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Connected and Automated Shuttles Deployment Experiment on French Motorways: The MOBAUTO² Project

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Abstract

The MOBAUTO² (Automated Mobility on Connected Motorways) project presents an innovative experiment deploying Automated and Connected shuttles on highways in the Île-de-France region (France). The project aims to complement existing express bus services between Longvilliers, Briis-sous-Forges, and Massy by introducing 12-seat autonomous electric shuttles operating at speeds up to 80 km/h. This initiative represents a significant advancement in Automated Public Transportation, featuring no-operator operation, connected infrastructure support, and comprehensive remote supervision systems. The project, launched in July 2023 with a three-year timeline, involves four major partners: VINCI Autoroutes, MILLA GROUP, SAVAC Group, and Gustave Eiffel University. The expected environmental impact includes potential savings of 400 tons of CO_2 annually, complementing the existing express bus service's 1,500-ton reduction. The project includes key evaluation domains (evaluation protocols covering traffic impact, service acceptance, socio-economic effects, and operational sizing...), aligned with France 2030's objectives for clean and resilient mobility development.

Keywords: Automated mobility, connected infrastructure, public transportation, Smart transportation, Connected and Automated Transport Systems (CATS), Mobility as a Service (MaaS).

Context, Objective and Expected Impacts

The MOBAUTO² project (Automated Mobility on Connected Motorways) project, a shared automated mobility experimental service connecting a multimodal hub and a bus station, aims to develop collective mobility on highways and reduce single-occupancy vehicle use in the regions of Longvilliers, Briis-sous-Forges, and Massy (Yvelines and Essonne). This project was awarded under France's national strategy "*Digitalisation et Décarbonation des Mobilités*" ([4]), part of the France 2030 program launched in October 2021. The program, specifically through the framework "*Mobilités routières automatisées, infrastructures de services connectées et bas carbone*", seeks to support the development of sovereign systems, components, and services that enable automated, connected, and low-carbon road mobility.

This initiative represents an industrial investment of €80 million, with nearly €44 million in public funding through France 2030. The overarching goals of France 2030 include producing 2 million zero-emission vehicles annually by 2030 and fostering sustainable and resilient mobility. To achieve these ambitions, a budget of €3.6 billion has been allocated. MOBAUTO² is one of eight winning projects from the first and second rounds of the call for proposals under the "*Automated and Connected Mobility*" theme. These projects involve piloting various forms of automated passenger transport services, including regular services, on-demand transport, and connections to multimodal hubs.

The objective of the MOBAUTO² project is to complement the existing highway bus service (Express Regional Bus Line) with an automated shuttle (12 seats, up to 30 trips/day, approximately 350 passengers daily) and thus support the strong growth in demand.

Figure 1. – Automated Shuttle Dedicated to the Project

The express line of *Île-de-France Mobilités*, connecting the Longvilliers multimodal hub with Briis-sous-Forges and Massy stations, attracts numerous travellers and occasionally reaches capacity limits during peak hours while operating with significantly reduced frequency during off-peak hours. MOBAUTO² seeks to better meet users' mobility needs by encouraging a modal shift from private cars to public transport, thereby contributing to CO_2 emissions reductions. The existing express bus line, which this project complements, already achieves an estimated reduction of 1,500 tons of CO_2 emissions annually (for 760,000 trips/year).

The MOBAUTO² project, by providing additional capacity and encouraging further modal shift, is expected to generate additional savings of around 400 tons of CO_2 per year, based on projected modal shift and vehicle occupancy rates. This goal will be achieved through:

- Increasing trip frequency to enhance service quality during off-peak hours.
- Providing additional trips to accommodate peak-hour demand.

While the MOBAUTO² project aims to deliver substantial advancements in automated public transport, its deployment on public motorways inherently involves navigating significant challenges. Key among these is ensuring robust system performance across diverse traffic and weather conditions, securing regulatory approval for high-speed, operator-free service, and fostering public acceptance and trust in this novel form of mobility.

The Project's Timeline

Project conducted over 3 years (started in July 2023)

- System Development: [1 year]
- Dry-Run Operation (technical runs with Operator and without passengers): [6 months]
- Experiment with Operator (with closed panel of passengers): [6 months]
- Experiment without Operator (with closed panel of passengers): [6 months]
- Extended Experiment without Operator (with expanded panel of passengers): [6 months]

Regarding testing progress, testing began in manual mode on closed test tracks during Summer 2024. Since March 2025, testing has been conducted in Autonomous Driving (AD) mode on the designated project route.

