Mobility reimagined

How mobility and technology leaders see the transport networks of our future

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We would like to thank the following experts for their time and insight:

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In addition to those listed above, the report benefited from contributions from a range of leading technology and transport companies who have wished to remain anonymous.

Contents

Research methodology

The research for this report was conducted by the international market research and data company, Savanta, on behalf of Hitachi Rail.

Savanta conducted 60-minute in-depth interviews with 36 senior leaders, via online video calls, in the technology and transport sectors between 14th May and 8th July 2026.

Sample Participants included: Tech companies (10), Academics in technology and transport (9), Local transport authorities (6), Industry trade bodies (4), Think tank representatives (3), Transport and infrastructure companies (2), Management Consultancy companies (2).

Foreword

We are in an era of profound change. Urban populations continue to grow and will represent two-thirds of humanity by 2050, placing ever greater pressure on roads, infrastructure and public services. And this dynamic is being amplified by the increasing speed and impact of climate change.

At the same time, passengers expect transport to be more convenient, reliable and sustainable than ever before. These challenges are interconnected and so too are their solutions.

One message emerged consistently from the leaders interviewed for this report: meeting the challenges of today and tomorrow will require a fundamental shift in how people and goods move. Our use of private vehicles must be rebalanced to match our ambitions for economic resilience, energy security, liveable cities and climate goals. Instead, the future lies in more integrated, more sustainable, and more efficient mobility systems built around high-capacity public transport.

Grounded in the perspectives of leaders across global tech and transport organizations

The perspectives captured in this report are unique in both their diversity and their reach. We have convened voices from across the global mobility and technological ecosystems, including transport operators, industry bodies, academics, hyperscalers and tech innovators from North America, Europe and Asia. Collectively, these leaders represent the organizations that are designing, operating and transforming the transport networks of tomorrow. Through a series of in-depth conversations, they provide a compelling view of where mobility is today, the direction in which it is evolving, and the critical challenges that governments, industry and society must overcome together to deliver the integrated, sustainable and intelligent transport infrastructure that the future demands.

Mobility is being redefined

The experts featured in this report are united by a belief that mobility is being redefined. No longer viewed as a collection of separate transport modes, mobility is increasingly understood as a connected system designed to help people and goods reach their destination in the most effective way possible. The emphasis is shifting from the vehicle to the journey, from ownership to access, and from fragmented networks to seamless, integrated mobility ecosystems.

Technology will be a powerful enabler of this transformation. Advances in artificial intelligence, automation, digital twins, predictive analytics and connectivity will help transport networks become more seamless, efficient and responsive. These technologies are already powering increased performance and asset lifecycles of transport systems. And while there is a belief that progress will be incremental over the next few years, those interviewed also believe that the transformations we will see by 2050 will be grounded in the advancements of technologies already emerging today.

The keys to progress

Yet the research also makes clear that technology alone is not the answer. Progress depends on collaboration between governments, operators, infrastructure providers and technology partners, as well as long-term investment in public transport and the policies needed to facilitate modal shift. Questions around the regulation of new AI powered technologies and the increasing need for data sovereignty and security will determine the rate of change.

Rail will play a central role in this transition. As one of the most sustainable forms of mass transport, rail already provides the backbone for many of the world's mobility systems. Looking ahead, its importance will only increase as cities seek to reduce congestion, lower emissions and support growing populations. Combined with other transport modes in integrated networks, rail has the potential to transform how people move while helping societies meet both their economic and environmental objectives.

At Hitachi Rail, we believe the future of mobility is about moving more people and goods, more sustainably, more efficiently and more intelligently. It is about creating resilient transport systems that can withstand climate pressures, adapt to geopolitical uncertainty and improve quality of life for communities around the world. The future of mobility is also not about individual modes operating in isolation. It is about orchestrating entire mobility ecosystems, where rail, road, active travel and emerging technologies work together to provide seamless journeys and better outcomes for passengers, cities and society.

This report brings together the insights of leaders at the forefront of that transformation. Their perspectives offer both optimism and realism: optimism in the potential of technology and innovation to reshape mobility, and realism about the governance, investment, resilience and collaboration required to make that vision a reality.

While the technologies, policies and pathways may differ around the world, the direction of travel is clear. The future of mobility is connected, intelligent and sustainable.

Giuseppe Marino
Group CEO, Hitachi Rail

Executive Summary

Mobility is being redefined

The future of mobility will not be determined by technology alone

To understand how transport systems may evolve towards 2050, Hitachi Rail convened leaders from across the global mobility ecosystem, including transport operators, infrastructure organizations, technology companies, academics, policymakers and industry bodies across North America, Europe and Asia. Their perspectives point to a clear conclusion: mobility is shifting from a collection of transport modes to an integrated system designed around the passenger journey.

While artificial intelligence, automation and connected infrastructure will play a critical role, the greatest challenge is not technological. Success will depend on the ability to connect infrastructure, data, operations and people into a seamless, resilient and trusted mobility ecosystem.

Five Key Findings

1. **Mobility is shifting from modes to systems**
   The future of mobility is not about individual transport modes. It is system-led. Users will increasingly judge transport by the quality of the overall journey rather than the performance of any individual mode.

2. **Rail to forge the backbone of future mobility**
   Despite rapid advances in autonomous vehicles and new mobility services, rail remains uniquely positioned to move large numbers of people and goods efficiently and sustainably. Leaders consistently view rail as the foundation of future integrated transport systems.

