

Paris-Saclay Autonomous Lab: new autonomous, electric and shared mobility services

- The purpose of the Paris-Saclay Autonomous Lab project is to devise and test different smart, autonomous, electric and shared public and private mobility services to supplement the existing transportation systems in the Paris-Saclay area.
- A comprehensive autonomous transportation system comprising autonomous vehicles, a supervision system, connected infrastructure and customer applications will be set up and experiments will be conducted to determine the requirements for scaling up an autonomous mobility service.
- The experimental system using autonomous electric vehicles – three Renault ZOE Cab prototype cars and a Transdev-Lohr i-Cristal shuttle – will be progressively made available to a panel of users.
- Groupe Renault, the Transdev Group, IRT SystemX, VEDECOM and the University of Paris-Saclay initiated the Paris-Saclay Autonomous Lab project. It was launched under the acronym EVAPS¹ with support from the French government's Investments for the Future program (PIA) entrusted to ADEME²; the Établissement Public d'Aménagement Paris-Saclay³; the Paris-Saclay urban community; the Essonne Department; and Ile-de-France Mobilités.

¹ Eco-mobilité par Véhicules Autonomes sur le territoire de Paris-Saclay – autonomous vehicle eco-mobility in the Paris-Saclay area

² French environment and energy management agency

³ Paris-Saclay urban development agency

Paris-Saclay, May 15, 2019 – The **Paris-Saclay Autonomous Lab** project was initiated by Groupe Renault, the Transdev Group, IRT SystemX, Institut VEDECOM and the University of Paris-Saclay. Its purpose is to develop new autonomous (i.e. driverless) mobility services using dedicated lane and public and campus streets to supplement the existing Saclay Plateau transportation systems.

The **Paris-Saclay Autonomous Lab** was inaugurated on May 15, 2019 at the SPRING 2019 innovation event by Grégoire de Lasteyrie, Île-de-France Regional Councillor, Special Delegate responsible for New Mobility and Mayor of Palaiseau; Francisque Vigouroux, Vice-President of the Paris-Saclay urban community responsible for Mobility and Transportation and Mayor of Igny; and Michel Bournat, Mayor of Gif-sur-Yvette and President of the Paris-Saclay urban community. The inauguration ceremony was attended by Thierry Mallet, Chairman and CEO of Transdev Group; Arnaud Molinié, Senior Vice President, Mobility Services, Groupe Renault; Paul Labrogere, CEO, IRT SystemX; Sylvie Retailleau, President of the University of Paris-Saclay; Philippe Watteau, Managing Director, VEDECOM; and Elisabeth Crépon, Director, ENSTA ParisTech.

This first stage of the **Paris-Saclay Autonomous Lab** project is one of the SAM⁴ experiments selected by the French government on April 24, 2019 following the EVRA⁵ call for projects under the Investments for the Future (PIA) program. The SAM experiments are part of France's national autonomous vehicle development strategy. They are designed to familiarize local citizens and stakeholders with these systems, expand their use and build a regulatory framework that notably includes the safety approval process.

Testing autonomous mobility services designed to supplement existing transportation systems

The **Paris-Saclay Autonomous Lab** project provides for:

- **A night collective transportation service** using an autonomous Transdev-Lohr i-Cristal shuttle **will serve the Saclay Plateau neighborhoods from the Massy station**. The service will be provided outside the normal operating hours of the regular transportation systems and will use the existing dedicated bus lane.
Between half past midnight and 3:00 a.m., an autonomous Transdev-Lohr i-Cristal shuttle will serve four stops (*Massy Palaiseau, Palaiseau Ville, La Vallée, Camille Claudel*), covering a total distance of nearly six kilometers in both directions and providing users with transportation between the Massy station and the Saclay Plateau to supplement the existing train, regional express, coach and bus services, etc.
The service is designed to fit in with the existing transportation systems and extend service beyond their scheduled operating times. It will optimize existing road infrastructure and commercial speed by using the public bus rapid transit lanes. It will also use the existing stops located in the main neighborhoods between the Massy station and the Camille Claudel bus station in Palaiseau.

⁴ *Sécurité et Acceptabilité de la conduite et de la Mobilité autonome* – safety and acceptability of autonomous driving and mobility

⁵ *Expérimentation du Véhicule Routier Autonome* – autonomous road vehicle experiment

- A daytime **on-demand car service** using autonomous Renault ZOE Cab prototype vehicles will be provided on the **Paris-Saclay urban campus**. People travelling to the campus by public transportation can then use it to freely move around the site.

