Connected, Cooperative and Automated Mobility (CCAM)

Proposals are invited against the following topic(s):

HORIZON-CL5-2025-01-D6-01: Advancing remote operations to enable the sustainable and smart mobility of people and goods based on operational and societal needs (CCAM Partnership) – Societal Readiness Pilot

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| **Call: Cluster 5 Call 01-2025 (WP 2025)** | |
| **Specific conditions** | |
| *Expected EU contribution per project* | The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts. |
| *Indicative budget* | The total indicative budget for the topic is EUR 12.00 million. |
| *Type of Action* | Research and Innovation Actions |
| *Technology Readiness Level* | Activities are expected to achieve TRL 5 by the end of the project – see General Annex B. Activities may start at any TRL. |
| *Legal and financial set-up of the Grant Agreements* | The rules are described in General Annex G. The following exceptions apply:  Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[1]](#footnote-1). |

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

1. Comprehensive set of principles, guidelines and requirements for remote operations that clarify operational complexities (e.g., safety, (cyber-)security, liability, privacy, certification and operator training, interoperability, cross-border operations) is defined, and a standardised approach to extend the Operational Design Domain (ODD) of CCAM solutions is established;
2. Infrastructure prerequisites, particularly in technology and communications (safe and reliable communication, especially considering SNS components for the automotive sector[[2]](#footnote-2)) are defined, which are critical for the successful implementation of remote operation capabilities, outlining the technical standards and investments necessary for seamless integration with current transport systems, while appreciating the potential environmental impact;
3. Safety validation methodologies extended to remote operations favouring acceptance and trust of road users in such CCAM systems;
4. Identification and description of at least two economically viable business cases for remote operations complementing the ODD of CCAM solutions, analysing the economic costs and benefits, market potential, and scalability factors, and providing a clear value proposition for public or private stakeholders for each use case;
5. Understanding the human factors of the entire system (including the in-vehicle and remote perspective), as well as legal requirements and working conditions for remote operators, addressing cognitive load, fatigue and stress, ergonomic considerations, and the identification of essential skills. Establishment of key conditions for job quality, safety, up-to-date competences and acceptance of working conditions in diverse cultural contexts;
6. Responsiveness to a deeper understanding of the needs and concerns of diverse social groups involved in or potentially affected by the R&I development, considering gender and other social categories, and thereby increasing the potential for beneficial societal uptake, and building trust in results and outcomes;
7. Policy and governance recommendations in view of establishing new or updating existing legislation to cover remote operations, e.g., through clear descriptions of stakeholder roles and responsibilities that may vary for different types of remote operations.

Scope: This topic aims at exploring the operational and societal conditions and prerequisites for complementing the ODD of CCAM solutions through remote operations, as defined by the United Nations Economic Commission for Europe (UNECE)[[3]](#footnote-3). Here “remote operations” is to be understood as the remote monitoring, assisting, and operating the Automated Driving System (ADS) by a person located externally. The vehicle operates with a high degree of automation (SAE Level 4), but a human operator can monitor its actions and surroundings remotely and intervene, if needed. Intervention ranges from providing strategic guidance and tactical commands to determining vehicle manoeuvres and taking over control in scenarios that include, but are not limited to, emergency responses, system malfunctions, ADS system limits, or complex navigational challenges unforeseen by the CCAM system.

The topic invites proposals to explore two use cases that should focus on remote operations on urban and rural public roads and/ or confined areas, dealing with at least two of the following areas:

1. Transport of people: use cases that enhance public transport services (i.e., by fleets of remotely operated shared vehicles, including, if relevant, on-demand responsive transport) improving accessibility and mobility for users in all their diversity in terms of all characteristics (e.g., age, gender, disability, etc);
2. Transport of goods: use cases that optimise logistics (e.g., remotely operated delivery vehicles in urban environment), improving efficiency and sustainability;
3. Combination of people and goods transport: use cases of integrated solutions (e.g., remotely operated vehicles that transport goods during off-peak hours and convert into passenger transport services during peak times), improving vehicle utilisation, while addressing congestion and reducing environmental impact.

For each of these use-cases, operational and societal aspects that would enable remote operations of multiple ADSs must be evaluated in terms of business models, infrastructure needs, safety assurance, legislation, as well as organisational aspects that may include cultural elements. Additionally, operator’s skills, performance and situational awareness of the remote operator must be addressed. The analysis of potential rebound effects and questions related to energy sufficiency and sustainability should not be neglected. Where applicable, the use of generative AI should be considered.

This topic aims to understand all the different components of the complex ‘system-of-systems’, combining technological advancements with a focus on human-centred design/ interfaces, as well as societal needs, considering their implications from the start. This will enable to lay the foundation for the development of advanced demonstrator use cases, integrating the various components in next phases, although technological adaptations of existing approaches to reach an integrated system-of-systems should already be validated in the relevant environment here.

Technological components of the system-of-system are foreseen to include e.g. infrastructure support, communications, cyber-security, key enabling technologies (possibly including generative AI, etc.). Proper selection of existing technology enablers and related SW developments to implement the remote operation functions is essential. Societal aspects must be identified (e.g., user-centric design, working conditions), through the inclusive engagement of stakeholders for problem formulation and concepts development, co-creation and co-assessment of deployment and operations.