Project's Partners

- **VINCI Autoroutes**: Motorway Operator, operating the A10 highway on this section, implementing roadside perception capabilities and a connected software platform to support automated shuttle evolution.
- **MILLA GROUP**: Manufacturer of automated electric shuttles, developing the Automated and Connected shuttle solution and service supervision.
- **SAVAC Group**: Passenger transport company and existing line operator, which will operate the automated shuttle service.
- **Gustave Eiffel University**: Recognized for expertise in mobility, infrastructure, and transport, evaluating the automated mobility system's impacts and its contribution to the French Shared Methodological Commons.

Experiment Settings and Partners

Test Site

The test site, located in Île-de-France, encompasses several strategic sections allowing automation technologies to be tested in real conditions on various road networks. The experiment will be conducted on a 28 km route, primarily on motorways, connecting three stations:

- Longvilliers Multimodal Park (Le Plessis – Mornay Station)
- Briis-sous-Forges (Motorway Bus Station)
- Massy (Atlantis Bus Station)

Figure 2. – The MOBAUTO² Test Site: the Southern Parisian Suburbs in the Île-de-France Region

Regarding the ITS equipment deployed, our test site infrastructure comprises several strategically integrated physical and digital elements:

- **Connected Toll Zones**: Automatic and real-time collection of configuration and status data from each toll gate at the Longvilliers toll zone.
- **Connected Barriers Zones**: Automatic and real-time collection of data from barriers controlling access to the Briis-sous-Forges bus station.
- **I2V Platform**: Consolidation of all infrastructure information and translation of specific V2X messages for connected and automated shuttles (including V2X messages for toll zone use case, barrier use case and traffic incidents use case).
- **RSU Network**: Deployment of 18 Roadside Units to transmit V2X messages to connected and automated shuttles via short-range communication protocols (with dual ITS-G5 and C-V2X compatibility).
- **I2V Cloud Server**: Implementation of cloud-based services to transmit V2X messages via long-range communication channels (4G web services).

System Development and Operations

The MOBAUTO² project introduces multiple technological and service-oriented innovations, delivering an advanced automated collective mobility service that includes:

- A **No-Op automated system** (without operator on board) up to 80 km/h.
- A robust **supervision and intervention system**.
- **Connected infrastructure** secured to assist the automated system in navigating highway singularities (toll gates, insertions and access to bus lanes, roadworks, and other incidents);

Automated and Connected Shuttles

The project features two fully prepared shuttles designed for safe operation across the entire project route. These vehicles integrate advanced technological solutions while maintaining critical safety features:

- The foundation consists of a fully homologated 100% electric chassis with a 150 km battery range. A robotized platform has been added in parallel to the original vehicle systems, ensuring that no modifications were made to essential safety functions including airbags, ABS, and steering assistance.
- Communication reliability is ensured through redundant connectivity solutions combining cellular networks (4G/5G) with V2X (ITS-G5) protocols. The shuttles feature a high-precision positioning system capable of accuracy up to 5 cm, complemented by multi-sensor perception arrays (cameras, radars, lidars) providing comprehensive long-distance detection capabilities at both front and rear.
- Geolocation (GNSS) and connectivity enabling remote shuttle supervision, real-time communication with infrastructure, and continuous interaction with passengers.

Figure 3. – Sensor Distribution and Perception System on the MOBAUTO² Shuttles

The interior architecture is thoughtfully segmented into distinct functional spaces:

- **Driver Space**: Features an enhanced driving station with a supplementary dashboard installed in parallel, incorporating a specialized driver-focused human-machine interface.
- **Passenger Space**: Physically separated from the driver area, offering controlled boarding access and dedicated passenger interaction through a specialized human-machine interface.
- **Onboard Safety**: Comprehensive safety equipment installed for both driver and passengers.
- **External Safety**: Equipped with signaling systems and interaction mechanisms designed for communication with other road users.

Figure 4. – MOBAUTO² Shuttles: External Design Profile

Supervision Centre and Monitoring Stations

The project implements a comprehensive supervision infrastructure distributed between two operational entities. SAVAC hosts two dedicated monitoring stations that provide continuous surveillance during vehicle operations. Complementing this arrangement, MILLA maintains one monitoring station specifically designed to support and assist SAVAC supervisors. Additionally, two field operators remain prepared to intervene along the route when necessary.

