UITP ADVANCING PUBLIC TRANSPORT

→ Position

Automated Mobility

The Next Step for Public Transport

→ Beti operated autonomous shuttle service at Rovaltain/ Valence TGV © beti/Alpcat Medias

Automated vehicles (AVs)*, properly integrated in public transport (PT), have the potential to significantly enhance PT service quality, by delivering better mobility solutions to more people over a wider area, through more inclusive, sustainable, and resilient services.

The promise of automated mobility lies not simply in technological novelty but in its ability to improve service delivery, reach underserved populations, and optimise operational efficiency.

This UITP Position brings together the views of PT stakeholders in a unified message, highlighting the transformative potential of automated mobility, identifying the key global and regional obstacles to its rollout, and providing recommendations to accelerate equitable, large-scale deployment globally.

Recommendations

→ **Prioritise the integration of Level 4 (L4) AVs into PT systems**.** This ensures the technological revolution delivers greater societal value and supports broader goals such as reduction of congestion, emissions, and mobility poverty.

→ **Support the development of L4 AVs of all sizes, including larger buses and shuttles, designed with PT in mind.** This ensures that automated mobility can serve a wide spectrum of use cases, from localised on-demand services to high-capacity core lines, expanding overall PT reach.

→ **Adopt regulatory frameworks that proactively support L4 AV testing and deployment at scale.** Regulations should guarantee safety and security while providing predictable pathways for large fleets to operate in mixed traffic.

→ **Invest in training programmes to prepare employees for new roles in remote supervision, fleet management, and field support.** Policymakers and the PT sector should ensure that automation strengthens the PT workforce rather than displacing it.

→ **Mandate that AV services be designed for inclusivity,** with accessibility requirements defined at the earliest stages. Automated mobility must not create barriers to PT for any user. The involvement of vulnerable user groups in service design is essential.

→ **Support public engagement, communication, and education initiatives to build trust and social acceptance of shared automated mobility.** Transparent dialogue and inclusion of diverse user groups can help reduce concerns and ensure successful adoption.

→ **Unlock new funding mechanisms that focus on large-scale, sustainable deployment rather than short-term pilots.** Long-term funding models targeting mature technology and established use cases are necessary to move from temporary experiments to lasting, integrated PT services.

→ **Facilitate joint procurement and cross-border cooperation to aggregate AV demand and reduce AV fleet costs.** Coordinating purchases around common standards strengthens the investment signal required by industry to develop new vehicles and accelerates technology availability for public transport.

* In this UITP Position, 'automated vehicles' includes vehicles of all sizes, offering services integrated into, or complementary to, public transport. This includes robotaxis, shuttles, mid- and full-size buses, and new PT-specific vehicles that may emerge. The Position covers automated road mobility for public transport. Automated metro and rail operations have a long-established history and are treated in other UITP publications.

** The Society of Automotive Engineers (SAE) defines six levels of driving automation, from **Level 0 (no automation — the driver controls everything) to Level 5 (full automation — the vehicle can perform all driving tasks in all conditions without human input).** Levels 1–3 involve increasing driver assistance and partial automation (e.g., adaptive cruise control, lane keeping, and conditional automation where a driver must take over if requested), while Levels 4 and 5 represent high to full automation, with Level 4 limited to specific conditions or areas (e.g., geofenced urban zones) and Level 5 unrestricted everywhere.

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Benefits of Automated Mobility in Public Transport

By embedding advanced vehicle automation in multiple service layers, from on-demand shuttles to high-frequency lines, public transport authorities (PTAs) can overcome the longstanding challenges of network coverage, cost, and workforce constraints.

Automated mobility is set to revolutionise how PT meets society's needs.