Stakeholders could include user groups and public advocacy organisations, mobility companies, technology providers, public agencies, planners, community groups, industry associations, first responders, social partners[[4]](#footnote-4) and workforce representatives. These should be involved in building awareness, trust, and support for remote operations, identifying skill gaps and skill transferability of operators as well as training needs. Additionally, various stakeholders should be engaged to examine unanticipated implications (e.g., environmental, social equity etc.) and to co-develop solutions, as well as other pre-conditions making remote operations feasible (e.g., policy, governance, territorial planning, infrastructural readiness, integration into Traffic Management Systems (TMS), organisational and legislative requirements etc.).

The dimensions of Responsible Research and Innovation (RRI) – reflection, inclusion, anticipation, and responsiveness – should guide the exploration of the technological components of the system-of-system to achieve societal readiness, involving relevant Social Sciences and Humanities (SSH) disciplines (e.g., psychology, geography, Science and Technology Studies, sociology, ethics).

The safety assurance of remote operations entails the development of a corresponding validation methodology, as the remote operator with the wireless communication system and the related interfaces becomes part of the system to be validated. Proposed actions shall develop the basic principles of such a methodology considering the framework provided by EU 2022/1426, building upon, to the extent possible, the results of the SUNRISE[[5]](#footnote-5) project and seeking close coordination with actions under HORIZON-CL5-2023-D6-01-02[[6]](#footnote-6), HORIZON-CL5-2024-D6-01-02[[7]](#footnote-7) as well as HORIZON-CL5-2024-D6-01-03[[8]](#footnote-8).

**This topic is a Societal-Readiness pilot:**

1. Proposals should follow the instructions applying to the Societal readiness pilot, as described in the introduction of the Horizon Europe Main Work Programme 2025 for Climate, Energy and Mobility. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.
2. This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the socio-technological interface and enable the design of project objectives with Societal Readiness related activities.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

Projects resulting from this topic are expected to apply the European Common Evaluation Methodology (EU-CEM) for CCAM[[9]](#footnote-9).

HORIZON-CL5-2025-01-D6-02: Preparing for large-scale CCAM demonstrations (CCAM Partnership) – Societal Readiness Pilot

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| **Call: Cluster 5 Call 01-2025 (WP 2025)** | |
| **Specific conditions** | |
| *Expected EU contribution per project* | The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts. |
| *Indicative budget* | The total indicative budget for the topic is EUR 4.50million. |
| *Type of Action* | Coordination and Support Actions |
| *Legal and financial set-up of the Grant Agreements* | The rules are described in General Annex G. The following exceptions apply:  Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[10]](#footnote-10). |

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

1. Pave the road for forthcoming CCAM deployment and deliver a comprehensive large-scale demonstration plan for CCAM vehicles across Europe;
2. Ensure the engagement of key stakeholders across the value chain in transport and mobility, including required industrial partners (such as OEMs and suppliers) and a range of end users and service providers, in preparing for demonstrations that will pave the way for subsequent implementations;
3. Establish the foundation for future use case specific projects in different domains, such as public and private road transport and logistics, alongside the large-scale demonstrations;
4. Outline a CCAM promotion strategy, supporting elevated public engagement and awareness;
5. Responsiveness to a deeper understanding of the needs and concerns of diverse social groups involved in or potentially affected by the R&I development, thereby increasing the potential for beneficial societal uptake, and building trust in results and outcomes.

Scope: In recent years, the work in vehicle automation has concentrated on technological advancements, human factors, extensive testing, and demonstrations to raise public awareness and facilitate market readiness. Even with the progress achieved, the challenges related to technical functionality as well as use, demand and affordability remain considerable.

To tackle these challenges, a sensible approach is needed to implement vehicle automation developments in real-life applications via large-scale demonstrations such as Field Operational Tests (FOTs) within Living Labs. Additionally, particular use cases for public road transport and logistics should be targeted. The validation of technical enablers (also considering technological readiness), understanding user behaviour, promoting acceptance and advancing societal readiness for both mobility of people and transport of goods remains a major focus. The tests and large-scale demonstrations should be conducted in both mixed traffic conditions and confined areas, where applicable. Ensuring interoperability of connected automated systems across various vehicle brands, regions, and Member States is essential.

Since successful large-scale demonstration activities require strong and early engagement from key stakeholders, comprehensive planning and preparatory actions, leveraging previous and ongoing efforts, are needed to ensure European competitiveness and leadership.

The action should leverage previous and ongoing projects at European and national levels on demonstration activities. It should consider the outcomes of the European software-defined vehicle of the future initiative. The frameworks and guidelines formulated by the CCAM Partnership shall be duly reflected[[11]](#footnote-11). This is to optimise the return on investments and create a strong basis for future large-scale demonstration projects to boost an industry-wide European deployment strategy for CCAM.

Proposed actions for this topic are expected to address all of the following aspects:

1. Define the prerequisites for performing large-scale demonstration projects, considering vehicle technology maturity and other technical enablers, physical and digital infrastructures, as well as approval frameworks for public road testing;
2. Prepare and refine methodologies, test procedures and tools for the execution of field tests and efficient data management;
3. Identify test and demonstration sites across Europe for CCAM functions, considering the extension of Operational Design Domains (ODDs), using vehicular communication technologies (V2X) that enables Traffic Management Systems (TMS) for improved traffic flow and operational efficiency;
4. Initiate a cross-sector stakeholder forum for the definition of use case relevant projects in different domains and their implementation.

The proposed action is expected to foster the collaboration between public and private stakeholders to achieve common objectives and assess societal impacts. Engagement of key stakeholders, covering the whole CCAM ecosystem, such as mobility and transport users, , public transport, shared mobility and logistics operators, infrastructure providers, traffic managers, public authorities, and research institutions must be ensured. In addition, European industrial players such as OEMs and suppliers should be adequately represented.