The monitoring system encompasses three critical functional domains:

- **Real-time Shuttle Monitoring**: The system collects and transmits vital vehicle data and location information while enabling teleoperation capabilities. These capabilities include mission dispatch and termination, emergency vehicle stoppage, and remote door control operations.
- **Passenger Interactions**: Communication with passengers occurs through the "*Hello Milla*" Human-Machine Interface, which maintains continuous audio and video streams throughout operations and delivers safety instruction reminders when appropriate.
- **Operational Security**: The comprehensive security framework features real-time vehicle diagnostics, direct communication channels between Milla and SAVAC for incident management, and synchronized intervention protocols when required.

This dual-centered supervision architecture ensures redundancy and enhances operational reliability through distributed monitoring responsibilities and coordinated response capabilities.

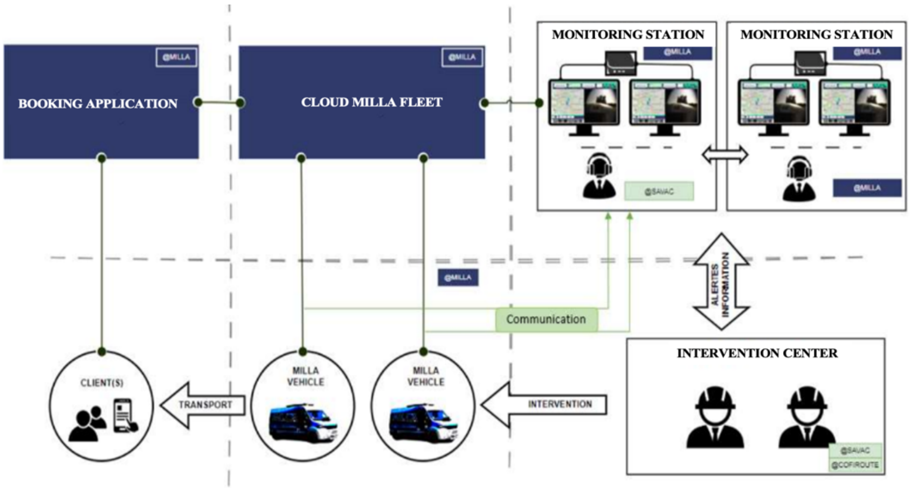

Figure 5. – Architecture of the Supervision System

Connected Infrastructure

VINCI I2V Platform allowing infrastructure to collect (perception systems), format data, and transmit (V2X standards, long and short-range communication) real-time information to the system {Shuttle + Supervision} to help manage singular points. Depending on the nature of the singular points identified on the motorway, the infrastructure-based solutions designed to help the system enhance its perception of the environment are summarised in Figure 6 below.