3. **AI's greatest impact will be operational**
   The most immediate value from AI will not come from passenger-facing applications, but from improving network performance. Predictive maintenance, asset monitoring, traffic management, scheduling and energy optimization are expected to deliver the greatest benefits over the next decade.

4. **Digital Twins and Physical AI are emerging as transformative technologies**
   Leaders see digital twins and Physical AI as critical enablers of future mobility. Together, they create the ability to model, predict and optimize transport systems in near real time, enabling operators to move from reactive management towards continuous optimization.

5. **Technology is advancing faster than the systems that govern it**
   Funding constraints, fragmented governance, increasing infrastructure pressure, procurement complexity, regulation and data sovereignty concerns are widely viewed as bigger barriers to progress than technology itself. The future of mobility will depend as much on institutional transformation as digital innovation.

What Is Changing?

Passenger expectations	Technology	External pressures
Seamless journeys	AI-powered operations and autonomous systems	Climate change and rapid urbanization
Real-time information	Digital twins and physical AI	Unmanaged data, unnecessary downtime (cost to cities)
Personalized travel experiences	Connected infrastructure and V2X networks (real time data sharing with surrounding network)	Growing demand for resilient infrastructure

What Will Enable Progress?	What Could Slow Progress?
→ Greater integration between transport modes	→ Fragmented governance structures
→ Connected and interoperable data environments	→ Increasing infrastructure pressure
→ Expansion and modernization of public transport	→ Funding constraints
→ Deployment of AI, automation and digital twins	→ Slow procurement cycles
→ Collaboration between governments, operators and technology providers	→ Regulatory uncertainty
→ Long-term investment in resilient infrastructure	→ Cybersecurity risks
	→ Data sovereignty concerns
	→ Public trust and adoption challenges

Looking Towards 2050

The leaders interviewed share an optimistic vision of mobility that is more connected, intelligent, sustainable and responsive to individual needs. Yet achieving that future is not inevitable. The organizations that succeed will be those capable of integrating technology, infrastructure and people into a single operating ecosystem that delivers better outcomes for passengers, cities and society.

The Hitachi Rail perspective

The future of mobility will not be won by individual technologies. It will be shaped by the ability to connect infrastructure, operational intelligence and passenger experience across entire transport ecosystems. Rail will remain the backbone of this transition, supported by the digital innovation and transformation that will make mobility more resilient, sustainable and integrated. The challenge ahead is not simply to build smarter assets, but to create the smarter systems that can increase the capacity, integration and performance of the transport network, while reducing operational costs.

THE RESEARCH FINDINGS

Mobility today: change, trends and digital transformation

For many of the contributors to this study, mobility's core purpose hasn't changed. People travel to reach work, shops, services and the people they care about. What's changing is how passengers expect to get there: journeys that are more digital, integrated and flexible, with less effort spent managing each step along the way. And for operators, the focus is shifting to how to optimize existing infrastructure while laying the foundations of the more integrated, seamless journey that the passenger now expects. This shift in expectations is starting to redefine what mobility actually means.

Mobility is being redefined from a mode to a system. Those interviewed consistently reframed what mobility actually means. It is no longer defined by the vehicle or the mode, it is defined by the outcome; enabling people to reach the things that matter in their lives, whether that's work, connecting with other people, or leisure.

There is a perceived shift away from fragmented mode-centric thinking toward integrated, multimodal systems, where rail, road, and on-demand services form a single joined-up journey rather than competing networks.
But no one owns the whole journey. Operators, regulators, and governments each control a piece, and none has the mandate to connect them all.

> "Whether it's active travel, whether it's shipping, aviation, roads, rail, it doesn't really matter what the transport mode is. If you have an integrated system where people can go from one point to the other and connect easily, that for me is the vision of the future. I think we need to get to a position where we think of ourselves as Team Transport as opposed to, 'we're rail, you're aviation, you're shipping'. We should all be working together about how we integrate. And too often we don't do it."
>
> **Darren Caplan, Chief Executive, Railway Industry Association**

The many faces of mobility are broad and different

01. Mobility as reaching destinations and enabling daily life

Considering the real purpose of mobility, it's not about traveling. It's always about reaching our destination to do something at, to do some activities, meeting friends and going shopping, going to work."

Professor Johannes Schlaich, Berlin University of Applied Science

02. Mobility as freedom and access

Freedom because then you can get in your car and go someplace. [...] It gives us freedom to work, to live in places that we might not otherwise be able to."

Technology Company, USA

03. Mobility as convenience and efficiency

On a mobility, or let's say at an individual level, it's been mostly about convenience, efficient trips from A to B."

Policy Institute, Germany

04. Mobility as connected, end-to-end journeys

An ideal transport system, a mobility system, is looking at origin-destination pairs of the traveling public and providing that end-to-end journey."

Professor Clive Roberts, Executive Dean for sciences, Durham University

05. Mobility as an interconnected ecosystem

It doesn't matter if it's a car, an aircraft, or a train, whatever is the case that is helping you to transport something. [...] No matter what they have to be [...] they are living in an ecosystem."

Technology Company, USA

06. Mobility as equity and collective responsibility

To me as a transportation planner, I'm always concerned about the issue of equitable transportation to all people. Transportation, whether digital or non-digital, should prioritize equitable access."

Academic Institution, USA

Leaders are clear that while we are experiencing a period of digital transformation, progress and expectations are uneven.

