

# AUTONOMOUS MOBILITY

→ MOVING TOWARDS  
FULL AUTONOMY



KEOLIS

**178,000+**  
km travelled.

**40,000+**  
hours of operation.

**55+**  
deployments  
worldwide.

**218,000+**  
passengers carried.

From the first launch by Keolis  
in 2016 up to December 2023.

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## THE CHALLENGE FACING AUTONOMOUS MOBILITY

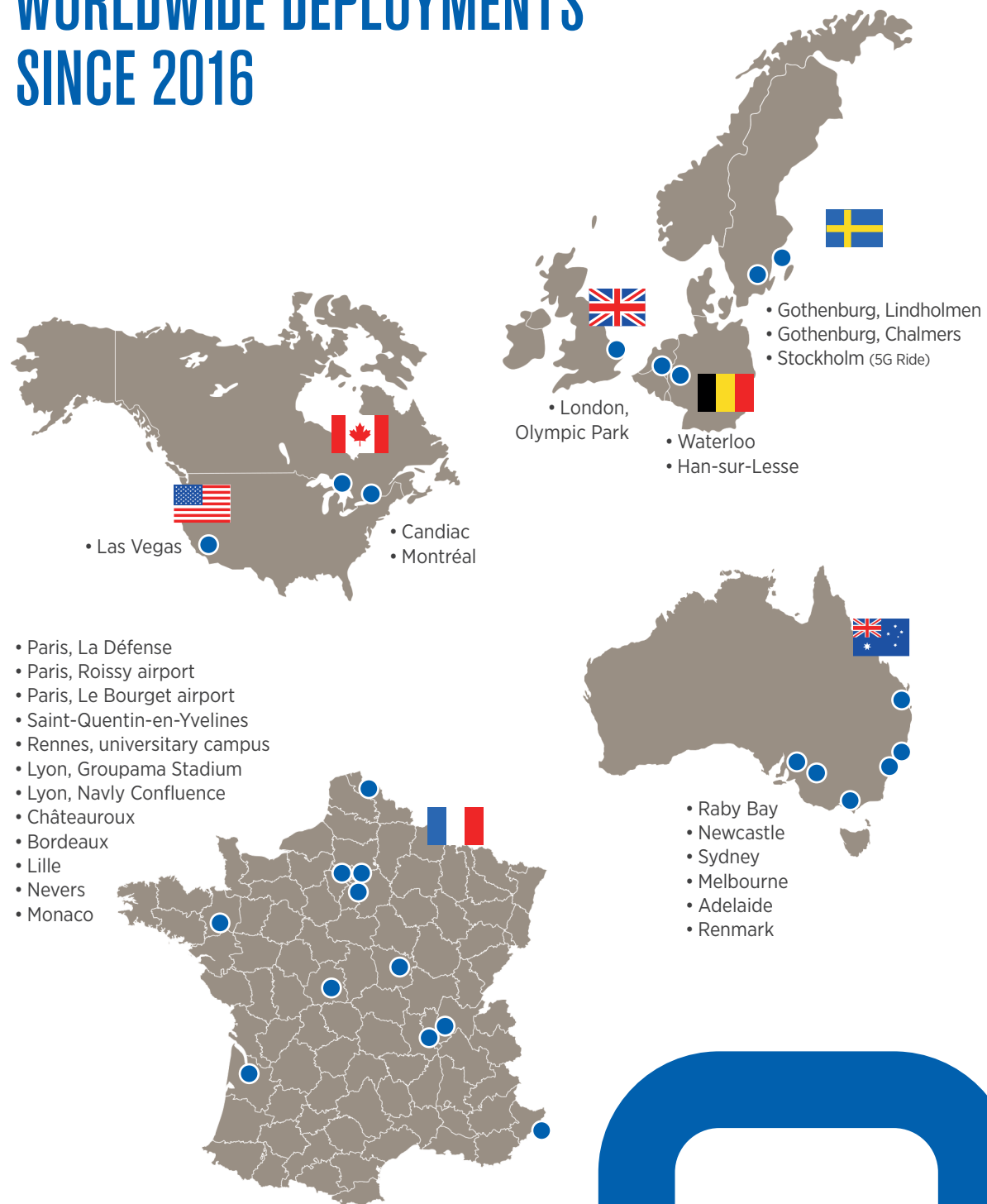
**Shift from the experimental stage  
to being a fully integrated part of  
existing transport networks**