The service will operate as follows:

- The user hails a car or books a car ahead of time by using a dedicated Marcel smartphone app.
- A prototype autonomous electric Renault ZOE Cab comes to pick up the user at the nearest pick-up point.
- The user enters the vehicle and is driven to the drop-off point closest to his or her destination.
- If need be, the vehicle stops on the way to pick up another passenger travelling along all or part of the same route.

The service is designed to provide a large number of pick-up and drop-off points, which do not interfere with other traffic and are located near (never much more than 300 meters from) the most frequented campus areas.

Understanding the requirements for scaling up autonomous mobility services

The Paris-Saclay experiments are designed to identify the requirements for rolling out an autonomous mobility service on a broader scale.

The project will focus on two main issues: technology, with an autonomous transportation system comprising two types of supplementary service; and acceptability, with user panels to study ridership.

Paris-Saclay Autonomous Lab incorporates advanced technologies in the smart vehicle systems, supervision system, connected infrastructure and secure telecommunications networks.

Paris-Saclay Autonomous Lab services will gradually introduce user panels to record user views and expectations (service quality, mobile app usability, in-vehicle comfort, etc.).

The remarkable project is located in the Paris-Saclay area, which lends itself to innovation, and involves complementary project participants committed to developing shared autonomous mobility.

Rolling-out a comprehensive autonomous transportation system

Paris-Saclay Autonomous Lab is a comprehensive autonomous transport system comprising autonomous electric vehicles, an operating control center to supervise the services, connected infrastructure and customer apps.

- **Smart autonomous vehicles**

The all-electric autonomous Renault ZOE Cab prototypes and Transdev-Lohr i-Cristal shuttle perform the full range of safety-critical driving functions such as detection of other vehicles and pedestrians, intersection and roundabout management, deceleration and traffic light recognition. They are equipped with GPS-type sensors, Lidar, cameras, inertial units and self-driving software. They provide full autonomy in specified areas.

Interior cameras and screens are provided for passengers throughout the trip.

The experiment is conducted with a “safety operator” on-board the vehicle.

- **Intuitive, user-friendly customer apps**

The *Mobibot by Transdev* smartphone app enables the user to **track** the Transdev-Lohr i-Cristal shuttle trip **in real time**. It displays the shuttle's arrival time at the user's stop, route simulation and time to destination including any distance to be covered on foot.

A **Marcel** smartphone app specific to the Renault ZOE Cab experiment can be used to book an **on-demand autonomous vehicle** for immediate or later use. The app directs the user from his or her current location to the nearest pick-up point and indicates the vehicle's arrival time. Within the vehicle, the app can be used to track the trip and time of arrival at the drop-off point.

- **Connected urban infrastructure**

Paris-Saclay Autonomous Lab vehicles are designed to merge with normal traffic flow and reach compatible speeds while ensuring a high degree of safety in two-way public streets and dedicated bus lanes. To achieve this, the project partners decided to roll out and test connected infrastructure consisting of connected traffic lights, sensors and roadside connectivity equipment (primarily thermal cameras and lidar devices located at 25 strategic points). The infrastructure provides vehicles and the supervision system with augmented vision to handle unforeseen events. The communicating traffic lights enable the vehicle to adapt its approach speed to traffic light status. To boost pedestrian and cyclist safety, the experiment will envisage to test the use of connected objects such as smartphones and wearables to be taken into account by the vehicle or send alerts to the equipped user.

- **Supervision from an Operating Control Center**

Supervision from an Operating Control Center located at the Massy station will track operation of the services in real time. The supervisor will display all vehicles in operation, check their status and the status of system components and use the connected infrastructure to anticipate any obstacles along the route and take appropriate action as required. The supervisor can be in direct contact with passengers and interact with them.

Developing an integrated approach within the smart city ecosystem to build tomorrow's mobility

The Saclay Plateau mobility system will help enhance the area's international image. Demand will grow, with the number of Saclay Plateau users and residents expected to exceed 50,000 in 2022 (versus 25,000 in 2016) and some 80,000 in the 2029 timeframe. The number of students is expected to reach 20,000 in 2022 and about 25,000 in 2029.

To address these issues in the near future, the public authorities decided, among other initiatives, to expand the use of new types of mobility (shared shuttles, on-demand vehicles, etc.) as part of the public transportation systems.

The **Paris-Saclay Autonomous Lab** project is an integral part of this approach. It is designed to demonstrate the suitability of autonomous mobility solutions as part of an existing transportation network, in terms of their performance, complementarity with existing systems and economic viability.

- **A public-private initiative for public and private services**

For **Groupe Renault**, the **Paris-Saclay Autonomous Lab** project is a further step in developing Marcel-type on-demand electric, shared and eventually autonomous vehicle solutions. On this project, the group serves as the operator, building on its expertise as an automotive manufacturer and leading producer of electric vehicles; its autonomous and connected technology capabilities; and its experience with mobility services via Marcel and Yuso.