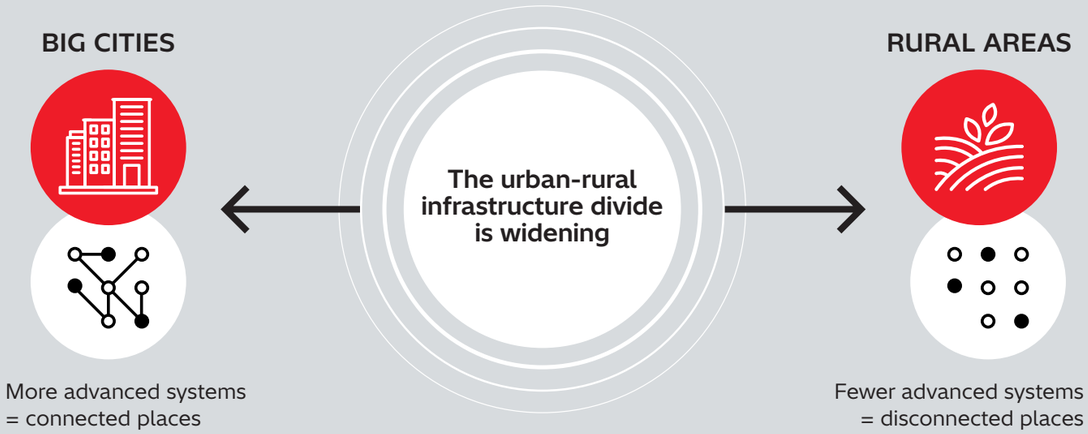
What we don't do, somewhat bizarrely, when we design mobility systems at the moment is decide where people really want to go. We consider the transport system to be a fixed thing. [...] From a traveling passenger point of view, you probably shouldn't really care how you make your journey. It's about how you make the optimal journey. And whatever you consider the optimum to be, whether that's time or cost or how busy the service is going to be, all of those sorts of things."

Clive Roberts, Executive Dean in the Faculty of Science, Durham University

In the mobility sector, AI progress is shifting management from isolated route planning to dynamic, system-wide optimization of urban networks, public transit fleets, and autonomous transit infrastructure. Operations and asset maintenance are evolving through computer vision and edge analytics, enabling organizations ... to conduct automated track inspections, identify defect risks, and schedule zero-downtime repairs. As autonomous mobility scales, foundational geospatial models continuously synthesize floating vehicle data to manage congestion, optimize curb space, and automate fleet health monitoring."

Kiran Srirama, EMEA CTO for Manufacturing and Industry, Google

Passenger expectations are evolving faster than the operators that serve them	The world is moving at different speeds
People now judge transport by the same standard as retail and consumer products – instant, personalized and seamless	Asia-Pacific adopting technological innovation quickly; Middle East investing fast; Europe has strong rail but slow procurement; the US remains car-dominated
Real-time information and through-ticketing* are still not universal	Within countries, the urban-rural infrastructure divide is widening. Advanced systems are concentrating in big cities, but the gap between connected and unconnected places is growing



Buying a single ticket that covers an entire journey across multiple operators or modes

> **There is already a massive divide, and it will be a growing, even bigger divide – between rural and metropolitan areas. Integration will absolutely happen in metropolitan and suburban areas, but it will fall flat for rural as it's still going to be really expensive provision for the public purse."**
>
> **Luisa Moisio, Director of Research, RSSB**

The gap isn't only about who and where – it's also built into the technology underneath where it is advancing, but unevenly

AI is delivering tangible benefits across transport, particularly in predictive maintenance, while the potential of digital twins is becoming clearer, albeit in largely mode-specific applications. However, progress is being constrained by fragmented data, with information often siloed across operators, jurisdictions and systems.

At the same time, edge computing is increasingly being adopted for real-time operational decision-making, with cloud platforms used more selectively for non-critical analytics. Legacy infrastructure continues to slow digital transformation across rail, where many operators are struggling to turn large volumes of data into actionable insights. Meanwhile, growing connectivity is increasing cybersecurity risks, which are evolving faster than the frameworks designed to manage them.

We are already seeing substantial advancements in predictive maintenance, and this is set to accelerate

Predictive maintenance and the digital asset management of transport systems has leveraged AI in the past few years to begin to enhance the lifecycle and efficiency of railway assets. For the maintenance of rail rolling stock, digital twins are increasingly anticipated to play a key role in enabling real-time comparisons between expected and actual performance to help pinpoint emerging issues. Substantial advances have already been made in the past few years with the application of digital twins in digital asset management, and this is expected to grow further in importance.

How AI is transforming predictive maintenance

In 2024, Hitachi Rail launched HMAX, its digital asset management platform, which integrates data from assets across the railway system including trains, signaling and infrastructure. Powered by advanced analytics and AI, HMAX enables operators to anticipate faults, optimize maintenance and unlock system-level performance gains. For example:

Copenhagen Metro × Hitachi Rail

- HMAX supports highly reliable urban rail operations through AI and data analytics.
- Continuous monitoring of rolling stock and track conditions enables a shift from time-based maintenance to condition-based maintenance.
- The Copenhagen Metro operates as a fully automated railway (GoA4), carrying approximately 330,000 passengers per day while maintaining over 99% punctuality.
- HMAX contributes to maintenance optimization, operational efficiency, and improved lifecycle performance of key assets.

Great Western Railway (GWR) × Hitachi Rail

- HMAX Mobility delivers condition monitoring and predictive maintenance for rolling stock fleets.
- Sensors and AI continuously monitor vehicle conditions, helping to improve fleet reliability and maintenance effectiveness.
- The solution is deployed across Class 800 and 802 fleets, covering 3,396 wheels, 970 traction motors, and 950 gearboxes.
- Reported benefits include reduced maintenance activities and spare parts inventory, improved operational efficiency, and extended asset availability.