With accelerating urban growth and ever greater demand on transport networks, the challenge in the next few years is to develop new mobility solutions that are efficient, sustainable and tailored to passenger needs. As a world leader in shared multimodal mobility, Keolis has put emerging urban mobility challenges at the heart of its strategy.

Since 2016 Keolis has conducted several trials of autonomous vehicles services open to the public in France, Australia, Belgium, Canada, Monaco, Sweden, United Kingdom and United States, fostering our reputation as a leading expert in this growing segment.

As French and European regulations in this area evolve, we begin to see fully automated driverless vehicles operating on public roads. Since 2022, Keolis launched its first "No-Op" services on its autonomous mobility test site (SEMA, detailed page 7), anticipating large-scale deployments to come as soon as national regulation changes.

# WORLDWIDE DEPLOYMENTS SINCE 2016



# A VARIETY OF USE CASES

## RURAL SITES

Waterloo  
Châteauroux



## PEDESTRIANISED CITY CENTRES

Paris, La Défense  
Nevers



## DEDICATED CITY-CENTRE SITES

Lyon Confluence  
Londres QE Olympic Park  
Sydney Olympic Park



## TOURIST SITES

Monaco  
Han-sur-Lesse  
Newcastle



## AIRPORTS

Paris CDG  
Le Bourget



## UNIVERSITY CAMPUSES

Rennes  
Lille  
Melbourne  
Adelaide  
Gothenburg



## URBAN CITY CENTRES (OPEN ROADS)

Downtown Las Vegas  
Saint-Quentin-en-Yvelines  
Montréal



## SHOPPING CENTRES

Bordeaux



## INDUSTRIAL SITES

Lindholmen



## + DEMONSTRATIONS AT EVENTS AND TRADE FAIRS

## SAFETY

Keolis seeks to constantly enhance the technological capabilities of its services, while providing the highest levels of safety.

As a result, the so-called Operational Design Domain (ODD) is continuously improving.

## OPEN ROADS



Dense traffic



left turn



On-street parking



Roundabout



Narrow street

## TECHNOLOGY AND INTEROPERABILITY



V2X



5G



FMS



KARSAN



## WEATHER CONDITIONS



Extreme cold



Snow



Light fog



Rain



Extreme Heat

# THE CHALLENGES AHEAD FOR AUTONOMOUS MOBILITY

## DRIVERLESS AUTONOMOUS VEHICLES

Since Keolis trialed the world's first-ever automated shuttle service in Lyon's Confluence eco-district in September 2016, we have continued to pioneer developments in this sector. Under the impetus of former government minister Marie-Anne Idrac, France published its National Strategy for the Development of Autonomous Vehicles in 2018, strengthening the legal framework, setting priorities and establishing specific applications.



## NEXT STEP: LEVEL 4 AUTONOMY

The large-scale deployment of fully autonomous vehicles (AVs) without an onboard driver is the current challenge. Changes in the regulatory landscape are paving the way for progress in this area. In France, the regulatory framework on sustainable mobility will allow fully AVs to operate in certain use-cases. And at European level, an amendment to the 1968 Vienna Convention

recognises that, in certain cases, an 'automated driving system' may replace an on-board human operator.

The move to full autonomy is a step towards a more sustainable and strong business model, which will also influence volume production of vehicles and onboard equipment which may also drive costs down.

## KEOLIS IS FOCUSING DEVELOPMENTS ON:

- safety and cybersecurity
- progressive steps
- public acceptance

# KEOLIS' AUTONOMOUS MOBILITY TEST SITE (SEMA)



In 2020 Keolis began trialing vehicles without an onboard operator at its Autonomous Vehicle Test Site (SEMA) in Châteauroux. This privately owned 80-hectare site allows us to freely operate vehicles and thus build on our capabilities under real-life conditions and in a safe environment. The site has proven to welcome athletes and the public all year around.



