New Mobility Now
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How to use this report
This report is an interactive PDF and is designed to be viewed with Adobe Reader and an Internet connection. The report can also be viewed offline, but any external links will not be accessible.
Introduction

Backdrop

In late 2017, WSP published far-reaching international research into how new and emerging technologies and related services could evolve to meet societal needs—and transform the way we move around, live and interact with each other. The New Mobility Now report captured the findings and explored four aspects of change that are fundamental to future transport and mobility, namely automated, connected, electric, and shared. The report also identified the need for robust business models to define what the transport industry should / could do to be ready for and embrace change.

Today, these automated, connected, electric (now better described as “zero emission” to reflect the widespread move to decarbonize transport) and shared trends continue to shape and influence not only transport technology, but also new and emerging service models that seek to address customer expectations and needs in a highly thought-out manner.

Over the last couple of years, the New Mobility (or Future Mobility in some countries) agenda has gathered pace, with new technologies and service models being deployed and governments (at all levels) as well as the private sector starting to consider what this (r)evolution could mean. For example, in the United Kingdom (UK), the Department for Transport (DfT) published their Future of Mobility: Urban Strategy which outlines a vision for the agenda and nine principles for deployment. In addition, the UK government announced a CAD 152-million (£90-million) fund to establish Future Mobility Zones designed to demonstrate technologies and services at scale.

The intervening two years has also seen significant activity in the New/Future Mobility sector. Activity in the area of automated and autonomous technologies has continued apace, and new shared models of mobility came to market—with the golden thread of digital connectivity and data running through them all. New modes of transport, accessed on-demand and paid for via apps, is widening customer choice as never before. The explosion of so-called micromobility, such as bike hire and electric scooters, has provided alternatives for the first- and last-mile for passengers but has also created a complex situation for governments and public transport authorities concerning how to integrate such solutions with existing systems and infrastructure. As we stated back in 2017, robust and sustainable business models are imperative to the success of New Mobility modes, and care needs to be taken in their planning, implementation and operation.

This Addendum

This addendum explores New/Future Mobility developments across the public transport sector with a focus on bus and rail-based modes. It addresses the potential for new technologies to facilitate customer-centric services, which are responsive to people’s evolving needs, and business models that bring benefits for the public and private sectors. Equally important, the addendum—based on work WSP is doing the world over—presents key challenges and opportunities for agencies, operators, asset / infrastructure owners, asset maintainers, planners and regulators to consider, as well as recommendations for next steps in New Mobility journeys.
To move forward, participants in New Mobility futures must first recognize the changing relationship between the customer and service providers.

Today, in a digitally connected society, customers increasingly expect accurate real-time and predictive information, tailored to their lifestyles and delivered in a way to suit them. They want to be able to purchase digitally, travel when they want, and customize products and services to their own liking; and they rely on engaging and communicating via app, SMS and voice.

The retail sector, followed by banking, has led the way in embracing the instant, always-on relationship with its customers. This expectation of immediacy has not been something that the transport sector has had to contend with on this scale until now; public transport is arguably playing catch-up.

Many of the disruptors in the mobility space, providing new modes and ways to access them, have put the customer at the centre of their thinking—capitalizing upon changing attitudes and needs particularly in younger, tech-savvy urban markets. Going forward, this customer-led perspective will shape the future of mobility and ultimately our communities.

Another driver of technological innovation is the impact of transportation upon the natural environment. With climate change recognized as a crisis, decarbonization efforts, already in the global spotlight, have intensified, adding momentum to the transition to cleaner fuels and operations for transit services, and shining a brighter light on the potential positive outcomes that the electric and shared-mobility aspects could bring.

**The Customer**

When considering the potential of New/Future Mobility in public transport, the customer’s needs are of growing importance. This move toward a more retail-led relationship could conceivably deliver significant benefits in terms of increased public transport usage and associated second-wave network benefits (air quality, congestion etc.). However, the changing needs, aspirations and attitudes of customers require a measured approach:

- **Consider customer segments carefully.**
  The needs of the young, the elderly, and those with visible and invisible special needs are very different.

- **Be agile with your interventions.**
  Customers expect service providers to respond to their needs. How can planners and operators be tuned into those needs and accommodate them accordingly?

- **Understand the problem to be solved.**
  Focus efforts on overcoming real shortcomings in the customer experience, or gaps in mobility, rather than applying innovation for its own sake.

- **Carefully consider the role of technology.**
  Digital technologies are great, but some customers still want the human in the loop; be inclusive.

- **Trust is central.**
  Customers trust transit companies with their personal, payment and travel-habit information; this trust is paramount in the New Mobility world.

- **It’s also about the cross sell.**
  In retail, loyalty and rewards may become part of the mix. Which companies could work best with a public transit offer?

- **Ponder the interface.**
  The evolution from web to app to voice to perhaps even predictive continues; the next generation is already geared to solutions this one does not understand.