There's so much expertise that often isn't captured in transportation networks. And I think, at least from my vantage point, that generative AI is going to be really useful in aggregating those insights, synthesizing them, and creating actionable items out of them."

Ronnie Chatterji, Chief Economist, OpenAI

The Hitachi Rail perspective

Success for rail is now system-wide performance: smarter, faster and more predictive.

Hitachi is leading investment in the convergence of information technology and operational technology.

Our next-generation digital asset management platform, HMAX, integrates data from assets across the railway system including trains, signaling and infrastructure. Powered by advanced analytics and AI, HMAX enables operators to anticipate faults, optimize maintenance and unlock system-level performance gains.

Digital transformation is not just about technology. It requires data trust, interoperability and human capital – digital adoption that creates value across the ecosystem.

The next phase of mobility will be defined by the convergence of infrastructure, operations, data and AI. This is where Hitachi Rail is uniquely positioned. Through partnerships with technology leaders such as NVIDIA, Google Cloud and Microsoft, we are accelerating the deployment of AI and digital innovation across mobility systems.

And in the longer term? 2050 vision

The vision for 2050 from the leaders interviewed for this study, is rooted in technologies already emerging today, with automation and integrated systems dominating transport.

Mobility hyper-personalized and built around the passenger

Technology will understand individual needs and preferences – preferred routes, willingness to trade time for sustainability, and real-time re-routing during disruptions.

Technology will understand your particular needs and be capable of giving solutions to your particular needs. Much more personalized information."

Julio Gomez-Pomar Rodriguez, Chairman, IE Center for Transport Economics & Infrastructure Management

It's going to be user-defined. Certain people might say I'm willing to spend an extra 5 minutes if it brings my carbon footprint down. You can imagine toggling those preferences. The sophistication underneath is at the user's discretion."

Technology Company, USA

Seamless multi-modal transportation will bring the destination rather than the mode into focus

V2X-enabled infrastructure – physical and digital equipment that can communicate directly with its surroundings and users, e.g. passengers, vehicles and traffic management systems – is expected to transform roads into dynamic, responsive traffic systems.

— Infrastructure is envisaged as becoming continuously communicative, with vehicles, roadside assets, traffic signals and control systems exchanging data in real time, through V2V (vehicle-to-vehicle), V2I (vehicle-to-infrastructure) and wider V2X (vehicle-to-everything) connectivity technologies.

— Roads and infrastructure are expected to become more dynamic, coordinating traffic flows in real time and managing a mix of autonomous and human-driven vehicles more efficiently.

In the future, buses could get an automatic warning when another vehicle is about to run a red light. That kind of technology could be a game changer for road safety, by preventing crashes before they happen."

Kevin Quinn, CEO, TransLink

It will be multimodal, right? It will be collaboration between not only railway but with other mode of transportation like automotives, so that each different mode of transportation will collaborate... to optimize things to make it more convenient to the people."

Chiharu Watari, Executive Vice President, JR East

Autonomy will be embedded in mobility by 2050

Digital transformation and autonomy is expected to reshape both road and rail but not erase the need for mass transport. The clearest disruption is likely in lower-demand bus services, where on-demand autonomous vehicles are seen by some as a more efficient and cost-effective alternative.

Rail remains the indispensable backbone

Despite the rise of autonomous vehicles, leaders underline that metro and rail systems remain essential for high-capacity urban mobility – a capability that no autonomous vehicle network can replicate.

We'll still use rail as our most efficient backbone. The metro system can transport 50,000 passengers per hour on 4-meter width – that's not possible with autonomous vehicles."

Professor Johannes Schlaich, Berlin University

Rail itself will continue to increasingly be autonomous; be it freight transport or high-capacity metro lines. In line with these developments, greater emphasis and investment will be required in cyber security measures.

A driverless metro line requires very high standards of cybersecurity – the digital revolution is strongly impacting this, both on the side of security and normal operation."

Professor Chiaia, CEO, INFRA.TO

Mobility's impact will also extend to where cities grow and how goods move

Leaders suggest that the location of well-connected transport areas will influence where people choose to live and work. Transit-oriented development is already a focus in some cities, and the expectation is that this relationship is likely to strengthen further.

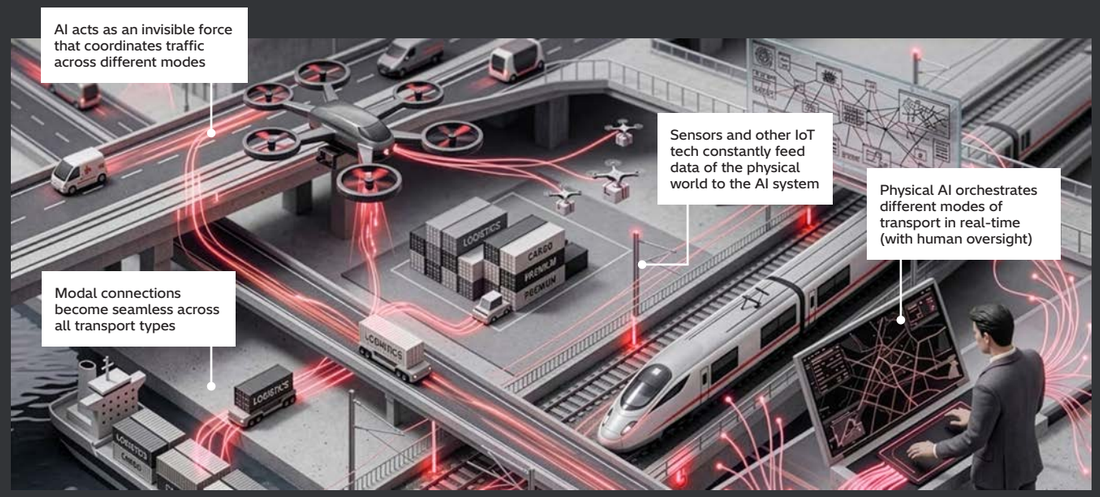
Freight transformed by end-to-end visibility