The following sections illustrate how automation will add significant value to existing PT operations, through proper integration of AVs of all sizes, from robotaxis to larger shuttles and buses. Technological advances and pilot projects have largely (but not exclusively) centred on smaller vehicles, where sharing may be limited. However, reaping the full benefits of automation in PT requires diverse vehicle types, developed specifically for PT operations and offering a variety of services. Public transport operators (PTOs), PTAs, and industry will need to work closely together to develop vehicle platforms, harness demand, and demonstrate market readiness to spur investment.

The implementation of AV services in PT will vary depending on local realities, such as user needs, the existing network, societal acceptance, and regulatory and financial conditions. What remains imperative is that the new technology strengthen PT for all users.

A) Expanding Coverage, Service Reach, and Frequency

PTOs frequently face budget constraints alongside demands for expanded or flexible services that can adapt to shifting demand patterns. AVs can enable efficient PT service provision across all communities (urban, peri-urban, rural, and low-density) by reducing reliance on individual car usage. This need is particularly pressing in locations where traditional PT is economically or logistically constrained and where AVs can add both societal and economic value through flexible, demand-responsive solutions integrated into PT networks. Automation can also transform existing services through increased frequency and extended operating hours. Over time, automation can reduce operational costs, allowing authorities to reinvest savings in broader service improvements.

AVs can enable efficient PT service provision across all communities (urban, peri-urban, rural, and low-density)... particularly in locations where traditional PT is economically or logistically constrained.

→ Autonomous on-demand transport is being piloted by Ruter in the Oslo area
© Ruter

B) Addressing Labour Shortages and Operational Efficiency

Many PTOs are experiencing driver shortages. L4 automation offers an opportunity to maintain or expand services despite workforce constraints. Moreover, L4 AVs contribute to the creation of highly skilled jobs in both the PT and automotive sectors. Change management and training are key enablers to including AVs in regular PT operations. Beyond passenger services, the automation of depot operations also offers benefits. Freeing drivers from tasks like moving vehicles for refuelling or cleaning allows more driver time to be devoted to passenger services, while automation can also help mitigate the risk of vehicle damage in busy, constrained depot environments.

At the same time, unions and taxi driver associations often express strong concerns about automation. Addressing these through structured dialogue, training programmes, and transition frameworks is essential for smooth adoption and wider acceptance. Any strategy or roadmap aiming at integrating automation into PT must include social dialogue with workers to build mutual understanding and ensure a successful transition.

C) Enhancing Safety and Security

Automation can play a central role in further improving road safety, including within PT operations. AVs are expected to reduce human error – the main cause of traffic incidents – making services safer for both passengers and other road users. Technology safety must be ensured from the beginning of any test or operation. Furthermore, robust cybersecurity and operational security frameworks will be essential to ensure trust and resilience as automation scales.

D) Enhancing Accessibility and Social Inclusion

The mission of PT is to deliver affordable and inclusive mobility services for all. The implementation of AV services should never create a barrier to PT for any user. This is particularly the case of vulnerable populations or persons with reduced mobility. Automated mobility services should be designed to efficiently serve vulnerable populations, including children, the elderly, and persons with reduced mobility and/or disabilities. As AV services are generally designed from scratch, they can integrate user needs from the start in terms of facilities (e.g., wheelchair-accessible vehicles) and passenger information (e.g., adaptation for visually impaired customers). Smaller, on-demand automated shuttles can provide services that bridge the gap between people's homes and fixed-line public transport.

AV deployment must enhance, rather than replace, services designed for those with additional needs. These solutions can play a key role in reducing transport poverty and enhancing inclusivity.

The needs of vulnerable users and those with reduced mobility must be considered from the very beginning. This is best achieved through active involvement of such user groups in service design and testing, rather than post-hoc evaluation of pre-designed services. At a system-wide level, automation can also leave more staff available to assist passengers with additional needs. AV deployment must enhance, rather than replace, services designed for those with additional needs. These solutions can play a key role in reducing transport poverty and enhancing inclusivity. At the same time, public dialogue initiatives will also play a crucial role in securing public acceptance of autonomous mobility solutions.