This topic is a Societal-Readiness pilot:

1. Proposals should follow the instructions applying to the Societal readiness pilot, as described in the introduction of the Horizon Europe Main Work Programme 2025 for Climate, Energy and Mobility. They entail the use of an interdisciplinary approach to deepening consideration and responsiveness of research and innovation activities to societal needs and concerns.
2. This topic requires effective contribution of the relevant SSH expertise, including the involvement of SSH experts in the consortium, to meaningfully support Societal Readiness. Specifically, SSH expertise is expected to facilitate the socio-technological interface and enable the design of project objectives with Societal Readiness related activities.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

The project should build upon the results of the FAME[[12]](#footnote-12) project and on the actions under HORIZON-CL5-2024-D6-01-05[[13]](#footnote-13) to ensure complementarity between activities.

Projects resulting from this topic are expected to apply the European Common Evaluation Methodology (EU-CEM) for CCAM[[14]](#footnote-14).

HORIZON-CL5-2026-01-D6-03: Next-generation environment perception for real world CCAM operations: Error-free and secure technologies to improve energy-efficiency, cost-effectiveness, and circularity (CCAM Partnership)

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| **Call: Cluster 5 Call 01-2026 (WP 2025)** | |
| **Specific conditions** | |
| *Expected EU contribution per project* | The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts. |
| *Indicative budget* | The total indicative budget for the topic is EUR 8.00 million. |
| *Type of Action* | Research and Innovation Actions |
| *Technology Readiness Level* | Activities are expected to achieve TRL 5 by the end of the project – see General Annex B. Activities may start at any TRL. |
| *Legal and financial set-up of the Grant Agreements* | The rules are described in General Annex G. The following exceptions apply:  Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[15]](#footnote-15). |

Expected Outcome: Project results are expected to contribute to all of the following outcomes:

1. Availability of validated prototypes of next-generation vehicle and infrastructure-based environment perception technologies for robust, reliable and trustworthy CCAM operations to anticipate and avoid foreseeable risks and unexpected safety-critical situations in complex real-world conditions (e.g., at pedestrian crossings, in construction sites, during interactions with emergency vehicles, etc.);
2. Understanding the degree (and limits) to which automated CCAM perception systems can anticipate, process, and respond to on-site ‘early-warnings’ (e.g., street design, sounds, smells and other signals from the environment, weather conditions, intentions of pedestrians, cyclists, and other active mobility users, etc.);
3. Improvement of the energy-efficiency of the sense-think-act systems of CCAM considering the vehicle, the infrastructure, the cloud at-the-edge, while at the same time increasing the performance to guarantee security and error-free reliability; these developments will contribute to the reduction of the potential climate and environmental footprints of CCAM systems;
4. Standardisation and adoption of modular, reusable, and upgradable software and hardware platforms, investigating scalable deployment concepts that lead to cost reduction and improved affordability while adopting a circular, eco-design approach (including efficient materials use, reduced waste, and the repair and reuse of components where feasible).

Scope: The initial deployment of Level 4 automated vehicle services in urban and other complex settings has encountered significant challenges in environmental perception and decision-making, leading to occasional remote assistance calls, blockages and accidents that have impacted public trust. At the same time, the increasing computing power demand is in conflict with a limited usage of energy and resources to meet sustainability requirements. Thus, emerging large-scale demonstrations of automated vehicles should be accompanied by objective-oriented research aimed at addressing these challenges directly, while targeting improvements in performance, accuracy, reliability, and cyber-security.

To successfully overcome these challenges, proposed actions for this topic are expected to address all of the following aspects:

1. Advancements in all steps of the sense-control-act process for both vehicle- and infrastructure-based smart sensor systems and networks, controllers, and actuators to ensure safety and trustworthiness of CCAM, as well as facilitating effective disruption management;
2. Utilisation of digital enabling technologies including, for example: AI at-the-edge, machine learning, data spaces with reference scenarios and suitable software architectures[[16]](#footnote-16);
3. Adoption of modular, reusable, and open software platforms supporting the environment perception for CCAM while ensuring transparency of operation, verification, and safety assessment to build trust, with respect to authorities, decision makers and the public via direct performance explainability;
4. Energy efficiency, circularity, and eco-design of the environment perception systems by decreasing potential energy and resource consumption in both production and operation as well as facilitating reusability, reparability and upgradability while further enhancing the performance;
5. Reduction of potential costs of environment perception systems through scalability, modularity and standardisation, making technologies financially viable for widespread implementation;
6. Support remote assistance as a stepping-stone towards higher levels of autonomy and vehicle automation in wider Operational Design Domains (ODD).

Solutions are expected to integrate electronic hardware architectures and software stacks in a co-design approach. Hence, it is strongly encouraged that solutions use, as far as possible, building blocks and tools from projects of the Software-Defined Vehicle of the Future (SDVoF) initiative under the Chips Joint Undertaking, e.g., on the hardware abstraction layer and SDV middleware and API framework. Results from projects funded under HORIZON-CL5-2024-D6-01-04[[17]](#footnote-17) and complementarities with projects funded under Horizon Europe Cluster 4 “Digital Industry and Space” should also be considered, where appropriate.

As the activities should demonstrate feasibility and their full potential for real-world applications, proposals should foresee exchanges with other relevant EU or national projects for e.g., coordinated validation, transport systems integration and large-scale piloting. Collaboration should also be sought with projects funded under HORIZON-CL5-2024-D6-01-01[[18]](#footnote-18) and other directly relevant call topics.

