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Road/Railway - Autonomous driving vehicles: EU automated road transport projects under the Horizon 2020 programme and the publication of the first European CCAM testing map on demonstration initiatives

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【概要：Summary】

The European Commission supports the introduction and deployment of Connected and Automated Mobility (CAM) with the introduction of legislation, standards and policies, roadmaps, and strategies. In 2016, the Commission presented its communication on “A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility” (COM/2016/0766 final). The Cooperative Intelligent Transport Systems (C-ITS) allow road users and traffic managers to share information and to coordinate their actions. In this context, C-ITS and CAM are expected to significantly improve road safety, traffic efficiency and the comfort of driving.

Under the Horizon 2020 programme, the EU also funded several projects in the area of autonomous road transport and CAM. This article gives a non-exhaustive overview on the projects related to the automated road transport part of the Horizon 2020 programme, with a focus on those projects, which continue in 2022 and on those, which were presented at the European Conference H2020 RTR conference, in the field of introducing CAM in real traffic conditions.

The 5th European Conference H2020RTR on 29-30 March 2022 aimed to gather results of selected H2020 funded projects in road transport areas including the introduction of CAM in real traffic conditions. It presented an overall picture of the achievements of EU funded R&I and identified the next steps needed to reach the overall EU transport policy objectives, including also some recently closed Connected and Automated vehicles and mobility related projects. One of the most important recent steps in the area of autonomous road transport and CAM is the release of the first European map of demonstrations and testing activities related to Connected, Cooperative, and Automated Mobility (CCAM). This map makes it possible to get a comprehensive overview of the CCAM initiatives, and it also visualises what is being tested where and by whom across the EU’s 27 Member States, the UK, and EFTA countries.

While these projects are important to make progress on the deployment of connected and automated vehicles (CAVs), some results of a survey under the EU-funded PAsCAL project show, that EU citizens still have an ambivalent opinion regarding CAVs.

【記事：Article】

1. Connected and Autonomous Vehicles (CAV)

Connected and Automated Mobility (CAM) approach has the potential to make the transport system safer, cleaner, more efficient, and more user-friendly and self-driving, autonomous vehicles are expected to change the entire transport sector. Based on the Society of Automotive Engineers SAE's definition, at the Level 5 of fully autonomous and automated vehicles, human driving is eliminated, and a fully automated car could make decisions in the dynamic driving without any human supervision. These level 5 fully autonomous vehicles are expected to be commercially available by 2030 (COM(2018) 283 final). Currently, level 3 automated vehicles with driving assistance functionalities including braking assistance, smart parking, or vocal interactions with the infotainment system are already on the roads (COM(2018) 283 final).

Leading automobile manufacturing companies but also IT companies are developing and testing high level autonomous vehicles and several IT companies are leading the development of artificial intelligence (AI) digital technologies and its subfield of Machine Learning (ML) for autonomous vehicles.

The introduction of digital technologies, such as internet of things, artificial intelligence, high-performance computers, and communication networks in vehicles are changing the transport environment and these technologies need to be introduced at European level to ensure that vehicles remain connected when crossing Member States' borders.

In the Declaration of Amsterdam of April 2016, European transport ministers urged the European Commission to develop a European strategy on cooperative, connected and automated vehicles. The aim is to achieve an EU-wide interoperability on time and to successfully deploying cooperative, connected and automated vehicles in road transport. Therefore, the European Commission has taken steps to introduce a harmonised package of actions and legislative framework. In November 2016, the Commission announced the European Strategy on Cooperative Intelligent Transport Systems (C-ITS) (COM/2016/0766 final), towards the deployment of a cooperative, connected, and automated mobility. This communication addresses the most critical issues, including cyber-security and data protection and interoperability. It constitutes an important milestone of an EU strategy on cooperative, connected and automated vehicles (COM/2016/0766 final, European Commission 2016). It is expected that the rapid and successful deployment of cooperative, connected and automated vehicles in road transport will make an important contribution to improving road safety, increasing the efficiency of road transport, and ensuring the competitiveness of the EU's industry (COM/2016/0766 final).

On 17 May 2018, the European Commission presented the "Communication on the road to automated mobility: An EU strategy for mobility of the future" (COM (2018) 0283 final), which aims to ensure a smooth transition towards a safe, clean, and connected & automated mobility system in the EU. The CCommunication COM (2018) 0283 final proposes rules for self-driving cars under common EU legislation. Regarding Connected and Automated Mobility (CAM), the EU Member States, industry and the European Commission collaborate to achieve the vision for connected and automated mobility across the EU (COM(2018) 283 final).