E) Supporting Sustainable Urban Mobility Goals

Automated mobility aligns with UITP's mission to promote greener, more liveable cities and lifestyles. AV integration into PT fleets can help foster modal shift and reduce reliance on private cars, contributing to lower emissions, reduced congestion, improved public health, and better use of public space. Recent studies have shown that widespread adoption of shared AVs could lead to significant reduction in car ownership and road traffic, provided AVs are integrated into a strong PT network[1]. In this case, zero-emission powertrains and proper integration into the PT network provide PTAs with the right levers to deploy services that effectively address the local context.

The large-scale rollout of automated mobility, primarily through adapted PT services, must not come at the expense of established sustainable modes such as walking, cycling, and shared mobility, which should continue to be promoted.

F) Driving Innovation and New Business Models

Automation opens up new possibilities for data-driven planning, flexible service models, and new service integration. With appropriate policy and regulatory support, PTOs can experiment with novel service types such as automated on-demand mobility, night services, or special mobility services for industrial parks or campuses. These innovations must remain grounded in user needs and be supported by sustainable use cases.

G) Enabling New Public Transport Jobs

Automation should not lead to the devaluation of the PT workforce. Rather, it provides an opportunity to rethink roles, upskill employees, and generate new types of employment. New roles in deployment, remote supervision, fleet management, and system maintenance are emerging, enhancing the range and quality of jobs on offer.

Automation provides an opportunity to rethink roles, upskill employees, and generate new types of employment.

All in all, UITP views automation as a powerful tool to complement existing public transport, extending its reach, improving its inclusivity, and ensuring its long-term sustainability.

Karsan Autonomous e-ATAK buses, automated by ADASTEC, operate passenger services at Rotterdam The Hague Airport
© Karsan

Common Barriers and Potential Solutions to Automated Vehicle Integration in Public Transport

AVs offer significant promise to complement and strengthen PT networks. However, realising this potential requires overcoming a set of systemic and interrelated challenges that are not solely technological in nature, but span regulation, funding, service integration, and user acceptance.

Addressing these areas holistically, through a customer-centric, service-led, and PT-oriented lens, is essential to shift from experimentation to sustainable deployment.

A) Technological Maturity and Cost

While lower levels of automation (Levels 2 and 3) can have a role to play, exploiting the full advantages of AV technology integration in PT requires L4 automation; i.e., vehicles capable of operating without a human driver or safety operator on board.

Commercial L4 operations on public roads are taking place in an increasing number of countries but remain the exception rather than the norm. **In the United States and China,** the success of robotaxi services in a number of cities demonstrates that mature, robust L4 operations are feasible, but also that these achievements required significant investment over a long period of time. Thus far, these deployments have largely been limited to single party usage of robotaxis, though some PT-specific pilots have also taken place, specifically in China, with large-scale L4 AV demonstrations and operations in complex urban environments. **In the European Union (EU),** L4 operations are poised to enter the market as more international technology suppliers begin investing in EU deployments. However, full AV integration into PT will need to take place gradually, through a series of service deployment steps, underpinned by vehicle and system homologation procedures.

A common thread across the globe is that the number of suppliers delivering robust self-driving systems (SDS) is limited and L4 technology is not yet available at a large scale. PTOs and PTAs who are willing to begin deployment often struggle simply to access the necessary technology. The PT sector needs to develop closer collaboration with the supply industry to create market stability and facilitate mature L4 technology development at scale, designed with PT in mind. At the same time, investing in pilot projects can generate important learnings, which, in turn, can speed up future technology adoption and accelerate the realisation of associated benefits.

As SDS production scales up, e.g., through integration into series-production vehicles, both procurement and deployment costs are likely to decrease, thereby removing one of the key barriers to large-scale adoption in public transport. Enhanced cooperation between industry and the PT sector is also needed. On the one hand, vehicle manufacturers, from cars to large buses, need to produce PT-specific vehicles, in line with local regulations and conditions. On the other hand, the PT sector should be enabled financially to secure the demand for those vehicles and foster investment by industry.