In view of the relevance of environment perception and decision-making of automated vehicles for the responsiveness of the innovation to diverse societal interests and concerns, accessibility, inclusiveness as well as regulation, proposals should consider societal, ethical, socio-economical and/ or legal aspects as far as feasible in the requirements of the technical solutions to be developed. This could involve the engagement of institutional users as well as citizen-science approaches, e.g., in collaboration with projects CulturalRoad[[19]](#footnote-19) and Diversify – CCAM[[20]](#footnote-20).

To achieve the expected outcomes, international cooperation is highly relevant, considering the lessons learned in this area (for example, from robo-taxi and freight transport trials in the US and China). Activities should foster links between the European ecosystem and relevant stakeholders around the world, in particular with Japan and the United States but also with other relevant strategic partners in third countries, while taking into account the legal, cultural, historical, and social aspects in Europe as well as other specificities of the European road network and cities (including: traffic rules, user behaviour, diverse user groups considering gender, age, disability, socio-economic status, streets morphology, and the structure and condition of roads in rural areas).

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

Projects resulting from this topic are expected to apply the European Common Evaluation Methodology (EU-CEM) for CCAM[[21]](#footnote-21).

HORIZON-CL5-2026-01-D6-04: Integration of human driving behaviour in the validation of CCAM systems (CCAM Partnership)

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| **Call: Cluster 5 Call 01-2026 (WP 2025)** | |
| **Specific conditions** | |
| *Expected EU contribution per project* | The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts. |
| *Indicative budget* | The total indicative budget for the topic is EUR 5.00 million. |
| *Type of Action* | Research and Innovation Actions |
| *Technology Readiness Level* | Activities are expected to achieve TRL 5 by the end of the project – see General Annex B. Activities may start at any TRL. |
| *Legal and financial set-up of the Grant Agreements* | The rules are described in General Annex G. The following exceptions apply:  Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[22]](#footnote-22). |

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

1. Validated human behavioural models representing the variety of human driving behaviour in safety-relevant scenarios, shared through a common repository and to be used:
   1. to define pass criteria/ assessment criteria for CCAM systems in type approval schemes, consumer testing campaigns and industrial development processes;
   2. to design safe, human-like behaviour of CCAM systems that can be anticipated easily by all road users and is acceptable to both CCAM vehicle occupants and all road users.
2. Application of such human behavioural models in the virtual safety validation of CCAM systems to realistically represent the behaviour of human-driven vehicles in closed loop simulations of mixed traffic, thereby reflecting the variety of human driving behaviour, including behaviour in complex real-world and emergency conditions.

Scope: The deployment of CCAM systems in mixed traffic will mean intense interaction with all road users such as the human drivers of other vehicles as well as pedestrians and riders of two-wheelers. These interactions (including implicit and explicit communication by humans and CCAM systems) will play a crucial role in the acceptance and thereby the penetration of CCAM systems in future road transport. CCAM systems will have to show safe and human-like driving behaviour, so that their decisions and actions can be anticipated easily by all road users, respecting the variety of typical driving behaviour across different countries as well as the need for CCAM systems to respect traffic rules and support road safety.

This will require validated models of explicit and implicit human driving behaviour to design and validate such system behaviour. These models will be needed in closed loop simulations of CCAM systems in mixed traffic to realistically represent the reactions of human drivers in other vehicles to the behaviour of a CCAM system. Models representing human driving behaviour are being developed by the projects i4Driving[[23]](#footnote-23) and BERTHA[[24]](#footnote-24) for selected fields of application, i.e. they will be calibrated for a limited number of scenarios. Bringing together and building upon the results of these projects – in particular a simulation library and an innovative methodology to account for uncertainty from i4Driving and a scalable, probabilistic driver behavioural model from BERTHA, research is needed to extend the fields of application that these projects are addressing with a focus on representing driver behaviour in a multitude of safety-critical scenarios, considering the variation and statistical distribution of human behavioural patterns and the factors influencing such behaviour, including the parallel execution of non-driving related tasks.

To achieve high degrees of robustness and applicability in a wide range of scenarios, detailed calibration and parameterisation is necessary, as driver behaviour depends on factors such as the road infrastructure, vehicle types, traffic conditions and rules, as well as regional influences and driver experiences / demographics, e.g., gender, age and other relevant social variables. Considering the deviation of average from ideal human driving behaviour, proposed actions must also validate the models for their extended fields of application, going well beyond the applications and degrees of validation accomplished by the above-mentioned projects under HORIZON-CL5-2022-D6-01-03. Proposed actions are thus expected to raise the technology readiness of such models to TRL 5. Data for parameterisation and validation should be captured by monitoring real human drivers in driving simulators and/or real traffic considering what is happening inside and outside the vehicle.

Proposed actions should integrate, to the extent possible, the validated models in the virtual validation and verification approaches as developed in the projects HEADSTART[[25]](#footnote-25) and SUNRISE[[26]](#footnote-26) and complemented by the project SYNERGIES[[27]](#footnote-27). Successful integration should be demonstrated in various safety-relevant scenarios as provided by the action(s) funded under HORIZON-CL5-2023-D6-01-02[[28]](#footnote-28). Models should be shared via the federated data exchange platform for CCAM to be developed by an action under HORIZON-CL5-2025-D6-06[[29]](#footnote-29).

Proposals are encouraged to also explore additional fields of application of validated driver behaviour models, while the integration of relevant expertise from social sciences and humanities (SSH) is expected.