On 13 March 2019, the Commission adopted a delegated regulation on specifications for the provision of C-ITS, supported by an impact assessment. However, this delegated regulation did not enter into force following an objection by the Council of the European Union (European Commission 2019).

Under the impact of the COVID-19 pandemic, the European Commission presented a communication on the future sustainable and smart mobility on 9

December 2020 (COM (2020) 789 final). To achieving the connected and automated multimodal mobility a reality, the EU needs to take full advantage of smart digital solutions and intelligent transport systems (ITS). The Commission will drive research and innovation, for a new European partnership on CCAM envisaged under Horizon Europe. It is expected to explore further options to support safe, smart, and sustainable road transport operations. It also intends to facilitate the preparation of relevant technical rules, regarding the use of automated vehicles cross-border and the deployment of recharging and refuelling infrastructure (COM (2020) 789 final).

The recovery from the COVID-19 pandemic should be used to accelerate the decarbonisation and modernisation of the entire transport and mobility system, limiting its negative impact on the environment, and improving the safety and health of EU citizens (COM (2020) 789 final).

Meanwhile, the European Commission continues to support the introduction and deployment of CAM with policy initiatives including developing policies, roadmaps, and strategies in close collaboration with stakeholders, the development of standards and legislation at the European level, the co-funding research & innovation projects under the Horizon 2020 programme, among others (European Commission 2021a).

2. Connected and Autonomous Vehicles (CAV) projects under the Horizon 2020 programme

Horizon 2020 was the EU's research and innovation funding programme from 2014-2020 with a budget of nearly €80 billion. The H2020 projects in the "Automated Road Transport" calls are part of the smart, green and integrated transport challenge, with the focus on demonstration of automated driving systems for passenger cars, trucks, and urban transport, and the underlying digital infrastructure. The H2020's "Automated Road Transport" field includes the following projects (European Commission (2022a).

The ADASANDME (688900) project develops cooperative intelligent transport systems that compensate human errors, facilitate driving behaviour, avoid collisions, and increase safety on road. The ARCADE (824251) project aims to build consensus across stakeholders from all sectors on a sound and harmonized deployment of Connected, Cooperative and Automated Driving (CAD) in Europe and beyond. The AutoMate (690705) project teams up the driver and automation for safe, efficient, and comfortable driving. The AVENUE (769033) project deploys, validates, and integrates autonomous vehicles (minibuses) in public transportation services. The BRAVE (723021) project intends to increase the society's confidence in automated vehicles. The CoEXist (723201) project integrates connected and automated vehicles on road networks. The ENSEMBLE (769115) project implements and demonstrates multi-brand truck platooning on European and allowing this concept to become a reality in Europe. The HEADSTART (824309) project 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. The ICT4CART (768953) project is designing, implementing, and testing in real-life conditions an innovative ICT infrastructure that will support higher levels of automated driving. The INFRAMIX (723016) project adapts the road infrastructure for future automated transport systems. The interACT (723395) project improves the communication and cooperation strategy between automated vehicles and other traffic participants. The L3Pilot (723051) project operates 100 vehicles with 1000 drivers in the public transport system to test automated drive systems in conformity with Level 3 and Level 4 autonomy under real conditions and in a wide range of applications.

The Levitate (824361) project develops 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. The MAVEN (690727) project combines automated vehicles and cooperative ITS technology for vehicle movement guidance in urban areas. The TransAID (723390) project intends to allow a smooth integration of automated vehicles in traffic systems. The TrustVehicle (723324) project advances technical solutions for automated driving to better assess critical situations in mixed traffic scenarios. Finally, the VI-DAS (690772) project integrates the monitoring of the exterior and interior of the vehicle to improve transportation safety (European Commission 2022a).

Most of these automated driving and autonomous vehicles related projects under the Horizon 2020 programme have ended already. However, there are still several H2020 projects in the automated road transport field, which are continuing.

3. Continuing automated vehicles' projects under the Horizon 2020 programme

There are some automated transport related projects, which are still continuing in 2022. These are mainly the ARCADE, AVENUE and Levitate projects. Furthermore, the PAsCAL project addresses all issues raised by the general public that hinders the wide market uptake of Connected and Autonomous Vehicles (CAV).