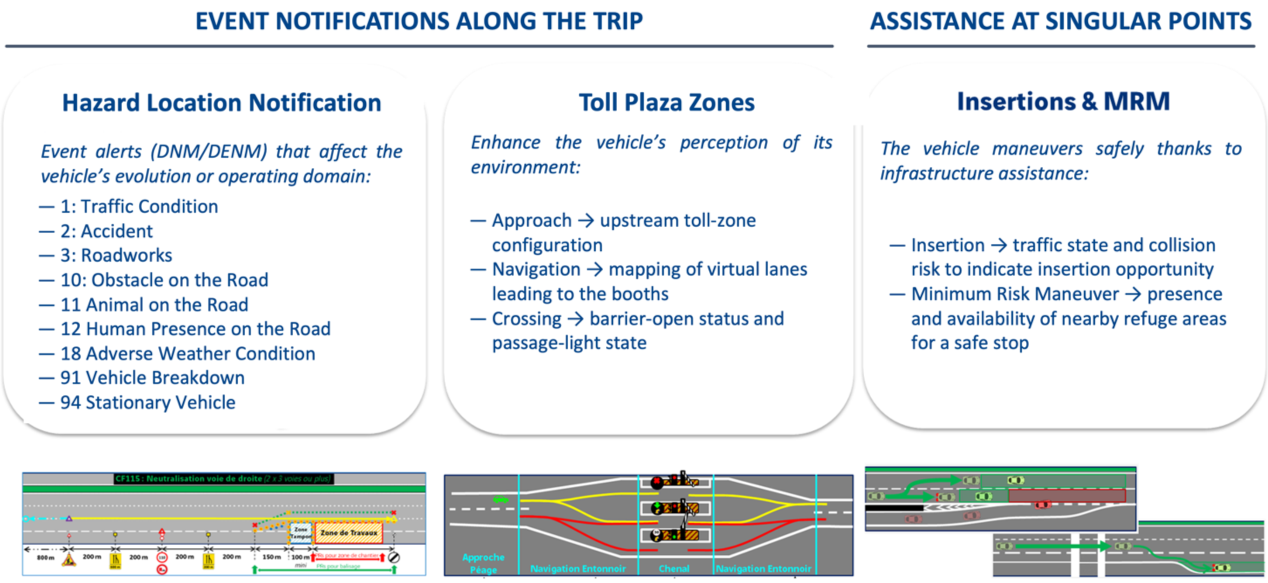

Figure 6. – Assistance of Connected Infrastructure at Singular Points

Three families of use cases addressed:

- Anticipation of road events (obstacles, pedestrians, vehicles, weather, roadworks, etc.)
- Navigation through toll areas (configuration and status of lights/barriers)
- Bus lane access and insertion (access barrier status and collision risks at insertions)

Deployment Preparation and Operational Procedures

The project progresses towards "operator-free" service, meaning no human driver physically onboard during the journey. Initial phases include onboard Safety Drivers, transitioning to phases relying on remote supervision and designated on-call Safety Drivers for incident response (Minimum Risk Manoeuvre – MRM[1]).

In preparation for the experimental phases, specific branding was necessary for the project shuttles to allow users to recognize them immediately and other road users to distinguish them from other vehicles. This branding also includes specific equipment integration in the passenger compartment to facilitate passenger accommodation.

Figure 7. – Branding and Livery of the Shuttles

Operational and intervention procedures were established and implemented for the project, specifying the distinct phases of shuttle operation. These procedures delineate the roles and actions of involved stakeholders, particularly regarding on-site intervention requirements. The key operational phases are outlined as follows:

1. **Taking up Duty:** Prior to initiating service, shuttles are stationed at the designated depot. Each Safety Driver is required to arrive at the depot and conduct a thorough inspection of the assigned shuttle to verify its operational readiness.
2. **Service Launch:** At the predetermined launch time, the Regulator is responsible for confirming the readiness of the Autonomous Driving (AD) system and associated ancillary systems (such as the I2V platform). Additionally, the Regulator must verify that the operational route is compatible with AD operation. Only upon satisfactory verification of these conditions is the shuttle permitted to initiate passenger service.

[1] A situation where the Automated Driving (AD) Shuttle determines that continuing in AD mode is no longer feasible and, as a result, initiates a safe stop on the side of the road.

3. **Operation under Nominal Conditions:** During nominal operational conditions, the shuttle follows its designated route between the specified stations. Throughout the mission, the Regulator is tasked with continuously monitoring operational conditions to ensure compliance with established criteria.
4. **Incident Requiring MRM and Replacement Bus:** During service operation, incidents may require a definitive safety stop (Minimum Risk Manoeuvre - MRM) and deployment of a replacement bus to complete the mission. The shuttle initiates MRM until it stops outside driving lanes (refuge area or emergency lane) and activates warning systems (lights and warning triangle). Upon MRM detection by supervision systems, the Regulator must (i) confirm MRM execution, communicate with passengers, and dispatch a Safety Driver, (ii) notify the highway operator to secure the area and mobilize relevant external actors (e.g., towing services, emergency responders, gendarmerie), and (iii) ensure the second shuttle completes its mission by stopping at the next drop-off station. This process ensures passenger safety and operational continuity during critical incidents.
5. **End of Service**: At the end of the service, the shuttle completes its mission by arriving at the designated drop-off station. The Regulator verifies that the stop has been successfully completed and opens the door if passengers need to disembark. The shuttles are then driven back to the depot.

Evaluation Methodology and Contribution to Shared Methodological Commons

There are methodological frameworks specifically designed for CCAM (Connected and Automated Mobility). The Trilateral Impact Assessment Subgroup for Road Transport Automation undertook the first effort to harmonize global impact evaluation studies [5]. However, this high-level framework does not cover all evaluation stages. Many efforts have been made in several European projects under the Horizon 2020 framework to adapt the FESTA methodology to large-scale automated driving pilots [1]. However, these methodologies were tailored to specific projects and are not universally applicable.