To achieve the expected outcomes, international cooperation is encouraged with research stakeholders in Japan and the United States but also with other relevant strategic partners in third countries. Such cooperation should exploit synergies as far as possible in capturing data for the parametrisation and validation of behavioural models, while considering regional and cultural differences as well as specificities of respective road infrastructures.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

Projects resulting from this topic are expected to apply the European Common Evaluation Methodology (EU-CEM) for CCAM[[30]](#footnote-30).

Projects funded under this topic are encouraged to explore potential complementarities with the activities of the European Commission's Joint Research Centre’s Sustainable, Smart, and Safe Mobility Unit and, where appropriate, establish formal collaboration.

HORIZON-CL5-2026-01-D6-05: Approaches, verification and training for Edge-AI building blocks for CCAM Systems (CCAM Partnership)

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| **Call: Cluster 5 Call 01-2026 (WP 2025)** | |
| **Specific conditions** | |
| *Expected EU contribution per project* | The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts. |
| *Indicative budget* | The total indicative budget for the topic is EUR 4.00 million. |
| *Type of Action* | Research and Innovation Actions |
| *Technology Readiness Level* | Activities are expected to achieve TRL 5 by the end of the project – see General Annex B. Activities may start at any TRL. |
| *Legal and financial set-up of the Grant Agreements* | The rules are described in General Annex G. The following exceptions apply:  Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[31]](#footnote-31). |

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

1. CCAM solutions - in hardware and software - with reduced power consumption, latency, and improved speed and accuracy, as domain specific adaptions of sector agnostic advancements in e.g. AI and/or cloud-edge-IoT technologies;
2. Enhanced levels of safety, (cyber) security, privacy and ethical standards of data-driven CCAM functionalities by using e.g. edge-AI applications for CCAM;
3. Approaches for well-balanced distributionsof AI calculations for expanding use cases (e.g. collective perception, decision making and actuation) for connected, cooperative and automated driving applications (using a balanced mix of edge-based solutions, cloud-enabled solutions and vehicle-central solutions), balancing speed and latency, energy use, costs, data sharing and storage needs and availability;
4. Validated approaches incorporating edge-AI solutions into the action chain from perception and decision-making up to actuation of advanced CCAM functionalities - both on-board and on the infrastructure side - for systemic applications such as traffic management and remote control, as well as tools and approaches for training of such functionalities, which require optimised and verified edge-AI models.

Scope: CCAM-enabled vehicles are constantly sensing their surroundings on road conditions, location, nearby vehicles and infrastructure. Such data is shared in real-time, while data from other sources is received. This needs powerful and optimised large data processing algorithms, which requires large amounts of computing power, data processing, real-time operation and high levels of security. However, most existing AI computing tasks for automated vehicle applications are relying on general-purpose hardware, which has limitations in terms of power consumption, speed, accuracy, scalability, memory footprint, size and cost. Hardware advancements driven by initiatives such as the Chips JU calls must be complemented by significant efforts to optimise AI algorithms for CCAM functionalities, ensuring their efficient performance on edge-specific hardware.

To encompass CCAM solutions in future steps towards e.g., the Software Defined Vehicle, this dual approach on AI advancements and hardware advancements is essential. Complementarities with projects funded under Cluster 4 “Digital Industry and Space” of Horizon Europe should also be considered where appropriate, especially in translating sector-agnostic innovations to the specificities of CCAM applications. Requirements on AI algorithm optimisation, latency, on-board energy availability, solutions to gain unbiased datasets for AI training, Electronic Control Unit (ECU) capacity and on potential safety-critical scenarios should be considered to ensure the timely triggering of actions, and in a later stage, anticipatory driving. Solutions should use, as far as possible, building blocks, interfaces, and tools from projects of the Software-Defined Vehicle of the Future (SDVoF) initiative.

Edge-AI involves deploying AI algorithms on edge computing devices, which are hardware systems constrained in proximity to the data source where they operate. This is done without relying on remote resources for the computational efforts. It thus facilitates real-time insights, responses and triggering of actions, with reduced costs as the processing power close to the application is used, greatly reducing networking costs. Combining AI with edge-AI can facilitate stable solutions to include the full activity chain from sensing, perception, decision-making up to actuation of advanced CCAM solutions, gaining speed and resilience which are essential in safety-critical situations.

To successfully overcome these challenges, proposed actions are expected to address all of the following aspects:

1. For next major advancements in AI applications in CCAM solutions, huge AI applications need to fit into limited hardware, to make it fit for purpose. Edge-AI devices often have limited computational resources, making it challenging to deploy large and complex AI models. Thus, it is essential to develop and reshape approaches and building blocks for CCAM solutions, viable to be run on edge-hardware. Use cases for the approaches and building blocks should focus on time-critical applications (such as the chain from (collective) perception, decision making and actuation of functionalities) and can be linked to the activities and results from projects AI4CCAM[[32]](#footnote-32) and AIthena[[33]](#footnote-33).
2. Develop optimised edge-AI algorithms and demonstrate their applicability and scalability, using real-world CCAM scenarios such as in the databases resulting from projects such as SYNERGIES[[34]](#footnote-34). The development and demonstration use case should include in-vehicle perception and understanding, such as object detection, segmentation, road surface tracking, sign and signal recognition, etc. Decision making and actuation of countermeasures is to be part of the chain of actions. The approaches for these building blocks and enabling technologies should facilitate a quick uptake in adjacent or following projects;
3. Optimisation of the models for edge deployment. This involves adjusting the size and complexity of models to allow it to run on the relevant edge devices and include training and verification approaches. Techniques such as model quantization, pruning, and knowledge distillation can be used to reduce the size of AI models without significant loss in performance. Additionally, over-the-air (OTA) updates can be used to manage and update models across a fleet of devices efficiently;
4. Develop tools and approaches for edge-AI model monitoring, to ensure that edge-AI systems continue to operate as expected and ensure resilience to failure conditions or attacks, and monitoring model outputs to ensure they are accurate even as real-life conditions and datasets change.