- **Think about how the customer can help you.**
  In an always connected age, customers could be your eyes and ears. How can customers become part of your community and help toward smoother running?

- **Take a retail-led approach, but strive for simplicity.**
  Borrow and repurpose the best of the retail sector, and learn from their triumphs and mistakes. Avoid complex bundled offers that obscure the real costs and benefits for customers.
The Case for Public Transport

To date, much of the attention in the New Mobility agenda has been on the highways sector with discussion on the implications for vehicles (and associated services), and with little attention to existing bus networks and services. Similarly, little attention has been given to the implications for rail-based transport, be that urban, inter-urban or long distance.

Bus and rail-based modes are the heart of public transport the world over. Today’s planning should address the potential impacts of new technologies, as well as business models and service models, on existing operations and infrastructure.

In this addendum, we consider “public transport” to be traditional (as opposed to on-demand) forms of publicly available rail (including metro) and bus transport. We do recognize, however, that new modes are emerging, challenging what we generally think of as “public transport”/“public transit”, which may well change over the coming years. Bus services may take the form of smaller more agile vehicles supplementing trunk-haul linear transit. Shared-vehicle services (including potentially autonomous solutions) could provide point-to-point access, and flexible on-demand services could provide alternatives to fixed, planned networks. These services may all fall under the public transport/transit umbrella where the definition could be “access to publicly available assets and services”.

In parallel, a new distinction is emerging between public transport services—generally provided through (and in some cases subsidized by) government funding and intended to be available to all—and new micromobility and shared modes that feature a mix of private- and public-sector funding, but which are all also accessible to those who wish to use them. To date, these are particularly focused on short-range, first- or last-mile trips, effectively filling gaps in the wider public transport services and allowing more diverse mobility patterns to emerge.

New customer-centric models are bringing together the automated, connected, electric and shared aspects of change with the intention that they be mutually reinforcing and ultimately commercially sustainable.

However, some evidence is emerging that new roads-based shared modes are contributing to congestion in cities and in some cases replacing walking, rail and cycling trips with more trips that are essentially car-based. As public and private stakeholders plan, rebuild, repurpose and expand infrastructure to accommodate rising city and urban populations, there are ongoing core considerations: how to reduce network congestion, reduce environmental impacts, support livable communities, and contribute positively to the places served. In this process, it is also imperative not to forget the edge of our towns and cities (the peri-urban or suburban) and rural communities, themselves intrinsically linked with nearby cities and towns, when planning future transport ecosystems. New Mobility services—when carefully planned and applied—could open these diverse markets to new forms of mobility that could help create better places.

Public transport is considered a safe and sustainable solution for moving large numbers of people quickly to and from the heart of cities and dense centres of activity. Well-designed public transport connects communities and has the potential to advance wellbeing. Some transit agencies now consider transport and mobility services to be a basic right and are calling for more sustainable transportation policies that recognize the needs of citizens and the importance of the communities served.

Therefore, focus should be on accessibility, affordability, simplicity, capacity and service punctuality, while deepening our understanding of how passengers experience their journeys and what their needs are. In a world where on-demand, frictionless and personalized service delivery is fast becoming an expectation rather than a nice-to-have, planners and operators should invest in and leverage essential technologies to create attractive systems and services that meet customers’ needs and contribute to the vision and objectives of the places public transport serves. In doing so, all forms of public transport will provide a viable, attractive alternative to sole-occupancy car travel.
Technology Pillars in Public Transport

The pace of technological change is significant; over the last few years there have been major innovations in the public transport/mobility space. These innovations are not only focused on infrastructure and vehicles but also on services, particularly those using highways.

While asset-based innovations are generally longer in gestation, service-based innovations are occurring much more quickly, with some successes in the marketplace, but also with some developments soon superseded. For instance, electric scooters and electric bikes have emerged as attractive options in the shared micromobility market, allowing operators to quickly deploy solutions in cities, even where the business case may appear marginal. Similarly, on-demand, bus-based transit is providing some towns and cities with flexible bus solutions as agile alternatives to traditional fixed transit routes.

This rapidly changing landscape creates a quandary for those planning, investing in and operating our public transport systems, generating key questions to answer.

Which technology trends and innovations are important to consider for today’s business as usual?

Which ones will benefit operations, increase the customer base or improve the customer experience?

What emerging technologies will enable benefits in terms of how users experience public transport systems and how services impact communities?

Here is a snapshot of the ways New Mobility has already affected public transport, and the associated outcomes for the environment and customers:

**Zero Emission**

Hybrid electric, battery electric and hydrogen technologies are resulting in reduced local emissions from road and rail services toward the ultimate goal of zero emission throughout the whole energy chain, from generation of electricity (or hydrogen) to point of use.

**Digital Connectivity**

The digitization of transportation continues, whether it be railway signalling, transit scheduling and monitoring, or digital connectivity for customers when they book, pay and travel.