B) Scaling from Demonstration to Sustainable Deployment

The next step for AV integration into PT should be large-scale deployment. To create a viable business case for manufacturers, demand must reach several tens of thousands of vehicles. Thus, early rollouts should prioritise larger vehicle fleets.

Key technological readiness issues include:

- **Operational design domains (ODDs):** Most currently available AVs are still restricted to narrow ODDs – geographically and functionally limited contexts. Expanding these boundaries while ensuring safety and reliability is a priority.
- **Fleet supervision and remote operations:** Developing scalable, secure, and interoperable fleet management systems is essential. Such tools are the foundation for large-scale AV operations and the only way to unlock its full potential. Integrating remote supervision into existing PT operation and control systems will also be a challenge. Harmonised technical and operational standards are a possible lever to address this and ensure interoperability in large-scale deployment.
- **Impact on public transport's operational dynamics:** Introducing AV fleets reshapes depot requirements (location, footprint, and layout), alters vehicle sizing and turnaround times, and requires development of new maintenance and charging schedules. PTOs and PTAs must rethink space allocation, spare parts logistics, and shift planning to support a mixed AV and conventional fleet.

→ PTO De Lijn operate a fixed line service in Leuven as part of the AMAM Project
© De Lijn

→ Self-driving vehicles from MOIA are on the road in several European and North American cities © MOIA GmbH

- **Passenger safety and security:** Along with vehicles' technical safety, the security of passengers using shared AV services is paramount. Certain user groups (e.g., women or minority communities) may be reluctant to share driverless services with strangers, particularly at night or in low-density areas. PTOs and PTAs should formally include such users in service design, specifying security and safety protocols and field intervention procedures.

- **Vehicle size and accessibility:** Large-scale AV adoption in PT requires an expanded AV market, enabling the integration of all sizes of vehicles, from robotaxis and shuttles to full-size buses, offering a variety of service types, including on-demand and fixed line. Cost savings and efficiencies gained through automation can free up funds for reinvestment in expanded PT services. Furthermore, automated services should aim for fully barrier-free mobility, enabling everyone to travel autonomously.

- **Managing change and innovation in public transport:** The rise of AVs is generating new roles and skill sets in the PT sector, such as remote vehicle supervisors and rapid-response field agents, while also enabling the development of new service models. As novel partnerships between PTOs and private partners emerge, new approaches to co-management of service level agreements, real-time data integration, and revenue/risk sharing will be needed.

Technology development should be guided by real-world mobility needs, not simply technological capability and availability. Closer collaboration between industry and the PT sector can begin to address these needs.

C) Regulation that Puts Vehicles on the Road

Successful AV technology testing and deployment requires regulatory frameworks that proactively support putting vehicles on the road.

- **International efforts,** such as the United Nations (UN) working group on automated mobility, offer valuable frameworks for harmonisation of safety, data, and operational standards across jurisdictions. Global regulatory coordination can accelerate deployment while ensuring public trust and safety.
- **In the United States,** self-certification procedures have enabled early developers to balance safety requirements with the need to test in open traffic.
- **In China,** individual cities have designated thousands of kilometres (km) of roadway for testing and worked with technology providers to set targets for large vehicle fleets.
- The approach **in the EU** is anchored in a unified type-approval framework, but its 1,500-vehicle annual cap per manufacturer severely limits scale. As of July 2025, only three member states (plus Switzerland) have comprehensive laws for automated mobility services. Beyond enacting legislation in the remaining countries, existing regulations must be harmonised. Streamlined permitting will accelerate innovation, boost knowledge transfer, and enable true mass market solutions.

Different regions and individual countries across the globe will adopt different approaches to risk and innovation, according to their wider regulatory and legal systems. What may work in one jurisdiction cannot necessarily be replicated elsewhere. Moreover, while market forces and currently available technology may push for the mass deployment of robotaxis, environmental and societal needs require AV service integration into PT networks.