The research will require due consideration of cyber security, connectivity and both personal and non-personal data protection issues, including the GDPR, and ensure that gender and other social categories (such as but not limited to disability, age, socioeconomic status, ethnic or racial origin, sexual orientation, etc.), and their intersections are duly considered where appropriate, as well as Explainable AI to enhance trust and regulatory compliance including alignment with the AI Act.

In order to achieve the expected outcomes, international cooperation is encouraged in particular with Japan and the United States but also with other relevant strategic partners in third countries. Such cooperation should exploit synergies in edge AI approaches for mobility and for CCAM, as well as its integration into the vehicle architecture.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

Projects resulting from this topic are expected to apply the European Common Evaluation Methodology (EU-CEM) for CCAM[[35]](#footnote-35).

Projects funded under this topic are encouraged to explore potential complementarities with the activities of the European Commission's Joint Research Centre’s Sustainable, Smart, and Safe Mobility Unit and, where appropriate, establish formal collaboration.

HORIZON-CL5-2026-01-D6-06: Federated CCAM data exchange platform (CCAM Partnership)

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| --- | --- |
| **Call: Cluster 5 Call 01-2026 (WP 2025)** | |
| **Specific conditions** | |
| *Expected EU contribution per project* | The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts. |
| *Indicative budget* | The total indicative budget for the topic is EUR 4.00 million. |
| *Type of Action* | Innovation Actions |
| *Technology Readiness Level* | Activities are expected to achieve TRL 6-7 by the end of the project – see General Annex B. Activities may start at any TRL. |
| *Legal and financial set-up of the Grant Agreements* | The rules are described in General Annex G. The following exceptions apply:  Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [[36]](#footnote-36). |

Expected Outcome: Project results are expected to contribute to all of the following expected outcomes:

1. Overview of CCAM-specific limitations of current data exchange solutions and existing dataspaces related to interfaces, harmonised ontologies and taxonomies, standards, formats, monetisation / compensation;
2. Mapping of information and reference data needs for KPIs collected by Member States and Associated Countries (where relevant and to the extent possible), related to impacts of CCAM technologies and solutions;
3. Federated sustainable CCAM Data Exchange Platform that facilitates sharing of data for both large-scale demonstrations and deployment, interfacing existing data spaces and improving the exchange, availability, and accessibility of data for the development, testing and deployment of CCAM services (including but not limited to Digital Twins, digital scenario representations, safety assurance and validation, ADS regulation monitoring, driver behaviour, AI model training, and the collection of national/EU level statistics and Key Performance Indicators);
4. Proposed governance structure for the Data Exchange Platform with a sustainability plan and viable business model.

Scope: Data sharing plays a pivotal role in supporting R&I, enabling deployment, and enhancing the competitiveness of the CCAM industry. Within the realm of data sharing, there are two distinct categories of data that are particularly pertinent: mobility data, and data for research and development. The common European mobility data space[[37]](#footnote-37) aims to facilitate mobility data access and sharing, and is supported by projects, notably from the Digital Europe Programme. This mobility data space will facilitate the sharing of data related to mobility patterns, traffic flow, and other macroscopic aspects that are essential for the development of CCAM solutions. Within the research, testing and deployment of CCAM solutions for the automotive as well as infrastructure sectors, there is a need for a dedicated data space tailored specifically to the requirements of CCAM stakeholders. This CCAM Data Space demands a more granular and extensive array of data to cater to the needs of both Tier X suppliers, Original Equipment Manufacturers (OEMs), traffic managers and infrastructure providers, particularly in terms of vehicle and traffic safety considerations. Specific aspects related to ongoing regulatory developments would need to be considered (e.g. Automated Driving Systems and General Safety regulations, adaption of type approval to the AI Act, including trustworthy AI integration).

Several data spaces exist or are being developed in Europe for CCAM in specific R&I initiatives. The FAME[[38]](#footnote-38) project has released a CCAM Data Sharing Framework (DSF) 2.0 describing best practices in data sharing and will develop a CCAM Federated Data Space as a proof of concept to facilitate the exchange of research and test data across R&I projects. Several CCAM Partnership R&I projects expressed interest in making data available and reusing data from other projects through the FAME Test Data Space, once it will be operational. The scenario-based validation approach for safety argumentation in highly automated functions will result in an integration of various scenario databases facilitated by a federated layer, as developed in project SUNRISE[[39]](#footnote-39) and SYNERGIES[[40]](#footnote-40). However, this integration falls short of constituting a comprehensive Data Space approach, both for new data sets and extensions of existing datasets. To achieve full Data Space functionality for CCAM, significant enhancements are required in terms of developing connectors, APIs, and protocols for seamless data exchange. Additionally, there is a need to refine user profile management systems and establish robust contractual frameworks to govern data access and usage rights. A generic data space blueprint and building blocks are being developed and governed by the Data Space Support Centre[[41]](#footnote-41). In parallel, the DeployEMDS[[42]](#footnote-42) builds a decentralised technical infrastructure and common governance mechanisms for urban mobility use cases in 9 cities and regions across Europe.