**Automated and Autonomous**

The trajectory to an autonomous future continues with further investments, pilots and deployments of road-based automated solutions—with advanced digital systems providing rail autonomy in many cities.

**Shared Services**

New service models are enabling agile bus transport as well as increasing the number of potential modes interchanging with traditional bus and rail services. (Car- and bike-sharing are also bringing options for customers.)

**Business Models**

When and how people are accessing public transport is changing. The move from paper-based to smart-card and digital ticketing continues, and Mobility as a Service (MaaS) solutions are providing some customers with the convenience of personalized, on-demand and cashless/on-account transportation.
The sections below explore each of the New Mobility pillars/trends in bus-based and rail-based transit.

**Zero Emission – Decarbonizing Public Transport**

Electrified transport is now playing a high-profile role in moving linear transport toward a zero-emission future. But electrified transport is by no means new.

The world’s first electric train operated in Germany in 1879, closely followed by the first electric tram line operated in Sestroretsk near St. Petersburg, Russia in 1880. The world’s first transit system designed specifically with electric traction was the Liverpool Overhead Railway, opened in 1893. Towns and cities across the world embraced electric traction with longer-distance railways, metros and tramways serving ever-expanding conurbations. Innovation was not just limited to the railways; the world’s first electric vehicle, a six-seater was unveiled in the United States in 1887, though with limited success.

While rail-based modes continued to invest and innovate in electric traction, roads-based systems (except for tramways / streetcars) moved to largely diesel fuels with a shift away only occurring comparatively recently.

The convergence of concerns over air quality and climate change with rapid advancement in electric drivetrain, battery and hydrogen fuel cell technologies has accelerated the decarbonization of public transit over recent years. Development of supporting technologies has facilitated application across multiple transport modes.

Electrified transit has created a host of opportunities to improve efficiency, reduce carbon impacts (particularly at the point of use) and radically re-think the design of transport, toward bringing the benefits of reduced pollution, lower noise, better performance and lower overall cost.

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In the bus realm, electric drivetrain technology is increasingly used, with energy delivered by batteries (BEV – battery electric vehicle) and via a hydrogen fuel cell (HFCEV – hydrogen fuel cell electric vehicle). There are pros and cons to both approaches in terms of supporting energy infrastructure, time to re-fuel, vehicle performance and duty-cycle impacts.

WSP is engaged in projects in North America, South America, Europe, Asia and Africa—developing strategies, procurement frameworks and policy around vehicle adoption and supporting infrastructure. We are leading electric-bus feasibility studies for Halifax Transit and Calgary Transit in Canada and EV charging design for IndyGO (Indianapolis, Indiana); have provided a comprehensive feasibility study for King County Metro Transit (Seattle, Washington), which has the largest fleet order of electric buses in the United States today; and we are developing the Zero Emission Bus Master Plan for Los Angeles County Metro, including planning for modification of its 13 bus divisions, acquisition of more than 2,300 heavy-duty transit buses and deployment planning on the 160-plus routes throughout the massive bus service area, with a goal for completion by 2030.

To help map a zero-emission fleet future, transit operators may benefit from a whole-fleet approach. WSP’s Battery Optimization Lifecycle Tool (Bolt) tool takes such an integrated approach, simulating a transit agency’s entire route system and identifying the routes that can be electrified today, key potential routes for near-term conversion and a recommended path for long-term transition to a zero-emission fleet.

In addition to battery electric and hydrogen fuel cell technologies, the introduction of cleaner fleets may involve biofuels such as biodiesel, biomethane or renewable natural gas, which offer almost carbon neutral solutions. Indeed for years, public transport operators and governing bodies have viewed such biofuels as a “bridge” or interim solution for operators in both developed and developing countries where there is no business case for BEV and HFCEV due to varied factors: insufficient funds or lack of supporting infrastructure for a truly zero emission solution, or because of prior investment in legacy infrastructure and/or a belief there will be insufficient return on new investments in more advanced technologies. For several agencies in California, WSP is comparing the net costs and benefits for investment in a range of options that include biomethane using legacy fueling infrastructure toward a full
transition, as well as investments in battery electric and fuel cell bus fleets and the supporting infrastructure. In the Pacific Northwest, our firm’s experts are comparing costs and benefits of using battery electric buses versus low-sulfur diesel electric hybrid buses as part of our design, engineering and planning work on several bus rapid transit projects.