Discover our test site here.



The SEMA test facility is the only one of its kind in the world. It is housed on the site of the National Shooting Sport center, where the French Sport Shooting Federation trains its Olympic and Paralympic teams. Our driverless vehicles are used to transport teams between the different shooting ranges.

Since its launch, the facility has pre-mapped more than 5 km of roads and the site has been developed to test different kinds of applications, such as crossing intersections with smart connected traffic lights.



The test site also provides ideal facilities for training the people who will operate and supervise Keolis autonomous vehicles, as well as future trainers. In a few years, the SEMA site has proved to be an invaluable resource for Keolis and vehicle manufacturers.

# HOLISTIC APPROACH TO SAFETY, SPECIFIC TO EACH SITE

With more than seven years of experience gained through operating autonomous vehicles around the world, Keolis has significant expertise across the entire project lifecycle – and especially safety.

## THE 7 KEY STEPS IN OUR SAFETY STRATEGY

- 1 **Assess the technologies deployed by OEMs, such as Operational Design Domain (ODD)**, object and event detection and response (OEDR), the functional capabilities of the vehicles (e.g. automatic obstacle avoidance, remote fleet management, etc.), along with their safety strategy, so as to define clear specifications tailored closely to each route, prior to deployment.
- 2 **Anticipate residual risks** and likely events, and adapt the system accordingly.
- 3 **Support the deployment of vehicles** to ensure compliance with specs; establish acceptance test criteria in accordance with the site; perform dry runs to ensure complete safety integrity.
- 4 **Adapt safety procedures** in accordance with specific on-site configurations.
- 5 **Train local teams** in line with the specific features of each site and vehicle.
- 6 **Communicate with other users** (pedestrians, cyclists, motorists).
- 7 **Ensure centralised supervision** much like a control tower – liaising with operators, OEMs and Keolis experts.

# 5G CONNECTIVITY – CRUCIAL TO REMOTE VEHICLE MONITORING

Delivering superior levels of performance compared with existing networks, 5G is poised to transform the way we live and work – including how we travel.

For autonomous vehicles, 5G ushers in real-time video monitoring and remote support coupled with a level of safety and reliability currently unattainable with 4G, making it possible to:

- Ensure extremely high data speeds combined with low-latency and maximum reliability.

- Improve the NTRIP\* (Networked Transport of RTCM via Internet Protocol) connection for more accurate vehicle positioning.
- Empower vehicles with collective intelligence so that they can operate as part of smart regions.

That being said, 5G is not the be all and end all of autonomous mobility. Connectivity must be seen more as enhancing (existing) vehicle capabilities.

**“Keolis is spearheading the global development of autonomous vehicles for public transport, and 5G technology brings new opportunities.”**

## 5G-CONNECTED VEHICLE TRIAL IN STOCKHOLM



\*protocol for streaming differential GPS corrections over the Internet for real-time kinematic positioning

In partnership with Ericsson and Telia, Keolis carried out an autonomous self-driving, electric SUV trial on the island of Djurgården, in the middle of the Swedish capital of Stockholm. 5G-enabled minibus was used to test remote control and supervision for the first time,

including automatic obstacle avoidance requests from the vehicle. The low, controlled latency of 5G enabled the connected minibus to respond to commands issued by the control tower supervisor on the basis of real-time video displays.

# NEXT STEP: SEAMLESS INTEGRATION WITH EXISTING TRANSPORT NETWORKS

Autonomous mobility will not become an effective reality without close collaboration between private operators and public-sector authorities. As part of this process, Keolis will provide further support to regional authorities and stakeholders in their transformation.

## AN INTEGRATED EXTENSION OF EXISTING NETWORKS

Autonomous mobility is an effective way of expanding an existing public transport network, especially in currently underserved areas or for the 'first and last mile' of the journey.