Consequently, substantial efforts are necessary to fully integrate these approaches into a cohesive and efficient Data Space environment that can effectively support the diverse needs of the CCAM research community and industry. Moreover, extensive datasets are also indispensable for the development of low-level modules such as driver monitoring systems, perception systems, and decision-making algorithms, as well as for sensors like GNSS, radar, cameras, and lidar. While projects like AIthena[[43]](#footnote-43) and AWARE2ALL[[44]](#footnote-44) have generated valuable datasets, the lack of centralised storage and access hampers their utility. Therefore, there is a strong need to incorporate such datasets into a unified CCAM Data Space that is aligned with the data space blueprint, taking advantage of the common building blocks.

By establishing robust interfaces, ontologies, and data management architectures, the CCAM research community and industry can effectively utilise and repurpose existing data, thereby reducing costs, and facilitating the development and validation of CCAM solutions, including the creation of digital twins through synthetic data. The enhanced sharing of data across the CCAM stakeholders should also benefit national authorities, and operators in their efforts to collect KPIs to monitor wider impacts of CCAM solutions including on safety, economy, and society.

Proposed actions for this topic are expected to address all of the following aspects:

1. Identify how to further evolve the data spaces for CCAM applications, connecting existing dataspaces and bridging data gaps;
2. Identify harmonisation and standardisation needs for taxonomies, interfaces, and data formats to push CCAM data exchange and extend and implement the CCAM taxonomies in the CCAM Test Data Space;
3. Identify information needs and reference data for KPIs collected from Member States and Associated Countries (where relevant and to the extent possible) of i.e. high-level socio-economic statistics, accidents, infrastructure, vehicles;
4. Establish a Federated CCAM Data Exchange Platform with tools and governance, including a viable business model to ensure the durability of the platform, which facilitates sharing of data for industry, social partners, authorities and academia that are supporting specific use cases related to: large-scale demonstrations, generation and maintenance of digital twins and representation of scenarios (for development or validation), performance and safety assessment, driver behaviour data from real and synthetic driving conditions, ADS regulation monitoring, AI model training, and common information source for national/EU level statistics and Key Performance Indicators;
5. Identify and describe methods/algorithms/processes to refine and use data for the specific use cases tackled by the Platform;
6. Identify the effects of the EU General Data Protection Legislation (GDPR) on AI learning workflows and possible mitigation measures.

A strong alignment with the common European mobility data space and related projects[[45]](#footnote-45) is expected. The work should ensure coherence and interoperability with other common European data spaces, especially regarding its cross-sectoral blueprint and building blocks, by aligning with the Data Spaces Support Centre and by using, as far as possible, the smart cloud-to-edge middleware platform Simpl[[46]](#footnote-46). The work should build on the outcomes of the FAME project and the FAME Test Data Space ([Data Sharing - Connected Automated Driving](https://www.connectedautomateddriving.eu/data-sharing/)). Finally, links with related activities under the future European Digital Infrastructure Consortium ([EDIC](https://digital-strategy.ec.europa.eu/en/policies/edic)) for Mobility and Logistics Data and cooperation with the CCAM Partnership’s States Representative Group (SRG) is expected. Particular attention should be dedicated towards establishing interoperability standards for data sharing within and across data ecosystems, through the implementation of the FAIR data principles and leveraging already adopted practices, especially in relevant European common data spaces.

In order to achieve the expected outcomes, international cooperation is encouraged in particular with Japan and the United States but also with other relevant strategic partners in third countries.

This topic implements the co-programmed European Partnership on ‘Connected, Cooperative and Automated Mobility’ (CCAM). As such, projects resulting from this topic will be expected to report on results to the European Partnership ‘Connected, Cooperative and Automated Mobility’ (CCAM) in support of the monitoring of its KPIs.

Projects resulting from this topic are expected to apply the European Common Evaluation Methodology (EU-CEM) for CCAM[[47]](#footnote-47).

1. This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: <https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf> [↑](#footnote-ref-1)
2. See SNS calls for further linkage. [↑](#footnote-ref-2)
3. [https://unece.org/sites/default/files/2023-03/Informal%20document%20No16e\_0.pdf](https://unece.org/sites/default/files/2023-03/InformaldocumentNo16e_0.pdf) [↑](#footnote-ref-3)
4. As per the legal basis of Art. 154 of the TFEU. [↑](#footnote-ref-4)
5. [Safety assurance framework for connected and automated mobility system](https://ccam-sunrise-project.eu/), grant agreement ID: [101069573](https://cordis.europa.eu/project/id/101069573). [↑](#footnote-ref-5)
6. Generation of scenarios for development, training, virtual testing, and validation of CCAM systems. [↑](#footnote-ref-6)
7. Scenario-based safety assurance of CCAM and related HMI in a dynamically evolving transport system. [↑](#footnote-ref-7)
8. Orchestration of heterogeneous actors in mixed traffic within the CCAM ecosystem. [↑](#footnote-ref-8)
9. See the evaluation methodology [here](https://www.connectedautomateddriving.eu/methodology/common-evaluation-methodology/). [↑](#footnote-ref-9)
10. This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: <https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf> [↑](#footnote-ref-10)
11. <https://www.ccam.eu/>