Regulatory frameworks should guarantee the safety of all road users and govern the use of public space in society's best interest.

A fundamental requirement can be seen in the most successful AV deployments: deploying large numbers of vehicles, in mixed traffic, driving hundreds of thousands of km. Predictable and flexible regulatory frameworks, which specify clear and realistic procedures for AV testing and deployment, can facilitate this scaled effort.

Regulatory frameworks should guarantee the safety of all road users and govern the use of public space in society's best interest. In addition to safety rules, regulatory frameworks must cover cybersecurity, operational security, and questions of liability and insurance. Without robust protections, AV fleets risk undermining public trust and resilience. However, regulation must also proactively support AV deployment for PT and not hamper innovation, if its full potential is to be unlocked.

D) Funding and Financing: Bridging the Gap from Pilots to Market

A critical barrier to large-scale AV deployment in PT is the absence of sustainable, long-term funding models for large autonomous fleets with the potential to have long-lasting impact on overall mobility systems. Too many existing programmes focus on incremental sensor upgrades for L2 and L3 – efforts that, while valuable, fall far short of the transformational societal benefits unlocked by L4 autonomy. By contrast, investing in L4 systems has a multiplier effect: as deployments grow, they generate data, refine business models, improve technology, and pave the way for exponential scaling.

PTAs and PTOs worldwide depend on tightly constrained public budgets and cannot obtain venture capital financing to underwrite autonomous fleets or new infrastructure. National and regional grants likewise tend to bankroll short-term pilots in which vehicles are rented or leased instead of purchased. Once that funding ends, services disappear, leaving early users and customers stranded, and no pathway remains for scaling. Unsupportive regulatory frameworks can further fragment demand, hampering cross-border or joint procurement plans that could aggregate orders and drive down unit costs.

→ RATP Group have operated Karsan/ Adastec buses in Paris © RATP Group

To bridge the gap from pilots to sustainable large-scale deployment, we must:

→ **Refocus funding on L4 autonomy for public transport.** Redirect resources from small, isolated pilots toward projects with clear roadmaps for large-scale rollout. L4 funding creates a self-reinforcing cycle of deployment, data collection, continuous improvement, and broader adoption.

→ **Pool purchase orders around common standards.** By aggregating demand across regions and operators, we can shift the industry's attention from bespoke local solutions to interoperable platforms – driving down costs, accelerating certification, and building a robust supply chain. However, these approaches must align with market maturity. Premature harmonisation may hinder innovation and responsiveness to local needs.

→ **Innovate and de-risk through new financing instruments.** Explore novel mechanisms, such as revolving loan funds, outcome-based contracts, and public-private co-investment, to share risk among manufacturers, operators, and governments and ensure continuity beyond pilot phases.

Driverless services are on the road and can transform mobility
© beti/Alpcat Medias

- **Champion cross-sector and cross-border collaboration.** Autonomous mobility must serve the many, not the few. Success hinges on breaking down silos between public and private providers and transcending national boundaries, so that automated mobility benefits everyone.

- **Funding for target pricing:** As the costs of L4 SDS stack development and industrialising the production of purpose-built vehicles are high, PTAs and PTOs should have access to public funding to procure larger fleets and reach target prices per vehicle through economies of scale.

- **Adopt broad, public transport-based service design:** Autonomous mobility services should be designed to complement, not compete with, existing services. In cases where autonomous services can provide better solutions, they can replace more traditional PT service delivery models. As technology advances, fixed route services will likely see updated service design, as driverless operations of larger vehicles is established.

- **Enable greater flexibility for PTAs in procuring integrated operations** that can adjust from fixed route services to on-demand services, and vice versa, as the market develops.

- **Enable greater flexibility for PTOs in developing partnerships and business models:** PTOs should be allowed to pursue economically sustainable integrated AV services, reducing reliance on public budgets. This may require revising contractual frameworks that currently restrict commercial partnerships beyond mandated services.