Autonomous vehicles are ideally suited for airports, university campuses, hospitals and tourist sites spread out over large areas.

Keolis has already integrated several such services into local networks, adapting passenger information in stations and onboard as well as on mobile apps and websites accordingly. Driverless autonomous vehicles are also able to provide demand-responsive transport services.



**Service 490**, Saint-Quentin-en-Yvelines



**490**

**Service N1**, Lyon



**N1** Bus N1 - Décines Grand Large - Parc Olympique Lyonnais

**Service 100**, Rennes



**100** BEAULIEU Administration

**Service 56**, Lindholmen, Gothenburg (Sweden)



**56** LINDHOLMEN SJÄLVKÖRANDE BUSS  
REDBÄGGATAN & HUGO HAMMARSSON KAJ

**Service 68**, Chalmers, Gothenburg (Sweden)



**68** CHALMERS SJÄLVKÖRANDE BUSS  
CHALMERSPLATSEN KEMIGÅRDEN

# FIRST SCHEDULED BUS SERVICE USING AUTONOMOUS SHUTTLES

In 2020, Keolis was chosen to operate France's scheduled first bus service using autonomous shuttles launched by Île-de-France Mobilités (IDFM), the public transport authority for the Paris Île-de-France region. A significant contract win, since the PTA required that the chosen operator commit to delivering the same quality of service,

punctuality and reporting levels as other regular bus services in the region. Between March 2021 and June 2022, three autonomous shuttles have run between a business park in Montigny-le-Bretonneux and Saint-Quentin-en-Yvelines/Montigny-le-Bretonneux train station (connecting with suburban trains). The autonomous vehicles

have operated alongside regular traffic, over a 1.6 km route. The service, free of charge for all passengers, was fully integrated to the network passenger information system, and users could check the shuttle timetable via the IDFM mobile app, alongside the regular bus services..

"IDFM has set key success factors for the service, which is a first in France. The evaluation of the quality of service is based on frequency, regularity, availability and speed, similar to the quality delivered for a bus line. Moreover, the integration of the service in the network to complement other modes and real time information are key criteria for the service success."

**Estelle Chevalier**,  
Île-de-France Mobilités

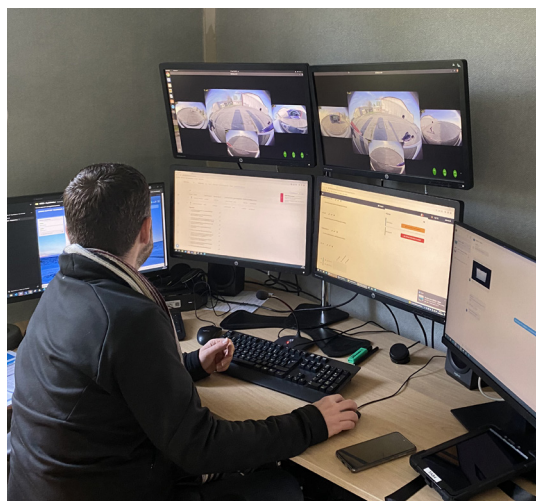


# LOCAL SUPERVISION AND TECHNICAL ASSISTANCE, TWO KEY AREAS OF EXPERTISE FOR FULL AUTONOMY

**No matter how autonomous they may be, vehicles still depend greatly on human input!**

As a transport operator, Keolis not only ensures the operational safety of the AVs it deploys worldwide, but also performs the vital role of monitoring fleets.

With the first fully autonomous mobility fleets (with no onboard operators) about to hit the roads, fleet monitoring is poised to become even more crucial, since supervisors can be called on to perform certain tasks with two key features : technical missions related to service supervision and fleet monitoring, as well as remote assistance for passengers.



Keolis fleet monitoring centre in Châteauroux.

## AUTONOMOUS MOBILITY CONTROL TOWER

To this day, fleet monitoring has mainly been about providing support for onboard operators.

To adapt to full autonomy new challenges, Keolis chose to train local teams on fleet management, supported by remote cross-functional technical assistance.