Marcel offers a ride-hailing service in the Greater Paris area that gives priority to CSR (corporate social responsibility) and fair and sustainable mobility. Yuso (Flit Technologies Group) is developing a dispatch technology for on-demand transportation (ride hailing, taxis, last-kilometer delivery, on-demand public transportation and autonomous shuttles).

Yuso developed the Marcel solution for this experiment. It includes the user app, safety operator app, and the dispatch and pooling algorithm that enables two customers to share the trip.

The project is an integral part of Groupe Renault's "Drive The Future" strategy aimed at offering autonomous mobility services as early as 2022.

The **Transdev Group** brings to the project its expertise as a leader in operating shared autonomous mobility services, including operation, fleet management and customer relations. Since 2005, it has transported 3.5 million passengers worldwide in vehicles without steering wheels or pedals. The Transdev Group also provides its *Transportation Technology by Transdev*, developed as part of its *ATS by Transdev* Autonomous Transport System (Supervision, Embedded intelligence, Connected infrastructure, Customer application), to ensure passengers' safety, quality of service and customer experience. These technologies are developed both independently by the group and with a partner ecosystem that includes the top research centers and leading industrial companies in the autonomous transport systems sector.

For the Transdev Group, the project is also a further contribution to developing sustainable regions by introducing efficient mobility solutions with reduced carbon footprint based on shared electric autonomous mobility and – where possible – the use of renewable energy sources.

For the **Paris-Saclay Autonomous Lab** experiment, the Transdev Group is also providing the i-Cristal autonomous electric shuttle with a maximum capacity of 16 passengers, which it developed in an industrial partnership with the Lohr Group. The shuttle builds on Transdev's experience with accessibility, interior fittings and customer interfaces. Its embedded technology includes Torc Robotics' onboard L4 Asimov self-driving software and its customer experience, based on *ATS CX by Transdev*⁶, features on-board comfort and atmosphere, customer-HMI⁷ interfaces and on-board services (Wi-Fi, reading materials and magazines, USB plugs, etc.).

IRT SystemX brings its expertise to the project by supplying specifications and recommendations covering architecture, operational safety analysis and system cybersecurity for the comprehensive autonomous transportation system.

IRT SystemX uses MBSE (model-based systems engineering) and scenario simulation to help master the system's architecture and life cycle. MBSE modeling is also used to handle safety and ensure compliance with the Level 4 safety requirements of the SAE standard. In terms of cybersecurity, SystemX helps protect the system by analyzing potential risks and provides a PKI (Public Key Infrastructure) solution to protect the infrastructure and the V2X data it carries.

⁶ *Autonomous Transport System Customer Experience by Transdev*

⁷ Human-Machine Interface

The **VEDECOM Institute for Energy Transition** contributes its multi-disciplinary scientific expertise. It helps overcome technological bottleneck to autonomous vehicles and connectivity and to remove acceptability obstacles via a rigorous approach to human factors and ergonomics.

This two-track approach makes it possible to develop value-added service solutions:

- Research, development and rollout of smart connected infrastructure to support the autonomous vehicle and ensure its safe operation on public thoroughfares;
- Research and development covering connectivity modules and more particularly connectivity between roadside equipment and onboard vehicle communication modules;
- Development of standardized interfaces to ensure interoperable supervision, the only way for local authorities to protect their infrastructure investments in the medium and long term independently of changes in autonomous shuttles and their operation;
- Research and development covering communication between vehicles, vulnerable (pedestrians, cyclists, etc.) and highly vulnerable users (children, elderly, disabled people, etc.) to ensure their detection and safety;
- Collection and analysis of user needs and expectations;
- Research, specifications and prototyping of user interface ergonomics inside and outside the vehicles used in the experiment (Renault ZOE Cab and i-Cristal shuttle);
- Study and analysis of user feedback on the acceptance and appeal of the services offered, to prepare their future profitability.

The **University of Paris-Saclay** brings its autonomous vehicle expertise to the project via ENSTA ParisTech's IT and Systems Engineering Unit. For the **Paris-Saclay Autonomous Lab** project it focused on developing algorithms covering route planning, obstacle avoidance and intersection management decision support and transferring them to industrial partners. These algorithms are implemented in the Renault ZOE Cab. The University also developed a remote operation method enabling an operator to supervise and control vehicles remotely. It is the only public research entity involved in the project.

In offering to support the initiative, **EPAPS⁸**, the **Paris-Saclay urban community**, the **Essonne Department** and **Ile-de-France Mobilités** demonstrated their determination to take a smart city approach to designing the city of the future by offering new mobility services for the general public.