Regarding the "Aligning Research & Innovation for Connected and Automated Driving in Europe" (ARCADE) project, it started on 1 October 2018 and will run until 31 July 2022. It is funded under the Horizon 2020 main programme of SOCIETAL CHALLENGES - Smart, Green And Integrated Transport. The total cost is €3,000,000 with an EU contribution of €3,000,000. The ARCADE project's objective is to coordinate consensus-building across stakeholders for a sound and harmonised deployment of Connected, Cooperative and Automated Driving (CAD) in Europe and beyond (European Commission 2022c). The ARCADE project supports the commitment of the European Commission, the European Member States, and the industry to develop a common approach to development, testing, validation, and deployment of CAD in Europe and beyond. The ARCADE project is coordinated by the European Road Transport Telematics implementation coordination organisation, Belgium, and involves 23 partners, 43 associated partners and over 500 subscribers from the public, industry, and research sectors, which jointly form the CAD network of European experts and stakeholders (European Commission 2022c). As main result, ARCADE is expected to deliver knowledge base on CAD regulations and policy, on organisations & projects, on standards, on testing methodologies & data and lessons learned. It should also deliver scenarios, positions, gap analysis and recommendations on 12 thematic CAD areas, updates of CAD roadmaps, as well as common Research & Innovation approaches across EU, US, Japan, and other countries involved (European Commission 2022c).

Regarding the "Autonomous Vehicles to Evolve to a New Urban Experience" (AVENUE) project, it started on 1 May 2018 and will end on 31 October 2022. It is funded under the Horizon 2020 main programme of SOCIETAL CHALLENGES - Smart, Green And Integrated Transport, with a total cost of €20,031,244.50 and an EU contribution of €15,599,780 (European Commission 2022d). The project is coordinated by the Universite de Geneve, Switzerland. The AVENUE project's objective is to design and carry out full scale demonstrations of urban transport automation by deploying fleets of autonomous minibuses in low to medium demand areas of 4 European demonstrator cities, including Geneva, Lyon, Copenhagen, and Luxembourg, and 3 replicator cities. AVENUE revisits the offered public transportation services and considers the passengers' special needs and time constrains to move from one place

to another, instead of trying to accommodate autonomous vehicles to the existing solutions of pre-scheduled buses (European Commission 2022d). Autonomous vehicle transportation will also have a high impact on public transport services and will provide more services and different services than the current public transport. They should find their first users in suburban areas, which are less well served by traditional transportation networks (European Commission 2022d). Based on the AVENUE project's public transport vision in urban and suburban environments, autonomous vehicles will revolutionise the way citizens use public transportation, by making timetables and fixed bus stop obsolete. Instead, they offer a service that will allow passengers to call and hop a ride at any time, at their doorstep, and deposit them as close as possible to their destination (European Commission 2022d). In this context, AVENUE introduces door2door services and the concept of the "Mobility Cloud" aiming in setting up a new model of public transportation. This model enables safe, efficient, on-demand and emission free personalised public transportation, available anytime and anywhere, blending conventional public transport with novel service models such these of the sharing economy (European Commission 2022d). The AVENUE project benefits from the experience of its 16 consortium partners from 7 European countries, and the operation of NAVYA's 65 minibuses in 22 cities from 13 countries in 4 continents that already demonstrated reliable and safe operation at pilot sites by transporting over 180,000 passengers.

The "Societal Level Impacts of Connected and Automated Vehicles" (Levitate) project started on 1 December 2018 and will continue until 31 May 2022 (European Commission 2022e). It is funded under the Horizon 2020 SOCIETAL CHALLENGES - Smart, Green And Integrated Transport programme and has a total cost of €6,447,215 with an EU contribution of €5,022,215 (European Commission 2022e). The coordinator of the project is the Loughborough University in the UK. The Levitate project aims to develop a wide-ranging evaluation framework to assess the impact of connected and automated transport (CAT) on all aspects of transport and individual mobility as well as at societal level (European Commission 2022e). The outcomes of Levitate will include a set of validated methods to measure the impacts of existing technologies and forecast that of future systems. The methods will be applied to a series of scenarios and a range of impact studies of new and future mobility technologies will be provided. Based on the Levitate approach, a new connected and automated mobility decision support tool will be developed to support future mobility policymaking (European Commission 2022e).