Cooperation is key: without it, autonomous mobility risks being seen as a luxury rather than a public good.

The ultimate goal should be to transform pilots into a resilient, scalable network that delivers real value to citizens.

E) Sustainable Use Cases: Integration with Public Transport

Automation must not create parallel systems that compete with or undermine established PT networks, nor should it weaken integrated mobility components such as shared services or active modes. Instead, it should complement existing services and contribute to integrated, user-centred mobility systems.

Key considerations for use case sustainability include:

- **Enhanced efficiency:** AVs of all sizes can increase efficiency in the PT network, from smaller vehicles operating on-demand services to larger buses operating automated bus rapid transit (BRT) lines. PTAs and PTOs should consider the full range of vehicles when making deployment decisions.

- **Targeted relevance:** AV services must fill genuine mobility needs – whether such needs are strengthening core network lines, first- and last-mile links, late-night coverage, rural outreach or offering a viable alternative to private cars in dense urban cores. Uptake is highest when solutions are tailored to clear gaps in the network. Autonomous on-demand services, in particular, make PT offerings more dynamic, modern, and personalised, delivering significant benefits for both passengers and operators.

- **Targeted regulation:** National and local authorities should adopt regulations to ensure that AV services maximise the benefits to the target communities through integration into PT and avoid potential downfalls such as increased congestion or competition with public transport. Such tools should be customised to local realities but may include the following: licensing schemes for commercial operators that require integration into PT; defining local economic conditions, including price ranges for services and minimum occupancy rates; and setting service levels that mandate connections to PT hubs, as well as services in low-demand zones or during off-peak hours.

- **Competitive user experience:** Where private cars still dominate, especially in city centres, automated services must deliver comparable or better flexibility, reliability, and comfort. By matching drivers' and passengers' expectations regarding demand, convenience, and ride quality, AVs can draw new riders into a cohesive, multimodal network.

- **Strategic complementarity:** Automation should strengthen the overall system, adding coverage, frequency, and quality where it is needed most, while preserving high-capacity trunk lines (buses, trams, and trains). It is crucial to integrate automated mobility services into the overall PT systems so that AVs can expand reach without cannibalising core services.

- **Intermodal integration:** AVs should form part of multimodal trip chains, supported by digital integration, shared ticketing, and real-time information. This can simplify travel by offering seamless planning, booking, and payment across modes, making automated services more attractive and accessible. Lack of integration limits the utility and appeal of automated services.

- **Social acceptance:** Public trust in automated services grows with experience, but this requires proactive engagement, transparency, and responsiveness to concerns. PTOs should be ready to invest in educational/awareness campaigns and targeted efforts to overcome potential scepticism and bridge any potential 'digital divide'.

Moving Forward

The PT sector is ready to lead the next phase of automated mobility. After years of pilots and technical progress, we have now entered a critical transition **from technology development to service deployment and scaling.**

Operators worldwide are ready to introduce L4 AVs to provide new mobility options, and the industry is steadily advancing its systems toward market maturity. While legal frameworks are emerging and demand from the PT sector is strong, continued investment and development are required, and access to mature technology and suitable funding mechanisms remains a critical barrier.

In recent years, PTOs and PTAs have launched numerous pilot projects in Europe and elsewhere that demonstrated that close collaboration with cities, national authorities, industry, emergency services, and researchers is fundamental to ensure success. It is imperative that these groups take proactive steps to work together, to define a vision for automation in PT that delivers tangible benefits for all. This is best achieved when AVs are fully integrated into PT systems.

UITP is committed to ensuring that this transition benefits citizens by enhancing and strengthening public transport. Automation will help address pressing challenges facing our cities and deliver transport services that reduce car dependency, extend PT coverage, improve inclusion, and make mobility more sustainable.

References

1 Ruter (2019), Oslo Study: How autonomous cars may change transport in cities.

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