Building on numerous best practices from previous projects, such as ARCADE, CARTRE, VRA, FOT-Net, and FESTA, the European Common Evaluation Methodology (EU-CEM) for Cooperative, Connected, and Automated Mobility (CCAM) emerged. Developed under the FAME project, this methodology is easily generalizable and offers recommendations to make evaluation results more comparable while providing a common vocabulary ([2]).

The proposed methodology for evaluating the automated MOB-AUTO^2 service is inspired by the FESTA methodology, adapted to the use case of an automated highway shuttle. It also relies on the knowledge and best practices acquired in the ENA – "*Expérimentations de Navettes Autonomes"* and SAM – *"Sécurité et Acceptabilité de la Mobilité autonome"* projects. It is, by default, compliant with the EU-CEM methodology for CCAM. Here, we focus exclusively on road tests, which are the core of the MOB-AUTO^2 experiment, involving real users and targeting a service pilot.

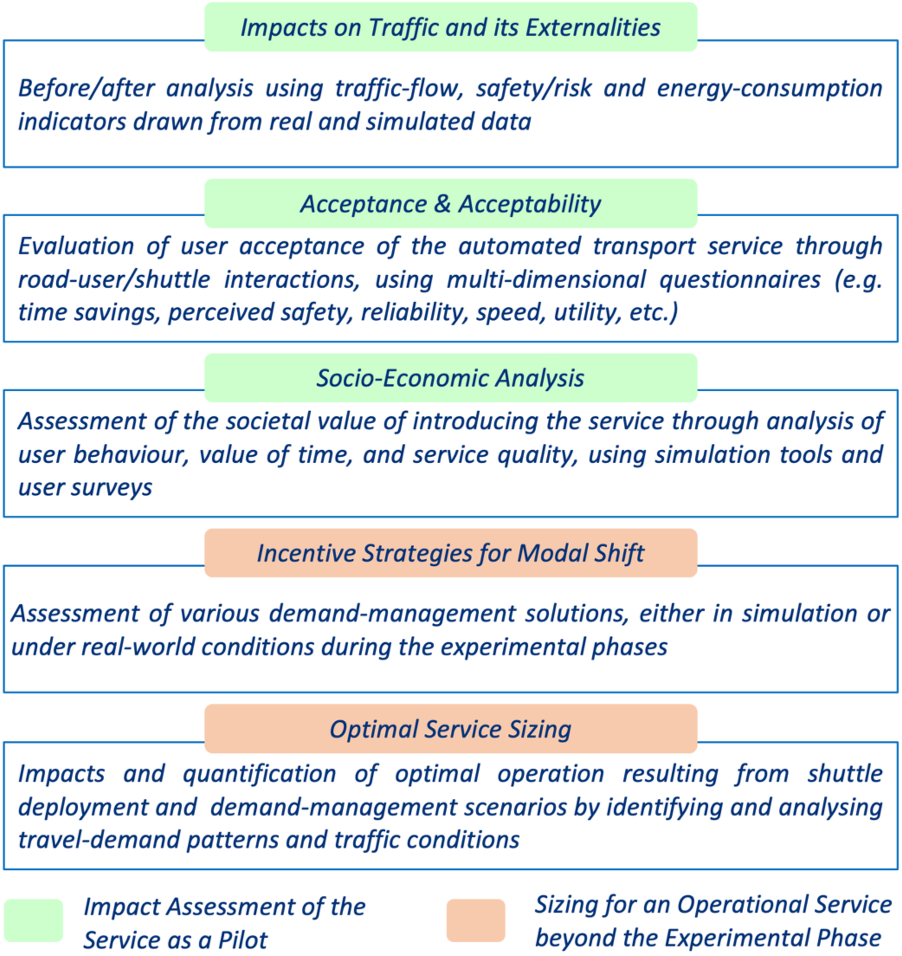

Figure 8. – Integrated Evaluation Framework: Pilot Impact Assessment and Operational Sizing for a Prospective Automated Mobility Service

While many CCAM initiatives and projects address low TRL technologies, the MOB-AUTO^2 project stands out with its high TRL (7-8), featuring a shuttle operating at speeds of up to 80 km/h on a highway between Dourdan (or Longvilliers) and Massy. This would represent a global first by becoming the foundation for the development of a new shared Automated Mobility offer.