In the rail domain, electrified railways represent about 25 percent of railway lines globally, with diesel still being the dominant form of propulsion in many areas. In the UK, the government has called for all diesel rolling stock to be removed from the network by 2040—a policy which will spur investment and innovation in the sector. Developments in hybrid, hydrogen and battery trains are all underway with notable examples of commercialization such as Alstom’s Coradia iLint, the world’s first hydrogen-powered train.6 In the UK, rolling stock company Vivarail has repurposed London Underground trains with a variety of propulsion options,7 and train-leasing company Alstom is carrying out train conversions with their Breeze hydrogen-fuelled technology in conjunction with train leasing company Eversholt.8 In the tramway realm, the first battery electric trams are now on test in Birmingham, negotiating the historic core of the city on battery traction, thus eliminating the impacts of overhead lines.9

Such technologies are in their comparative infancy in the rail sector, and while battery and hydrogen fuels can be used for relatively light-duty cycles, short distances, branch lines etc., heavy haul and intercity routes are likely to rely on predominantly alternating current (AC) overhead traction for some time to come.

Elsewhere on rail, recent innovations in bi-mode trains such as the Hitachi Class 800/801/802 in the UK, which have an electric drive train supplemented by diesel technology, allow these electric trains to operate away from electrified areas. While this solution addressed a specific regional challenge, namely an incomplete electrified network, the technology does not address the long-term aspiration of a decarbonized fleet.

Decarbonizing transit systems is not optional; it is an imperative and requires careful multilayered planning. For example, when constructing the future network, consideration must be given to the materials used, which have traditionally been carbon-generating. With respect to electricity generation, there must be a shift to renewables in production, away from high-intensity carbon-heavy sources (such as coal and gas) so that zero emission truly means clean through and through, not just at point of use.

Digital Connectivity

The digitization of transit, be that operations, ticketing or enhancing the customer experience, is continuing apace across all modes.

In highways-based transit, vehicle position monitoring and associated communications are commonplace. For example, in London all buses and routes are covered by digital radio communications providing high-quality voice and data links.10 Such connectivity, including Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I) and intelligent infrastructure technologies, is also finding its way into bus services and other road-based modes. Emerging demand-response bus services, such as Arriva Click in the UK,11 are using data analytics to optimize customer demand, vehicle availability and routing. Numerous operators across the globe are now providing their customers with free WiFi as part of improving their travel experience.

The move toward automated and ultimately autonomous public transit services will capitalize upon the connectivity between vehicles and networks, enabling new forms of on-demand mobility. Investment in so-called Connected Autonomous Vehicle (CAV) technology is significant but largely focused on the small-vehicle market.

Ultimately, CAVs underpinned by digital networks, could allow for a reimagining of the relationship between public transit vehicles and the networks / places / communities they serve, as explored through the WSP-Farrells Making Better Places whitepaper.12 In next-generation connectivity, enabled through 5G and widescale WiFi, the connectivity between networks, vehicles, customers, non-users and the built environment will get ever more complex as data is shared, used and applied continually.
On the railways, digital signalling has been commonplace for decades. The Merseyrail Integrated Electronic Control Centre (IECC) was one of the first deployments in the early 1990s of digital technology in the UK. Thinking has advanced over the last three decades with Network Rail’s Digital Railway Programme driving transformation in how digital technologies can deliver significant operational and customer benefits, such as increased train headways and more accurate and expansive customer information.

Again, digital connectivity for passengers is commonplace through ticketing apps and on-board WiFi, but integration with other transport modes is very limited—this being an area actively perused by those seek to create new business models. (See the Business Models section beginning on page 12.)

Several levels of automation with different standards apply to rail- and roads-based vehicles.

**Roads**

On roads/highways, the SAE International J3016 defines its six levels of driving automation, from no automation (Level 0) to full automation (Level 5). Fully automated (or genuinely autonomous), level 5, driverless technologies remain a reality that is some years away from mainstream adoption, and which in its early stages is likely to be available in very specific environments or operational domains. (“Driverless”, or “Autonomous”, is now used as a shorthand term by the media/press to describe a range of different automation levels, few of which are truly “driver-less”).

Examples of automated road transit in pilot or deployment can be found around the world: In the United States, the spectrum of automated driving

- **Level 0**: Human driver monitors environment and controls vehicle; computer monitors for warning purposes only
- **Level 1**: Computer controls speed or steering only
- **Level 2**: Integrated computer control of speed and steering
- **Level 3**: Computer monitors environment and controls speed and steering with full human backup
- **Level 4**: Computer monitors environment and controls speed and steering with some human backup
- **Level 5**: Computer monitors environment and controls speed and steering with no human backup
automated vehicles in Brooklyn Navy Yards\textsuperscript{15} are operating in public; in Australia, the Armidale Regional Driverless Initiative (ARDi) shuttle bus has been operating in mixed traffic conditions on public roads around a university campus and more recently in the city centre of Armidale, New South Wales;\textsuperscript{16} and in Scotland, Stagecoach has embarked on an ambitious trial of full-size automated vehicles in public service on a full-length route cross the Forth Road Bridge.\textsuperscript{17} As an example of the expectations of autonomous public transit, Dubai, has announced that “by 2030, 25 percent of all transportation trips in Dubai will be smart and driverless”\textsuperscript{18} Such large-scale goals, pilots and trials help drive continued developments in the New Mobility innovation pipeline.