Alongside the transformation of mobility for passengers, leaders also envision freight journeys becoming far simpler; with the expectation that customs, multi-modal routes, and handoffs across borders can happen more easily. AI and agentic systems will enable real-time flow management, allowing freight operators to dynamically reroute based on conditions anywhere in the supply chain. Electrified and digitally coupled systems could also improve the speed, reliability and traceability of goods movements, while enabling more automated operations.

[Electrification] coupled with innovation also will allow [freight wagons] to automatically decouple and especially it will bring electrical (and data) connection across all the wagons. Today there is no electricity [...] and this will allow freight trains that could run at higher speed, with standardized devices powered and connected for predictive maintenance and good traceability."

Giorgio Travaini, Executive Director, Europe's Rail

Leaders believe transport will converge into a closed-loop system that senses, predicts and adapts across all modes in real time



Innovation leaders expect major AI and technology advances by 2050, with AI-enhanced digital twins enabling more connected, closed-loop systems

Now / 2026

- AI is already transforming activities, especially in operations and experimentation.
- Physical AI is already in use for design simulation and early operational applications.

2030

- Mostly incremental progress – targeted pilots and use cases such as predictive maintenance, rather than system-wide transformation.

By 2035–2040

- Autonomous driving is expected to become more common, including greater use of autonomous capabilities in mass transit across more regions.

Next 2-4 years

- Test operations for autonomous vehicles are expected to increase in more regions.
- AI-enabled research and simulation using Physical AI are expected to speed up innovation.

By 2050

- AI-enhanced digital twins are expected to improve significantly, especially in their ability to integrate multiple data sources.
- Leaders describe a more fully connected, closed-loop system, where AI plays a central role in automation, predictive maintenance, and MaaS services.

How will we get there?

When pressed on the ‘how’, the leaders interviewed for this study focused on the importance of digital twins and Physical AI, autonomous technologies, and Mobility as a Service, as the pillars that will drive the transformation of mobility.

What is a digital twin for transportation?

A digital twin is a virtual representation of a physical asset, system or transport network that is continuously updated using real-world data from sensors, operational systems and connected devices. It allows operators to monitor performance, simulate scenarios and predict potential issues before they occur.

Digital twins were cited by many as the technology that could be most useful to achieve their vision for 2050 because planning for this future demands the ability to model scenarios, simulate options, and sharpen investment decisions.

> **You’re talking about route optimization, about creating digital twins to proactively predict any issues that might keep the rail down. The more you optimize the route, the less resources you consume, and that compounding effect by itself is going to affect the industry dramatically.”**

Dayan Rodriguez, Corporate Vice President, Manufacturing and Mobility, Microsoft

> **(digital twins)... lowers the cost of experimentation because you’re able to test things that you otherwise have to do in the physical environment in a virtual environment... lowering the cost of experimentation allows organizations to make more bets, validate these bets, and then choose a path with a more informed point of view. This is where I think the digital twins idea is going to have a lot of applications.”**

Ronnie Chatterji, Chief Economist, OpenAI

> **The next transportation revolution connects intelligent vehicles with intelligent infrastructure – creating networks that sense, reason and adapt. Hitachi Rail is using NVIDIA’s three-computer solution across AI infrastructure, digital twins and accelerated computing at the edge, so live operational data improves AI models, helping predict failures, reduce disruptions and optimize railway performance over time.”**

Deepu Talla, Vice President of Robotics and Edge AI, NVIDIA

What is Physical AI?

Physical AI combines artificial intelligence with sensors, connected assets and autonomous systems to understand and act in the physical world.

Leaders believe Physical AI will play a significant role both in terms of enhancing the application of digital twins and in achieving the closed loop system set out in their 2050 vision. Physical AI is the technology leaders are most excited about.

By interacting with and responding to the physical world through using sensors combined with Edge computing and AI technology, reduces design, simulation and validation cycles dramatically, enabling innovation at a much faster speed. Therefore, respondents believe using Physical AI will increasingly solve the limitations that digital twins face on transport systems. Physical AI is the enabler for powerful digital twins. It allows AI to move from pattern recognition to real-world action and gives digital twins their live operational data. That is where the next major step change in transport technology will come from.

Case study: Applying NVIDIA's Three Computer Model to the railways

To bring the full power of Physical AI to railway systems, Hitachi has combined its own datacenter CPU infrastructure with NVIDIA GPUs, giving railway operators faster and more cost effective access to AI development in railway environments.

The platform is underpinned by Hitachi Rail's proprietary digital twin models of railway networks, simulation environments built from the company's operational technology expertise, which allow AI systems to be trained and validated on simulated data before any deployment on live infrastructure.

With Hitachi, NVIDIA provides libraries, tools, and accelerated edge computing to enable physical AI applications, including Hitachi's trains fitted with NVIDIA IGX Thor™ chips, allowing customers' data models to be further trained using real time data from the live railway network. This creates a virtuous feedback loop helping to optimize railway performance over time.