The project employs an integrated methodological approach that combines quantitative and qualitative techniques - real and simulated data collection, multidimensional questionnaires, advanced simulation tools, and field experiments. The methodology, summarised in Figure 8, draws on the FESTA and FAME frameworks ([1, 2, 5, 6]) and leverages impact studies conducted in C-ITS projects (SCOOP@F, C-ROADS, INDID) as well as several autonomous-shuttle trials (ENA, SAM). Its objective is to provide a rigorous assessment of automated shuttles' effects on urban mobility, road safety, and user experience, thereby informing their optimal integration into future transport systems ([3]).

Conclusion and Next Steps

Automated mobility services extending Express Bus lines offer an effective alternative to single-occupancy vehicles for centre-periphery connections in urban areas, addressing a pressing mobility need and aligning with the National Strategy for Automated Road Mobility deployment. By summer 2025, the MOBAUTO² project is scheduled to initiate its inaugural passenger experimentation phase, a pivotal milestone for validating operational performance under real-world conditions and laying the foundation for subsequent driverless trials.

What distinguishes MOBAUTO² is its pioneering approach to Cooperative, Connected, and Automated Mobility (CCAM), backed by a high Technology Readiness Level (TRL) that bridges essential gaps in current frameworks and technologies. Real-world road tests with actual users, and shuttles traveling at up to 80 km/h on the highways between Dourdan (or Longvilliers) and Massy, underscore its potential to deliver a globally unique mobility solution.

This innovative initiative not only fulfils France 2030 objectives to develop clean, resilient mobility and accelerate digitalization and decarbonization, but also establishes a scalable model for shared automated mobility systems. By tackling environmental challenges and fostering societal acceptance, MOBAUTO² exemplifies how automated mobility can transform urban transportation and serve as a blueprint for future sustainable networks worldwide.

Realizing MOBAUTO²'s full potential requires overcoming hurdles beyond technical development. Navigating the complex regulatory landscape for driverless highway operations, ensuring reliable performance in unpredictable environments, and building user trust remain paramount challenges for this project and the broader field of automated mobility. MOBAUTO² is ideally positioned to provide critical insights into the safe deployment of high-speed automated shuttles on motorways, the effectiveness of I2V communication in complex highway scenarios, and user acceptance of driverless shared mobility services outside urban cores.

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References

[1]. FOT-Net (2021). Festa Handbook, Version 8. FOT-Net Data. https://www.connectedautomateddriving.eu/wp-content/uploads/2024/07/FESTA-Handbook-Version-8-FINAL-Version-20-09.pdf (accessed on April 18, 2025).

[2]. FRAME (2024). *Common Evaluation Methodology (EU-CEM) Handbook.* Deliverable D4.2, Draft Version, 2024. https://www.connectedautomateddriving.eu/wp-content/uploads/2024/05/EU-CEM-Handbook_DRAFT_240502.pdf (accessed on April 18, 2025).

[3]. El Faouzi N.-E., T. Bellet, C. Buisson, N. Coulombel, A. Furno, P.-A. Laharotte, L. Leclercq, A. Banet, F. Touzout, S.F. Varotto (2024). Evaluation Plan and Methodology, M*OBAUTO² Deliverable L003*, June 2024.

[4]. MTECT (2023). Stratégie nationale de développement de la mobilité routière automatisée 2020-2022 Bilan et Perspectives [*National Strategy for the Development of Automated Road Mobility 2020-2022 Review and Outlook*]. Ministère de la Transition écologique et de la Cohésion des territoires & Ministère délégué chargé des Transports. https://t.ly/5OjLn (accessed on April 18, 2025).

[5]. Innamaa, S., *et al*. (2018). *Trilateral Impact Assessment Framework for Automation in Road Transportation*. EU-US-Japan Trilateral Impact Assessment Sub-Group for ART. Version 2.0., April 2018.

[6]. Innamaa, S., *et al*. (2020). *Evalu ation Plan*. L3 Pilot Project Deliverable D3.4. version 1.0, July 2020.

[7]. Laoufi M., A. Ignace, N.-E. El Faouzi, J. Kokolo (2024). MOBAUTO^2 : Expérimentation de navettes connectées et automatisées sur autoroute. 52nd *ATEC-ITS France Annual Meeting*, 21-22 January, Paris, Beffroi de Monrouge, France.