There are some great opportunities to consider automation of buses in relatively more-controlled and lower-speed environments, which can resolve some of the last-mile issues. In addition to this scenario, it is very important to consider use cases in rural areas to unlock long-forgotten markets.

Automation can respond to the rise of on-demand services, especially for suburban and rural areas where there is no economic benefit for frequent services. Operators are now undertaking studies to see how they could integrate automatic buses into their current operations, giving a better reach for their services as well as providing greater connectivity through more feeder services for the main routes.

**Rail**

Automation in the form of driverless trains was pioneered in 1967 on the London Underground’s Victoria Line, with automated operation between stations and an in-train driver responsible for controlling the doors at stops, identifying obstacles along the tracks, and managing emergency conditions. San Francisco’s Bay Area Rapid Transit (BART) system has had built-in Grade 4 capability since the 1970s. Fully automated trains were implemented as far back as 1985 when the Vancouver Sky Train was launched; in 1987, the UK’s Docklands Light Railway system opened with driverless trains—with the unique experience of passengers sitting in seats where the traditional “cab” had been.

Advances in train control over the last 50 years have taken us from semi-automated to fully automated operation, and increasingly automated (and semi-automated) planning and network management. These changes in technology have opened the door to a greater degree of predictability, increased capacity and increased responsiveness to potential delays.

**Enhanced Predictability**

The introduction of automated systems to carry out tasks formerly done by the operator has enabled notable operational improvements: Everything from driving to timetable planning to crew rostering can now be triggered by automated sequences and data flows; the processing of large (route wide) volumes of information can happen in seconds; and the delivery of high-quality, high-integrity outputs is faster.

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**Quick Facts:**

**What is an automated vehicle?**

Vehicle automation refers to the spectrum of driver assistance technologies as defined by the Society of Automotive Engineers’\textsuperscript{1} (SAE) International Standard J3016. The higher the level of automation, the more information the vehicle uses about the driving environment to automate driving tasks.

SAE level 1-3 is relevant today whereby the human driver is required to perform some or all of the driving task(s).

An SAE level 4+ (“autonomous”) vehicle has the most advanced levels of automation. Completely “hands/feet/brain off”, the vehicle navigates, reads its surroundings, and interacts with other vehicles, road users and the road infrastructure.
and at a level of consistency that was previously unattainable in comparable timeframes.

Such operational improvements mean that rail-based transit can be more responsive to customers, as they use accurate real-time and predictive information for in-the-moment travel needs.

**Increased Capacity**

The European Train Control System (ETCS) and Communications-based train control (CBTC) have recently seen a steep rise in the level of implementation. These systems use radio-based communications to transmit driving profiles (speed and braking curves) to the train and present them to the driver on a head-up display. The driver can then use these profiles to drive, keeping the trains as close together as safely permissible, responding to actual operational status. This process is automated and continuous throughout a journey, and in certain installations this automation means no driver interaction is needed.

Examples include the combination of Automatic Train Operation (ATO) and ETCS level 2 into the central core of Thameslink in London and the Sydney Metro Northwest line, a driverless metro line, which began operation using CBTC signalling. In North America, the United States and Canada are embracing CBTC for the next wave of train control upgrades. As part of the modernization of the New York City Subway, the Metropolitan Transport Authority’s upgrade of the Flushing Line is well underway, with CBTC technology being tested in the Queens Boulevard corridor; and, in Canada, the Toronto Transit Commission plans to complete the migration of the existing subway (metro) system to CBTC over the next few years. In addition, several extensions of the Vancouver SkyTrain, which has long incorporated CBTC, are planned over the next decade. In Hong Kong, the Mass Transit Railway Corporation is looking to upgrade its railway systems, and from 2020 onwards trains will begin to operate under the new GoA4-capable CBTC signalling system starting with the Tsuen Wan Line and Island Line. Although the ETCS was pioneered in Europe, it is now being implemented globally as the preferred approach for main line railways, with high-profile applications in Australia, Belgium, China and Denmark, among others.

These technologies enable improved network capacity, as trains can be safely driven closer together allowing more trains per hour. They also give the flexibility to respond to real network status.

Today, European and Asian systems use Grade 4 driverless trains in high-capacity metro-subway operations. Nearly a quarter of the world’s metro systems have at least one fully automated line in operation. If confirmed projects advance to plan, by 2023 full automation will become the mainstream design for greenfield metro lines.19
Increased Responsiveness

Traffic management and regulation systems are being introduced to predict conflict scenarios that potentially lead to delay as well as propose alternate paths or timings to prevent delay. The integration of these systems into train operating company stock and crew management systems enables real-time reactive planning for crew rostering and stock maintenance, functions which have been traditionally manually processed. Through this type of automation, the network can predict, avoid or mitigate potential delays, thus improving the consistency of the service. This responsiveness allows further flexibility for operators to, for example, reduce their total number of assets while still providing the same level or even better service for customers and allowing, in some cases, more work flexibility for drivers and crews.