Valérie Pécresse, President of the Île-de-France Region and President of Île-de-France Mobilités, said that *“Following the autonomous shuttle experiments carried out by Île-de-France Mobilités in La Défense, Paris and the Bois de Vincennes, we are now entering a new stage in the history of autonomous vehicles. This experiment covers an area focused on innovation, the Saclay Plateau, with an operating control center and a connected roadway that will communicate with the vehicles. This experiment is a crucial step in preparing the public transportation systems of the future, and more particularly as we roll out new services for the inhabitants of the region that complement existing transportation systems at night, during off-peak periods and in underserved areas.”*

“As part of its Ecomobilité plan, the Essonne Department aims to promote new types of mobility that are more environmentally-friendly and inclusive and that improve transportation systems and travel for all its citizens,” said **François Durovray, President of the Essonne Departmental Council**. *“The development of autonomous shared vehicles is part of the plan. By supporting this large-scale project from its inception in 2017, by making its dedicated bus*

⁸ *Établissement Public d'Aménagement Paris-Saclay – Paris-Saclay urban development agency*

lane available between the Massy station and the Ecole Polytechnique, the Essonne Department takes its place as a testing ground for defining an autonomous mobility service within the department and at national level.”

Michel Bournat, President of the Paris-Saclay urban community and Mayor of Gif-sur-Yvette, said that *“Mobility is a major goal for Paris-Saclay. Mobility boosts the area's attractiveness and thus its economic development; it improves quality of life for all those who live and work here, and it helps drive environmental action. Autonomous vehicles have the potential to help us meet these goals and Paris-Saclay offers full conditions for experimenting with these future transportation modes.”*

Shared autonomous mobility provides an opportunity for cities to reap its ultimate benefits, including flexibility and availability of service, smoother traffic flow, improved air quality and space savings.

About Groupe Renault

Groupe Renault, which has manufactured cars since 1898, is an international group operating in 134 countries. In 2018, it sold nearly 3.9 million vehicles. Worldwide, the group employs more than 180,000 people and has 36 manufacturing sites and 12,700 points of sale. To address the major technological challenges of the future and continue to pursue its profitable growth strategy, Groupe Renault focuses on international expansion. To do this it builds on the synergies between its five brands (Renault, Dacia, Renault Samsung Motors, Alpine and LADA), the electric vehicle, and its unique alliance with Nissan and Mitsubishi Motors. With a 100% Renault owned team committed to the Formula 1 World Championship since 2016, the brand is involved in motorsports to boost innovation and name recognition. www.group.renault.com

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About Transdev

As an operator and global integrator of mobility, Transdev – The mobility company – gives people the freedom to move whenever and however they choose. We are proud to provide 11 million passenger trips everyday thanks to efficient, easy to use and environmentally-friendly transportation services that connect people and communities. Our approach is rooted in long-term partnerships with businesses and public authorities, and in the relentless pursuit of the safest and most innovative mobility solutions. We are a team of people serving people, and mobility is what we do. Transdev is jointly held by Caisse des Dépôts Group (66%) and the RETHMANN Group (34%). In 2018, with 82,000 employees in 20 countries, the Group generated total revenues of 6.9 billion euros. www.transdev.com

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About VEDECOM

The VEDECOM Institute for Energy Transition was founded in 2014 as an unprecedented collaboration between automotive and aerospace companies, mobility ecosystem infrastructure and service operators, academic research institutes and local authorities in the Ile-de-France region. VEDECOM's purpose is to strengthen ties between academic and industrial stakeholders. It supports them in their common drive to generate effective innovation in the field of mobility, with particular attention to electric vehicles, autonomous and connected vehicles, and shared mobility and energy infrastructure and services. www.vedecom.fr

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About SystemX

Set up in 2012 as part of the Investments for the Future program, the SystemX Technology Research Institute (IRT) serves as a digital transformation accelerator for industry, services and regional and local authorities. The Institute's 2019-2025 roadmap sets out three main missions: to accelerate the use of technologies to create value; to boost the collaborative R&D capabilities of businesses; and to encourage the production of knowledge within the academic ecosystem focused on major scientific challenges. www.irt-systemx.fr

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About the University of Paris-Saclay

The University of Paris-Saclay rings together 19 institutes of higher learning and excellence research centers that pool world-class training and research. They include three universities, nine post-graduate engineering school and seven research institutes, including ENSTA ParisTech. The University of Paris-Saclay offers a wide range of programs, from undergraduate to PhD, within world-class schools in the fields of natural sciences and humanities. Located in the heart of one of Europe's largest business and private-sector research hubs, the University of Paris-Saclay is a major industrial development driver, particularly in the fields of cutting-edge and medium technologies. www.universite-paris-saclay.fr/fr

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