Finally, the "Enhance driver behaviour and Public Acceptance of Connected and Autonomous vehicLes" PAsCAL project (ID: 815098) started on 1 June 2019 and the end date is 30 November 2022. The 36-month PAsCAL project proposes an awareness-driven and large-scale penetration approach to address all issues raised by the general public that could hinder the wide market uptake of Connected and Autonomous Vehicles (CAVs) (European Commission 2022b).

Since the general public's attitudes towards connected and autonomous vehicles (CAVs) remain reserved overall, the EU-funded PAsCAL project will address issues related to the interaction of "users" in or near CAVs, with safety being one of the main concerns. Under the topic of the driver behaviour and the acceptance of connected, cooperative and automated transport, the PAsCAL project will also intend to study the impact of connected transport on people's well-being, quality of life and equity (European Commission 2022b). As an international project, it will also investigate the "new driver" needs. The PAsCAL project will develop guidelines and recommendations to accelerate the evolution of CAV transport systems.

The coordinator for this projects is the Luxembourg Institute of Science and Technology and the EU contributes €3,974,041.25 (European Commission 2022b). There are other 14 participants including the Automobile Club d' Italia, University of Leeds, The University of Liverpool, COMMUNAUTE D' UNIVERSITES ET ETABLISSEMENTS UNIVERSITE BOURGOGNE - FRANCHE - COMTE, Universität Mannheim, and others (European Commission 2022b). As an international the PAsCAL project is expected to develop a multidimensional map of public acceptance of higher levels of CAVs (European Commission 2022j). It will also develop guidelines and recommendations to accelerate the evolution of CAV transport systems (European Commission 2022j).

4. The 5th European Conference H2020RTR conference results and the publication of the first map of European CCAM testing and demonstration initiatives

The 5th annual European Conference H2020RTR conference, which was co-organised by the European Commission, the European Road Transport Research Advisory Council (ERTRAC), the European Green Vehicles Initiative Association for the 2Zero partnership (EGVIAfor2Zero) and the Connected, Cooperation and Automated Mobility Association (CCAM) took place on 29-30 March 2022 in Brussels, Belgium (European Commission 2022g). The conference aims to gather selected H2020 funded projects on road transport areas to give the attendees an overall picture of the achievements of EU funded R&I and identify the next steps needed to reach the overall EU transport policy objectives.

During the conference H2020 projects were presented with their new achievements and resolved challenges (European Commission 2022g). Furthermore, the next research steps in different essential areas for road transport including Automated Road Transport were presented. Also, projects of the "Connected, Cooperation and Automated Mobility" (CCAM) partnership were presented. In the conference area "Introducing Connected Automated Mobility in real traffic conditions ", the results of the projects L3Pilot (Piloting Automated Driving on European Roads), ENSEMBLE (ENabling SafE Multi-Brand pLatooning for Europe), SHOW (SHared automation Operating models for Worldwide adoption), HEADSTART (HARMONISED EUROPEAN SOLUTIONS FOR TESTING AUTOMATED ROAD TRANSPORT) were presented (European Commission 2022g).

The L3Pilot (Piloting Automated Driving on European Roads) project started on 1 September 2017 and ended on 31 October 2021. The project's cost was €45,925,461.19 with an EU contribution of €35,960,979.39 (European Commission 2022f). L3Pilot's major objective was to test the viability of automated driving (AD) as a safe and efficient means of transportation, exploring and promoting new service concepts to provide inclusive mobility (European Commission 2022f). The project focused on large-scale piloting of SAE Level 3 functions and assessment of some Level 4 functions. The major technical objectives were to create a standardised Europe-wide piloting environment for automated driving, to coordinate activities across the piloting community to acquire the required data, to pilot, test, and evaluate automated driving functions and connected automation and to innovate and promote AD for wider awareness and market introduction (European Commission 2022f).

The ENabling SafE Multi-Brand pLatooning for Europe (ENSEMBLE) project has the main objective to prepare for the adoption of multi-brand truck platooning in Europe to improve fuel economy, traffic safety and throughput. This will be demonstrated by driving six differently branded trucks in one (or more) platoon(s) under real world traffic conditions across national borders. (European Commission 2022h).