Traffic management and regulation systems (although not stock and crew at this time) are in service on the Northern, Jubilee, Victoria and Thameslink lines and will be implemented as part of Crossrail in London, HS2 and the East Coast Mainline Upgrade in the UK. These advances, however nuanced the specifics of the network are, all have one thing in common: They are increasing the complexity of the systems we introduce and operate. To help manage this complexity, it is important to develop the right approach to address each situation, implementing solutions that are robust and sustainable using a systems integration approach. Such an approach brings together both the technical and scheduling sides of large-scale projects into a singular and aligned function to deliver desired outcomes.

Automation is the inevitable outcome of increasingly integrated societies where precision and consistency are paramount. Investments in automated and autonomous technologies are significant across all modes of transport, and this trend is expected to continue. Although still in early stages, boats and ferries are also experimenting with automation, showing that the trend is not just limited to cars, buses and trains. While it is clear that there are significant benefits to be realized from a fully and genuinely autonomous transit end state, it is vital that automation is considered within the context of a customer / human centric ecosystem.

Shared Services

New Mobility services are emerging and disrupting the traditional public transit landscape. They can largely be characterized as app-driven, drawing upon a pool of shared assets, which are used by individuals or groups of customers.

These shared services come in many forms. Bikeshare, such as London’s docked Santander Cycle scheme or Portland, Oregon’s Biketown scheme, offers users the flexibility and health benefits of a bike without needing to own one. Uber has recently extended its offer in London with its “Jump” electric bikes but operating on a dock-less (pick up anywhere, drop off anywhere) model. Electric scooter hire is another variant on the so called micromobility model with operators such as Lime and Bird operating in cities across North America, Australia and New Zealand and Europe. Car sharing is rapidly growing too with operations such as Zipcar in London offering per-hour car rental via an app-driven, on-account service, and providing electric and conventional vehicles of all sizes.

These shared mobility models have potential implications for public transport, negatively in terms of abstracting existing customer bases (as has been seen with ride-hailing shared services in various cities) but positively in terms of reducing single-occupancy vehicles. Regulation can be used to minimize the undesirable impacts on the sustainability of mass transit services; but, in addition, public transit needs to evolve to secure its place in the new and evolving hierarchy of transport modes—most likely in this context by seeking to pull its weight in terms of high-capacity, high-frequency services on routes where demand continues to be high. Shared services can be woven into the end-to-end journeys, to underpin and support levels of demand across this entire range.

Business Models

A key trend across mobility and transportation is disruption to the business models that underpin how and when customers plan, buy and execute their travel. The transition from paper tickets to stored value (smartcards) to mobile phone payments has been rapid. In Japan, the Suica smart card was introduced in 2001 and has since grown to allow for purchases at kiosks and stores as well as train tickets. The London-wide transport
payment system, supported by innovative stored value smart Oyster cards\textsuperscript{28} from 2003, has now transitioned almost entirely to a fully contactless payment system that integrates seamlessly, from a customer viewpoint, with the latest bank card and smart phone technologies, for on-demand, best-value fare payments.

With app-based transit allowing for the planning and payment of transit trips, the market is evolving to one where customer information and ticketing live harmoniously side by side. There are countless examples the world over where seamless bus and train information and ticketing exist within the same app. While apps provide a degree of easier access to transit service information and booking, they are by no means the end state. In the UK, start-up Dazzle\textsuperscript{29} is using voice integration with Facebook Messenger and WhatsApp to provide traveller information and ticket purchasing, harnessing the power of payment platforms such as Google Pay and Apple Pay.

Couple these payment solutions with emerging shared services (outlined above) supplementing our traditional public transit networks, and we have a very congested and confusing marketplace with a myriad of apps, payment methods and service offerings.

Mobility as a Service (MaaS) is hailed as the solution to a complex, multichoice mobility market place. Advocates of MaaS promise a future where customers are provided with tailored travel choices (across all available modes) based on their needs at any given time. Best value fares (or charges) are calculated automatically and paid on-account or in some cases paid for by using mobility credits (targeted at certain in-need groups). MaaS promises a future where seamless multimodal access is available to all—potentially offering some users viable alternatives to car ownership.

Investment in the MaaS concept is significant, as is interest by government agencies and transit operators the world over. The transport sector has attracted considerable interest from numerous technology firms focusing on the potential of MaaS as a disruptor.

Finland, arguably the home of the MaaS concept, has a large-scale pilot in Helsinki\textsuperscript{30} operated by MaaSGlobal under the brand name Whim—offering customers “all you can eat” transit for CAD 360 (€249) per month. Whim is also operating in Birmingham, UK, though with a slightly different customer model. Importantly, success in both geographies differs due to dissimilar legislative, commercial and customer environments. In the UK, MaaS featured as one of the core components that the DfT hoped to see in the Future Mobility Zones fund competition.\textsuperscript{31}

Important to remember, though, is that many people only use a single primary mode, and for them the journey to and from their transit stop / station—the first-and-last-mile journey—is sometimes the most problematic. The opportunity to integrate with micromobility providers, such as bikeshare and scooter share, and ride-hailing technology will help.