With its customers, Hitachi Rail is harnessing this technology in an array of ways, from simulating the training of autonomous tram systems, to delivering catenary monitoring inspections in live time (rather than the ten day cycle previously required). These applications of Physical AI underline the powerful transformational capabilities of the technology.

— In rail especially, leaders describe the ability to use Physical AI to predict issues before they disrupt service, rather than waiting for faults to emerge.

— Leaders also point to Physical AI improving route optimization with operational gains in both efficiency and sustainability.

> **Physical AI allows us to design something, simulate how it will operate, and validate it in many environments, at a speed we've never seen before."**
>
> Dayan Rodriguez, Corporate Vice President, Manufacturing and Mobility, Microsoft

However, leaders warn that Physical AI works best when intelligence is built into the wider system, not just individual assets

— System connectivity is key. Smarter individual assets are not enough. The value of AI is only realized when insights can flow across the full system, from sensor to inventory to decision; from insight to action.

— For example, if a sensor detects a potential issue and the digital twin identifies it as a fault in a rail component – that insight only becomes useful if it is connected to systems like inventory management, so operators can see whether the part is available and act on it.

> **The number one requirement from an AI and digital twins is connectivity everywhere."**
>
> Technology Company, USA

On the edge, or in the cloud?

Regarding how data is processed, respondents believe Physical AI needs to process information in situ, on the edge (on trains, sensors, cameras, and signaling equipment), so it can make decisions instantly without relying on a network connection. For detecting and responding to a potential fault in a railway system, for example, the ability to review data in real-time versus a more expensive and labor-intensive process that can take up to ten days in the cloud, provides clear and substantial benefits.

The belief is that both edge and cloud computing will continue to hold relevance though. The edge for fast, real-time decisions, and the cloud for heavier processing, long-term analysis, and improving models over time.

AI powered digital transformation and automation is set to make operations more efficient, resilient and energy-optimized

The vast majority of leaders foresee significantly more automation in manufacturing, maintaining and operating, especially in scheduling of services, traffic management, and real-time control

> **I think particularly when intelligence is embodied in robotics, it can be much more effective on building smarter physical infrastructure for mobility, including unleashing new innovations on the physical side that we can't yet imagine."**
>
> Ronnie Chatterji, Chief Economist, OpenAI

> **How can I use physical AI to manufacture what goes into these vehicles faster? I can design it, simulate how it's going to operate, and validate it in many environments that in the past required driving a vehicle to multiple locations."**
>
> Dayan Rodriguez, Corporate Vice President, Manufacturing and Mobility, Microsoft

Those interviewed also explain that automation enables route and energy optimization by reducing fuel use and tuning energy consumption.

Beyond operational efficiency, leaders also expect automation to ease disruption for passengers.

> **If you think about the end-to-end travel experience in rail, you have the impact on the travelers in all the preparation of the service. I think everything related to travel itself in rail can be highly automated... For example, management of problems, the need to change schedules, or reorganize the travel of every single passenger, given any issues that you have on the infrastructure or during that moment."**
>
> Emanuele Veratti, Partner, Bain

But as autonomous technology is expected to advance across every part of the system, leaders are clear that human judgment will remain essential for safety-critical decisions, emergency override, and passenger reassurance.

> **In the operation center, AI can very quickly detect and assess issues that may affect rail operations. More importantly, it can just as quickly provide data-backed recommendations to the controllers for decision-making. However, for safety and operational-critical decisions, I strongly believe that there is no replacing the human-in-the-loop."**
>
> Ngien Hoon Ping, Group CEO, SMRT Corporation

> **Humans in the loop will matter both for our preferences as consumers and also for regulatory and accountability reasons when it comes to safety. They might be positioned in different parts of the mobility network, but they'll still be really central to the operations and also the trust and accountability factor for sure."**
>
> Ronnie Chatterji, Chief Economist, OpenAI

Electrified Infrastructure

Transport infrastructure is moving towards an electrified, highly efficient future.

In rail particularly, the combination of electrification with digital tools and automation is expected to make infrastructure far more energy efficient.

Over time, that infrastructure is also expected to become increasingly integrated with the energy systems – able not only to consume power, but to store, share, and return it to the grid through V2X models

> **Vehicles will be capable to flow power back to the grid, or vehicle-to-home, or vehicle-to-anything – we call it V2X. So, the vehicle can be a power source itself. That has to be cabled.., it comes down to the infrastructure that is being used."**
>
> Professor Sheldon Williamson, Ontario Tech University

AI unlikely to deliver major carbonization benefits

AI is expected to improve routing and operational decision-making, enable more energy-efficient train operations, and strengthen predictive maintenance and asset management. Together, these changes could reduce inefficiencies and help lower emissions. However, leaders do not see AI alone as enough to deliver the biggest carbonization gains. In their view, the largest reductions will depend more on major infrastructure investment and government-led shifts in travel behavior.

> **Digitization, when it comes to carbonization, is definitely not the biggest impact. It is more of an efficiency thing. The big changes come from how we build infrastructure and how we travel. […] Big infrastructure adjustments towards more transit-oriented, more cycling-friendly. I mean, these are the big impacts."**
>
> Policy Institute, Germany

The passenger experience and Mobility as a Service:

The passenger role in shaping future transport will be broader than ever. Passengers are anticipated to increasingly be system-shaping actors: setting preferences, generating intelligence, informing design, and determining whether innovation earns adoption.