    <https://www.connectedautomateddriving.eu/> [↑](#footnote-ref-11)
12. Framework for coordination of Automated Mobility in Europe, grant agreement ID: [101069898](https://www.connectedautomateddriving.eu/about/fame/). [↑](#footnote-ref-12)
13. Robust Knowledge and Know-How transfer for Key – Deployment Pathways and implementation of the EU-CEM. [↑](#footnote-ref-13)
14. See the evaluation methodology [here](https://www.connectedautomateddriving.eu/methodology/common-evaluation-methodology/). [↑](#footnote-ref-14)
15. This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: <https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf> [↑](#footnote-ref-15)
16. In line with the European Artificial Intelligence strategy and requirements for trustworthy, explainable, and safe AI. [↑](#footnote-ref-16)
17. AI for advanced and collective perception and decision making for CCAM applications [↑](#footnote-ref-17)
18. Centralised, reliable, cyber-secure & upgradable in-vehicle electronic control architectures for CCAM connected to the cloud-edge continuum. [↑](#footnote-ref-18)
19. Cocreate, Embrace – grant agreement ID: [101147397](https://cordis.europa.eu/project/id/101147397). [↑](#footnote-ref-19)
20. Diversify CCAM by integrating European cultural and regional variations in the design and implementation of citizen-friendly systems to foster mobility equity - grant agreement id: [101147484](https://cordis.europa.eu/project/id/101147484). [↑](#footnote-ref-20)
21. See the evaluation methodology [here](https://www.connectedautomateddriving.eu/methodology/common-evaluation-methodology/). [↑](#footnote-ref-21)
22. This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: <https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf> [↑](#footnote-ref-22)
23. Integrated 4D driver modelling under uncertainty, grant agreement ID: [101076165](https://i4driving.eu/). [↑](#footnote-ref-23)
24. BEhavioural ReplicaTion of Human drivers for CCAM, grant agreement ID: [101076360](https://berthaproject.eu/). [↑](#footnote-ref-24)
25. Harmonised European solutions for testing automated road transport, grant agreement id: [824309](https://www.headstart-project.eu/). [↑](#footnote-ref-25)
26. Safety assUraNce fRamework for connected, automated mobIlity SystEms, grant agreement ID: [101069573](https://ccam-sunrise-project.eu/). [↑](#footnote-ref-26)
27. Real and synthetic scenarios generated for the development, training, virtual testing and validation of CCAM systems, grant agreement ID: [101146542](https://cordis.europa.eu/project/id/101146542). [↑](#footnote-ref-27)
28. Generation of scenarios for development, training, virtual testing and validation of CCAM systems. [↑](#footnote-ref-28)
29. Federated CCAM data exchange platform (see below). [↑](#footnote-ref-29)
30. See the evaluation methodology [here](https://www.connectedautomateddriving.eu/methodology/common-evaluation-methodology/). [↑](#footnote-ref-30)
31. This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: <https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf> [↑](#footnote-ref-31)
32. Trustworthy AI for CCAM, grant agreement ID: [101076911](https://cordis.europa.eu/project/id/101076911). [↑](#footnote-ref-32)
33. AI-based CCAM: Trustworthy, Explainable, and Accountable, grant agreement ID: [101076754](https://cordis.europa.eu/project/id/101076754). [↑](#footnote-ref-33)
34. Real and synthetic scenarios generated for the development, training, virtual testing and validation of CCAM systems, grant agreement ID: [101146542](https://cordis.europa.eu/project/id/101146542). [↑](#footnote-ref-34)
35. See the evaluation methodology [here](https://www.connectedautomateddriving.eu/methodology/common-evaluation-methodology/). [↑](#footnote-ref-35)
36. This [decision](https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf) is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under ‘Simplified costs decisions’ or through this link: <https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf> [↑](#footnote-ref-36)
37. [Creating a common European mobility data space - European Commission (europa.eu)](https://transport.ec.europa.eu/transport-themes/smart-mobility/creating-common-european-mobility-data-space_en) [↑](#footnote-ref-37)
38. Framework for coordination of Automated Mobility in Europe, grant agreement ID: [101069898](https://cordis.europa.eu/project/id/101069898). [↑](#footnote-ref-38)
39. Safety assUraNce fRamework for connected, automated mobIlity SystEms, grant agreement ID: [101069573](https://ccam-sunrise-project.eu/). [↑](#footnote-ref-39)
40. Real and synthetic scenarios generated for the development, training, virtual testing and validation of CCAM systems, grant agreement ID: [101146542](https://cordis.europa.eu/project/id/101146542). [↑](#footnote-ref-40)
41. [Data Spaces Blueprint](https://dssc.eu/space/BPE/179175433/Data+Spaces+Blueprint+%7C+Version+0.5+%7C+September+2023) [↑](#footnote-ref-41)
42. See for more information: <https://deployemds.eu/> [↑](#footnote-ref-42)
43. AI-based CCAM: Trustworthy, Explainable, and Accountable, grant agreement ID: [101076754](https://cordis.europa.eu/project/id/101076754). [↑](#footnote-ref-43)
44. Safety systems and human-machine interfaces oriented to diverse population towards future scenarios with increasing share of highly automated vehicles, grant agreement ID: [101076868](https://cordis.europa.eu/project/id/101076868). [↑](#footnote-ref-44)
45. The awarded proposal should build on the outcomes of the preparatory action PrepDSpace4Mobility and the EMDS study under CEF. It should collaborate and align the deployEMDS project and the future action under call DIGITAL-2024-CLOUD-AI-06-MOBSPACE. [↑](#footnote-ref-45)
46. More information [here](https://digital-strategy.ec.europa.eu/en/policies/simpl). [↑](#footnote-ref-46)
47. See the evaluation methodology [here](https://www.connectedautomateddriving.eu/methodology/common-evaluation-methodology/). [↑](#footnote-ref-47)