved in CCAM research activities. Information about the partnership and the setup of its governance will be disseminated through the communication channels of these association, which should be able to reach hundreds if not thousands of stakeholders all across Europe. There will be a high diversity of actors. Industry will be involved both at the level of large industry players such as vehicle manufacturers and suppliers as well as open for SMEs to join. For researchers, all types of organisations will be welcomed: private research providers, publicly funded research institutes, and universities. Associations such as ERTICO, EARPA, ECTRI, FEHRL will help to inform them. For authorities, the different levels will be targeted: national bodies, such as road operators and managers, but also regional and local authorities. Existing networks for innovation at the regional and local level such as POLIS and Eurocities will be used to reach these local actors. For operators of public transport, the international association of public transport UITP is involved in the proposal and will inform its members about the Partnership. For representatives of users, associations will also be used to reach the users representation bodies, which are often organised at national level. For example, the FIA gathers national associations of mobility users from all the EU: the involvement of users representatives in the setting of R&I priorities and within projects can ensure that the partnership is well aware and assess systematically the aspects of users acceptance and involvement.

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To ensure openness, this association will be a new dedicated legal body, created to represent the stakeholders of the Partnership. It will take the legal format of an international non-profit association, registered under Belgian law. For the objective of openness, the annual membership fee will be as low as reasonable, only to guarantee the activities to be performed by the association, to reach a financial equilibrium and comply with legal and fiscal requirements, and to ensure the continuity of the activities along the lifetime of the Partnership. Membership fees will be differentiated between private and public organisations, and between large and small organisations, to represent a fair contribution for the different types of actors, and be a low entry point. Therefore, this minimal membership fee should not be a barrier for smaller players such as small universities, SMEs and startups to get involved.

During the implementation phase of the Partnership, for establishing research priorities and agreeing on recommendations to the annual Work Programmes, an open consultation of all members will be organised: so all stakeholders will have the opportunity to provide their research priorities and contribute to the design of the Partnership activities. This could be done via the collection of interest from the members for collaborative research activities they would like to be involved in the next years. Such exercise could be done every year, or every two year, depending on the needs of the Work Programme preparation. This approach is already implemented by public-private partnership throughout Horizon 2020 and it is a good practice that can be applied for the field of CCAM. It helps to see what the main trends among the stakeholders are, and which priorities are highlighted by the stakeholders. It also supports the networking among actors, who through this exercise can see which other stakeholders are interested by the same research topics.

It is only for the sake of efficient discussions that a Delegation with a limited number of representatives, representing the different types of stakeholders, will meet with the European Commission services at the meetings of the Partnership Board. This Delegation will report back about the discussions to all the members of the association, to provide transparent information to all. The Delegation will include a fair representation of the different stakeholders represented in the association.

Beyond the involvement in the association, full openness is guaranteed by the nature of the Co-programmed Partnership instrument, which uses the normal rules of participation for open calls of the Horizon Europe programme. So being member of the association is not a condition to participate to projects funded by the Partnership. Any organisation complying with the rules for participation in Horizon Europe can reply to the calls and submit a proposal. By experience from the Contractual Public Private Partnerships running under the current Horizon 2020 programme, one can see that a majority of partners in projects are not member of the association: so this approach ensures full openness and flexibility, and there is no restriction done for newcomers and small entities.

The Partnership commits to organise on a regular basis dissemination events such as public conferences or thematic workshop, in order to communicate publicly about the activities of the Partnership. Participation to such events will not be restricted to the members of the association, and there will be no registration fee. The objective of such events would precisely be to disseminate information wider than the already participating stakeholders, in order to reach actors not yet involved. So such events will contribute to both the transparency and the openness objectives. Workshops could for example be organised on priorities newly identified, which were maybe not very visible at the beginning of the partnership but found to have high importance later during the partnership lifetime. Such activities would then help to identify new actors, to call for coordination, or to get integrated within the activities.

Projects funded by the Partnership will commit to publicise their activities, via websites open to the public, social media activities, and any other means that will seem appropriate. Such

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activities will however depend and be described case by case by the individual project agreements, and will follow the provisions of the Horizon Europe programme.

Projects funded by the Partnership will also be encouraged to use and contribute to the EU-wide knowledge base on CCAM, to the common data exchange framework, and to the common evaluation framework, which are highly relevant activities to supporting the objectives of the Partnership and will therefore be further developed by the partners.

Regarding the involvement of international actors, links should be established through the public events such as conferences and workshops, where international representatives could be invited as speakers or guests.

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