A preference setter:
The future passenger sets their parameters once (time, cost, carbon emissions, accessibility) and expects the system to configure itself around them.

A data contributor:
Making the system smarter.

A co-designer:
The best-designed systems are built with users – what a route feels like at night, where the journey gaps are, etc.

An adoption gatekeeper:
Technology will be adopted because people trust it, in terms of reliability, in how data is used, and genuine convenience

> **Travelers like you and me should experience a seamless journey regardless of whatever technology is used – we should not be hampered. At the end of the day, it's all about the customer."**
>
> Professor Sheldon, Ontario Tech University

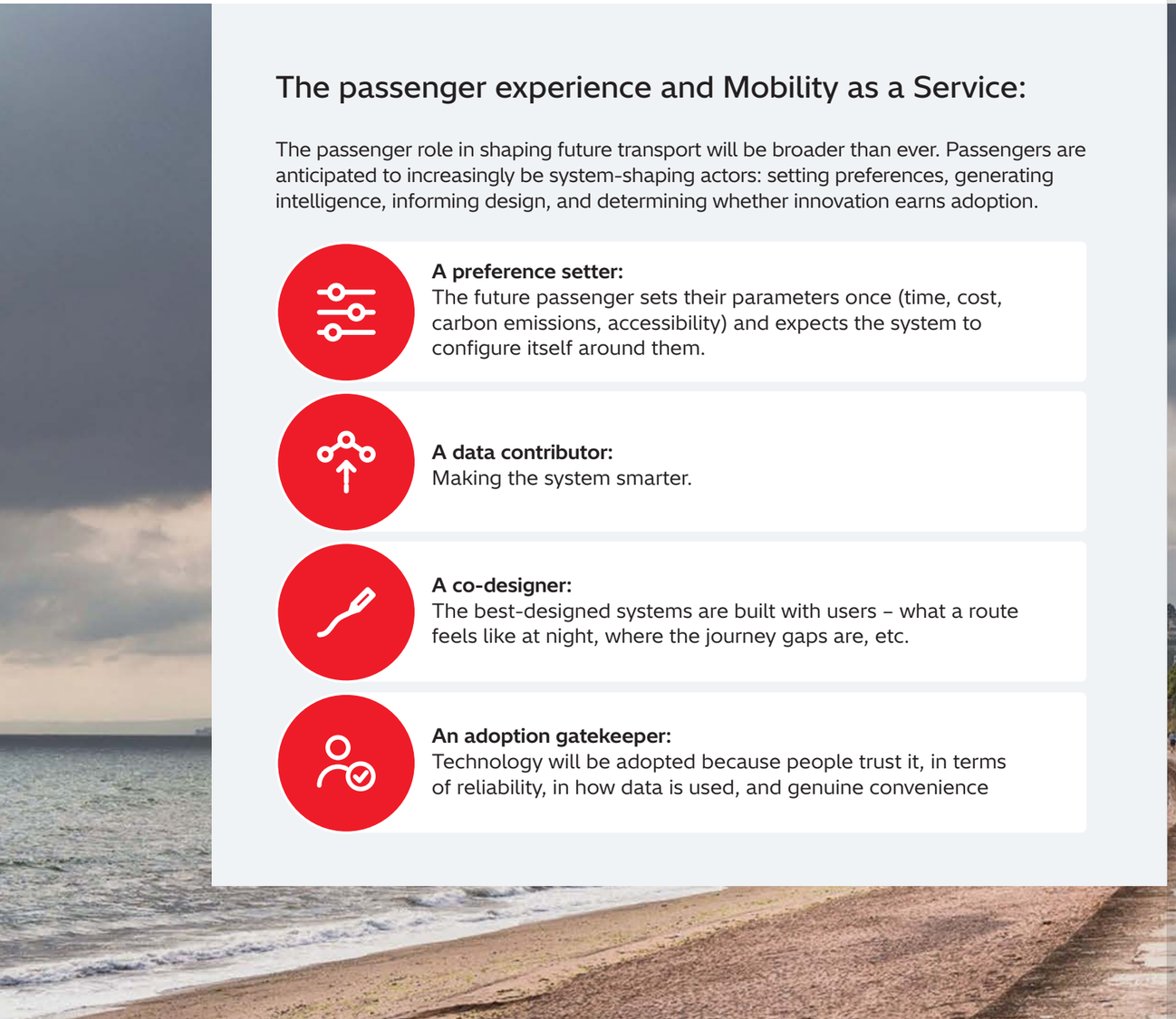
Leaders are skeptical that AI will transform MaaS in the near term, the real impact is likely long-term.

> **My gut feeling is that it won't happen in 2030… the hype is there, but in reality, I don't think it will be."**
>
> Luisa Moisio, Director of Research, RSSB

However, inclusion is at risk of being an afterthought

Innovation leaders warn that digital transformation can exclude as well as enable, and the populations most at risk are growing, not shrinking. The strongest voices agree that inclusion must be a design condition, not a retrofit.

> **Vulnerability is changing and shifting – and that definitely has an impact on the type of transport and the accessibility of that transport. We have an aging population, with increased longevity and comorbidities, and disabilities that we might be growing into rather than born with. So, I think that does set a very different scene for the future."**
>
> Clive Roberts, Executive Dean in the Faculty of Science, Durham University



What dynamics must we navigate to reach the mobility of the future?