This realization is reflected in a service resulting from the collaborative effort between Amtrak\textsuperscript{32} (the national US railway operator) and Lyft (an on-demand ride sharing company); the service gives an easily accessible option for the first and last mile. Similarly, BusPlus\textsuperscript{33} in the UK provides add-on bus fares to rail tickets.

Arguably though, for integrated business models (including MaaS) to succeed there needs to be a similar paradigm shift in infrastructure provision to match that in planning and ticketing. Improving integration between new and emerging modes, adding day-to-day utility functions into the mix and providing a cohesive community focus form the vision of a new generation of so-called Mobility Hubs. Mobility Hub thinking provides for seamless lifestyle and transit interchange between modes to really capitalize upon digital technology and new service models. The Dutch Mobipunt\textsuperscript{34} is a transport hub envisaged on the neighbourhood level, where different sustainable and shared transport modes are linked with each other.

Business models could not only impact how we plan, pay for and execute public transport but also how we access it and how public transport is integrated within our communities.
Taking on Challenge and Seizing Opportunity

Though the pace of technological development is often rapid, implementing positive change is generally a transitional process involving a series of well-thought-out decisions that address each community's particular needs. The broad challenge ahead is to know how to plan for change across entire public transport networks. As noted in Decision-Making for Alternative Futures: Exploring System Dynamics to Guide New Mobility Decisions Today, collaborative exploration of the factors that can shape the behaviour and development of transport systems is essential to today's planning. In this way, diverse stakeholders can get their pressing questions about New Mobility answered, achieve a shared vision of their transport system and better understand how to create resilient transport plans—ones that can adapt to meet the current and future needs of our evolving cities and places.

To help understand the diverse factors involved in the transition to New Mobility in public transport, here are some potential challenges and opportunities to consider:

### Challenges

- New Mobility developments provide challenges for public authorities and governments in regulating, coordinating and funding public transport. For example:
  - How can cities compensate for reductions in fuel-excite revenues that will result from the electrification of private vehicles? In some cases, depending on how funding is ring-fenced or utilized, this revenue is used to fund or subsidize the operation of public transit services.
  - Should public authorities take the lead in regulating New Mobility technologies, recognizing that regulation may stifle innovation? Or, should authorities seek to enable these potential new solutions, focusing on measuring outcomes and minimizing unintended consequences?

- To what extent can rail and bus operational regimes accommodate or start to move to on-demand agile service models to maximize the potential of an increased market and reinforce the societal benefits, including the equity aspect of public transit?

- How can we protect and enhance the customer breadth (inclusivity) of public transport as business models and mobility offers become more complex?

- Accommodating more mobility options raises an integration challenge—for city planners, as they consider how these modes fit within existing urban realms and infrastructure, and for rail and bus operators. How can operators manage the integration of New Mobility with the existing transport infrastructure? How can they manage the combination of traditional and automated (and ultimately fully autonomous) public transit vehicles within fleets?

- The interaction between the old and new operational regimes and the development of new skillsets to manage new technologies drive further questions concerning how to manage as well as operate new and emerging elements of safety.
Opportunities

- New technologies and services are encouraging a shift toward a sharper focus on customer needs, providing new user-centric alternatives to private car ownership and use. By identifying and leveraging customer and performance data, operators could better understand needs and plan services in relation to the wider transport network, thus offering greater flexibility and an improved experience.

- Initiatives to help today’s car drivers better understand the “full” trip-by-trip cost of journeys made (including sunk or prior costs) would be expected to encourage a faster pace of behaviour change toward walking, cycling and all forms of public transit and New Mobility.

- Careful steps to plan-in and prioritize capacity and reliability improvements will help to maintain the competitiveness of mass transit relative to private electric vehicles and other mobility services. The most efficient Future Mobility solutions are likely to lean heavily on existing mass transit networks, making improvements within them rather than having to create this capacity elsewhere in the transport network.

- Connectivity and automation would be expected to deliver benefits related to fleet efficiency and optimized use, as well as more efficient maintenance.

- Better analysis of data streams would allow regulators to understand their cities and customers in greater depth, and then respond in more dynamic and beneficial ways. Similarly, cities could have improved ability to prioritize and manage valuable urban space, particularly at the curbside, for dozens of uses that are largely not fulfilled today.

- The move to zero emission/decarbonized fleets could be a catalyst for next-generation fleet facilities, which could be enabled by the sale of redundant assets.