Most importantly, the project aims to achieve safe platooning for trucks of different brands by

approaching relevant authorities to jointly define road approval. The project also works towards the standardization of different aspects of platooning including manoeuvres for forming and dissolving of platoons, operational conditions, communication protocols, message sets, and safety mechanisms (European Commission 2022h). The project also includes practical tests of real-life platooning, which serves the 1) "learning by doing" testing across a C-ITS corridor in Europe. 2) it assesses the impact on traffic, infrastructure, and logistics, while gathering relevant data of critical scenarios, among others (European Commission 2022h). This project started on 1 June 2018 and closed on 31 March 2022. The total cost is €25,940,580.85 with an EU contribution of €19,780,383.21 (European Commission 2022h).

Finally, also the project "Harmonised European Solutions for Testing Automated Road Transport" (HEADSTART) was presented at the conference. The project HEADSTART started on 1 January 2019 and closed on 31 December 2021. The project's total cost is €5,999,028.75 with an EU funding contribution of €5,999,028.75 (European Commission 2022i). The HEADSTART project defines testing and validation procedures of Connected and Automated Driving (CAD) functions including communications, cyber-security, and positioning by cross-linking of all tests to validate safety and security performance according to the needs of key user groups. The project intends to define and develop test, validation and certification methodologies and procedures for CAD functions, as well as to harmonise existing testing and validation approaches. The project demonstrates the developed methodologies, procedures, and tools through the testing of 4 CAD use cases. Finally, consensus is reached by creating and managing an expert network of CAD testing to promote adoption of the project results. The HEADSTART project includes a large representation of stakeholders from European and national activities on CAD testing. They intend to reach a harmonised European solution for testing, validating, and certifying automated road vehicles (European Commission 2022i).

Finally, on 28 March 2022 it was announced that the EU-funded ARCADE Coordination and Support Action has released the first European map of on the most recent and important efforts related to Connected, Cooperative, and Automated Mobility (CCAM), which makes it possible to get an overview of the CCAM initiatives in the EU's 27 Member States, the UK and EFTA countries (CCAM 2022). The Knowledge Base lists more than 313 projects out of which close to 50% are located in one of the EU Member States (CCAM 2022). So far, 170 test sites have been mapped from about 50 projects and initiatives, classified by test types (public road tests, corridors, test tracks, and simulators) and by vehicle types used in the pilots (shuttle, passenger vehicles, and trucks). This first European map on automated mobility related demonstrations and testing activities is seen as an important step towards reaching the goals of the Declaration of Amsterdam and the European Commission's 3rd Mobility Package.

5. The citizens' ambivalent expectations regarding connected and autonomous vehicles (CAVs)

While autonomous vehicles are often portrayed positively in reports, this positive image is not clearly reflected by the opinion of the citizens. According to the findings of the EU-funded PAsCAL project's survey with 529 participants aged 18 to 71 from France, Germany, Italy, and the UK, the people's expectations regarding the consequences of introducing CAVs on European roads is ambivalent. On average, the survey's participants expected CAVs would positively affect road safety and environmental sustainability, while expectations were neutral regarding efficiency and negative for privacy issues. However, the respondents' opinion also

varied between the countries. Regarding safety, more than 49% of respondents across all countries expected an improvement with the introduction of CAVs, while 28% or more from France, Germany and the UK thought CAVs would worsen road safety (European Commission 2021b). Overall, Italy had higher positive expectations, with 64% expecting an improvement and only 19% anticipating less road safety. Regarding ecological sustainability, 48-57% of all participants expected CAVs to bring an improvement, while at most 22% expected it to worsen (European Commission 2021b). For efficiency, improvement was expected by about a third of respondents, ranging between 34% (Italy) and 37% (Germany and the UK), while in France only 25% had positive expectations (European Commission 2021b). Respondents in France and Germany expected to a larger percentage (39%) efficiency to deteriorate and also expected higher negative impacts on privacy. Only 5% and 8%, respectively, expected that data security would improve (European Commission 2021b). Therefore, as these survey results under the EU-funded PAsCAL project show, the EU citizens still have an ambivalent opinion regarding CAVs (European Commission 2021b).

However, since there are only limited numbers of partially autonomous vehicles on the roads with SAE Level 3 autonomy at most, this opinion and perception of the public regarding autonomous vehicles is still based on prejudices as the practical encounter with SAE Level 4 and above CAVs is practically not given.

Therefore, the public's opinion could still change significantly over time, depending on the speed of introduction of CAVs, their level of autonomy, and their performance on the roads.

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