### Fleet management

Dedicated fleet management software (FMS) tools for scheduling vehicles, providing on-demand transport services, etc.



### Supervise tactical maneuvers

when technologically possible, as example: authorising a vehicle to bypass an obstacle or restart.



### Managing interaction with passengers,

for example if the vehicle is required to stop, and with support staff, if required to intervene on the vehicle.



### Flawless understanding of the site

so they can efficiently assess any issues and respond swiftly in case of service disruption.



### Full cross-functional technical assistance

(vehicles, connected infrastructure, technical tools and software...)

# CREATING NEW JOB OPPORTUNITIES

As technological advances drive vehicle automation, new forms of autonomous mobility are emerging, offering ever improving levels of performance and safety. Keolis is gearing up for the rollout of fully autonomous services by preparing a new generation of operators and supervisors. Onboard operators will progressively become remote operators, meaning

that their day-to-day tasks are set to change. All Keolis automated vehicle operators are trained in the required technical skills and operational procedures, with safety being a priority. They are also trained to intervene manually and anticipate high-risk events. In the years ahead, training will be adapted to reflect the changing role of operators.

**Francis**, operator in Saint-Quentin-en-Yvelines



## MORE THAN 165 KEOLIS OPERATORS TRAINED IN REMOTE SUPERVISION



**"I had the privilege of being Keolis' first-ever autonomous shuttle operator in 2016. So I've seen first-hand how both the technology and services have changed. I've also been given the opportunity to change, too, as I'm now a trainer."**

**Junior**,  
operator trainer in Lyon



**"I feel like I'm taking part in the creation of a brand-new service, one that will grow to meet needs not covered by other modes, as it is the case here in the rural areas around Châteauroux."**

**Nordine**,  
Supervisor, local Automated Vehicle specialist operator and trainer in Châteauroux

## TAILORING SERVICES TO THE NEEDS OF COMMUNITIES



**INNOVATIVE, INTEGRATED MOBILITY  
FOR SMART CITIES**

In Gothenburg, Sweden, Keolis has operated (from January to June 2021) autonomous electric shuttles that were fully integrated into the city's public transport network. The self-driving shuttles served business and residential areas, the university and car parks along a fixed 1.8 km route.

## TECHNICAL HIGHLIGHTS

Can operate in extreme weather: cold, frost, snow, high winds.

## PROVIDING THE ONLY PUBLIC TRANSPORT SERVICE IN RENMARK, AUSTRALIA

Operated in 2021 as a 12-month trial in partnership with the City Council and State Government, this autonomous electric shuttle was Renmark's only shared mode of transport. It served several key locations including the main street shopping precinct, tourist centre and civic areas of the township along a 2.4 km loop.

## TECHNICAL HIGHLIGHTS

Able to run in complex environments (cross a 4-lane highway) and operate in extreme heat (40°C and above).



# PUBLIC ACCEPTANCE, A KEY CRITERION FOR DEVELOPING NEW MOBILITY SOLUTIONS

Keolis fosters relationships of trust with public partners based on listening and dialogue. We believe this is the best way to understand the needs and concerns of each local community and, in turn, implement the right transport solutions, such as autonomous mobility.

Several passenger surveys have been conducted to gauge how people perceive autonomous vehicles: do they trust them and would they consider using them in the future?



**"In my opinion, autonomous shuttles can meet real needs in areas that are underserved by public transport."**

Julie, passenger

**"It's an innovative service."**

**Hélène**, passenger

**"The vehicles look futuristic. We're entering a new dimension!"**

Thomas, passenger

## PUBLIC SERVICE

Autonomous mobility will be provided first and foremost as a public service, in other words as public transport, so that it can remain affordable.

## A FAIR TRANSPORT OFFERING

Autonomous mobility  
can improve  
accessibility and offer  
more inclusive  
transport solutions.

## SUSTAINABILITY

All-electric autonomous vehicles support authorities in their shift to greener energies.

Conception et réalisation: EPOKA

**Keolis – Photo credits:** Keolis, Keolis Downer, Sytral.



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