- Beneficial partnerships could improve the use and efficacy of public transport. By engaging more fully with agile small- and medium-sized enterprises and the well-established communications and technology companies, shared delivery models could supplement, augment and “feed” existing public transport services, rather than compete with them.

- As we imagine a more dominant role for public transit in serving our growing cities and less populated areas, automation and on-demand flexibility could open up new potential for operators to serve communities and markets that are underserved (or not served at all) today. “Stationing” automated vehicles in outlying areas to respond to a diverse range of local needs could help link people with others, with jobs and with transit interchanges.

- Buses are a strong candidate for automation, particularly on exclusive transit corridors or in suburban areas where service demand is highly variable. By (re)focusing the driver on tasks oriented directly to customer service or positions in control centres, automated buses could provide an opportunity to reduce the cost of fares or provide additional services for the same budget.
Conclusion

The wide-ranging technological and service changes underway in the public transit sector have great potential to meet the transportation needs in our changing cities. It is important, though, to focus on the potential outcomes for people and communities, rather than the technologies themselves. By working together, public and private stakeholders can, through the use of technology, deliver the infrastructure and services needed to make the lives of those working and travelling on the network better than they are today.

Key Points

- Understand customers, their different needs, and the impacts of technological solutions on their safety and convenience. Emerging technologies and business models must be applied to solve problems for people and benefit the public good.

- Ongoing vigilant effort to mitigate the unintended consequences of the deployment of technology is particularly important when considering the implications for different socio-economic groups and different ages and abilities, and the potential impact on the public transport workforce.

- A multistakeholder approach (across what will be the interlinked mobility, digital and energy sectors) to public transport and mobility planning could help balance needs which may be in tension, and help plan for more robust and resilient networks.

- Though conditions may differ according to context, successful public transport futures, wherever they are, will be shaped by decisions that keep the customer at the centre of actions.

Also important to consider, the success of New Mobility is not a given, and the needs and conditions between different geographies/communities varies greatly. Just because an intervention has worked in one locale does not mean it will be suitable elsewhere. One size does not fit all in New/Future Mobility; but for all cities, regulation will be an important lever to ensure we achieve the best outcomes for people and communities.

A few questions can help guide thinking for those shaping transport futures: Why did an intervention work? What made it successful? What is similar where you are? How might you change its implementation?

Keep in mind that progress comes through continuous improvement rather than one giant step forward. See the next page for five steps that can help today, to direct and guide a plan of action in the transition to a New Mobility future.
**Five Steps Toward New Mobility**

1. **Map your “now” against the zero emission, connected, shared and automated pillars of New Mobility.**
   
   As cities move toward seamless intermodal connectivity, it is best to understand how implementing New Mobility developments, and which ones, will fit into the entire public transport network serving each community. From this holistic perspective, consider the relevance and importance of each New Mobility pillar, your current and intended level of engagement and the urgency for change. A flexible roadmap is essential to ensure the development of resilient networks capable of responding to ongoing end-user needs, with business models that deliver value to the communities they are meant to serve.

2. **Understand the community’s appetite for change by deeply “knowing” the community served by public transport—behaviour, preferences and demographic breakdown.**
   
   (The third aspect can inform the prior two points.) Keep in mind the dynamic nature of the community; new user groups/customers should continually inform your plans. Pilot programs, trial implementations and conducting due diligence are not only key to test concept viability before widespread implementation, they also help to introduce the public to proposed changes and help set realistic expectations regarding the path to realize expected benefits.

3. **Collaborate consciously.**

   Public transport is getting more complex; the mobility, energy and digital sectors are becoming entwined with differing agendas and aspirations. Working together, public and private sector stakeholders will be able to understand how to approach New Mobility options and take practical, near-term steps toward actualizing public transport systems underpinned by New Mobility. True collaboration is central to navigating complexity toward local shared visions for cities and places around the world.

4. **Adapt what exists.**

   In most cases, New Mobility solutions can build upon existing networks; they do not need to replace them. New Mobility developments can catalyze the augmentation, improvement and widening of existing public transport systems and services. What works—the well-established, trusted and successful parts of operations—must be maintained; technology can help increase their efficacy or reach and should not erode them.

5. **Find your springboard for action.**

   This might involve identifying one or more quick wins to reap early success and make a statement about the tone, style and speed of the move toward New Mobility in your context. The springboard might also “hard-wire” plans for Future Mobility with existing policies or development plans where there is already momentum.
Key Contacts

Alec Knowles
Canada
alec.knowles@wsp.com

Desmond Wright
Sweden
desmond.wright@wsp.com

Alex Wan
Asia
alex.wan@wsp.com

Kitty Chiu
United States
kitty.chiu@wsp.com

Giles Perkins
United Kingdom
giles.perkins@wsp.com

Simon Cartwright
Middle East
simon.cartwright@wsp.com

Rachel Skinner
United Kingdom
rachel.skinner@wsp.com

Scott Benjamin
Australia
scott.benjamin@wsp.com
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