Data sovereinty will shape how the 2050 mobility vision is delivered

Respondents believe that growing geopolitical uncertainty is increasing concern around data sovereignty, AI governance and dependence on foreign-owned technology platforms. As mobility becomes more connected, there is greater focus on where data is stored, who controls digital systems, and who holds decision-making authority.

> **The thing at least we're watching most closely is global concerns about sovereign AI and the national strategic importance of someone owning their own AI as a given country. That's where, for example, maybe Europe's a lot less comfortable with American-based systems, or the Chinese have already walled off their ecosystem quite extensively."**
>
> Technology Company, USA

Equally, rising and volatile fuel and energy prices are already affecting transport demand, operating costs and long-term planning decisions.

- For operators, higher costs can quickly affect financial viability.
- For users, increased prices can change the relative attractiveness of different modes, making some forms of transport more appealing than others.

> **The energy prices have gone through the roof. And so, how are we going to manage that? What is the cost implications? Again, balancing our climate goals with operational resilience is really critical. But then again, like diesel prices, our diesel budget is over by $10 million this year because we weren't anticipating a war that was gonna drive up diesel prices."**
>
> Holly Arnold, former CEO, MDOT Maryland, USA

Climate change is increasingly a major test of infrastructure resilience

Climate change is viewed as an immediate operational challenge, but also one that will only have increased in importance by 2050. More frequent and severe weather events are exposing the vulnerability of existing infrastructure, increasing the need for systems that can withstand floods, extreme heat, and disruption.

There is a broad agreement that the expansion of public transport infrastructure will be essential to meeting climate targets, and that continued, large scale investment and public funding will be required to help deliver it.

> **It's kind of fundamental that we look at what the climate is going to look like and design accordingly. Because otherwise, again, when you look at the modern car, the modern car is that climate controlled environment. And if our public transit is not going to keep pace with that, then people are going to choose the car."**
>
> Clive Roberts, Executive Dean in the Faculty of Science, Durham University

> **We need to rethink mobility ...at the global level holistically...in order to fulfill our climate goals as well as to reduce congestion, we need smart mobility solutions."**
>
> Enno Wiebe, Director General, UNIFE

Building long-term resilience to counter instability

Respondents believe that building long-term resilience will depend on stronger infrastructure, more flexible procurement and sustained public trust. Key factors are expected to include:

- Strengthened infrastructure is seen as the most immediate resilience gap.
- Existing networks must be strengthened against climate change through renewal and repair, as well as greater use of predictive maintenance to identify weaknesses early.
- Economic volatility, supply chain and constrained public budgets are all risks to long-term resilience. This points to the need for more adaptive procurement and diversified supply chains.

Many industry leaders also emphasize that public trust is important, particularly as infrastructure becomes more automated over time. This reinforces the continued importance of human oversight in keeping systems credible

The governance required to deliver the 2050 vision

Governance and regulation are seen by industry leaders as a potential pain point in achieving their visions for the future.

AI regulation is necessary, but is also a double-edged sword. Leaders support AI regulation in principle but warn that over-regulation is already raising concerns about investment moving away from Europe. Respondents argued that the most effective regulations are those that build trust and set standards, rather than stifle speed of progress.

Regulation is definitely needed, but European CEOs are saying it is easier to do business in the US – and one of the reasons is the level of regulation they face."

Dayan Rodriguez, Corporate Vice President, Manufacturing and Mobility, Microsoft

Political will and funding remain the biggest bottlenecks. Infrastructure investment cycles are long and politically fragile. Leaders are skeptical that even the most ambitious programs will be delivered at scale.

Data sovereignty is becoming a strategic imperative

Where transport data is stored, who processes it, and which AI engines are used has shifted from a theoretical debate to an urgent operational concern, driven largely by recent geopolitical tensions.

Industry leaders describe this as a very recent change – something that has moved in "months, not years" – as organizations become more aware that control over mobility data means control over sensitive insight into how a country functions. Consequently, addressing data sovereignty is a critical part of creating more integrated data environment where there is little or no data fragmentation.

In this context, data sovereignty is no longer just about storage location: it also extends to IoT data capture, cloud infrastructure, and the AI engines that process and act on that data.

Leaders point to sovereign-by-design data systems as the foundations that will allow innovation to continue regardless of how regulation evolves.

I think that regardless of where the regulation world moves, we can be sure that there's going to be higher and higher priority put on treating data sovereignly and making sure that it stays under the control of certain organizations. I think that any system that can help guarantee data sovereignty while enabling innovation to be built on top of that, that's where I think that's going to be one of the key building blocks to ensuring regulatory compliance. I think the regulatory world is going to be changing rapidly over the next 5, 10 years. But if you have the fundamental building blocks in place to help you regardless of where the regulatory world moves, in other words being able to show that we're doing things safely, securely, responsibly, and keeping data protected, then I think you're in a better place to build from."

Technology Company, USA

The real value of using the data is not the data per se, but the value of the data is when it becomes aggregated. So, we need to find a framework where everybody is comfortable to share the data so that then you can create that value."

Giorgio Travaini, Executive Director, Europe's Rail

In summary

Rail will forge the backbone of future mobility
High-capacity public transport will only increase in importance.

AI's greatest value is operational
The first wave of transformation is happening behind the scenes, notably in predictive maintenance. System optimization and asset management will help to deliver greater transport efficiency and capacity.

Build around journeys, not modes
Integrated mobility will outperform isolated networks.

Resilience is becoming a competitive advantage
Climate and geopolitical uncertainty are reshaping priorities.

Govern data as critical infrastructure
Data sovereignty, cybersecurity and trust will determine adoption.

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