

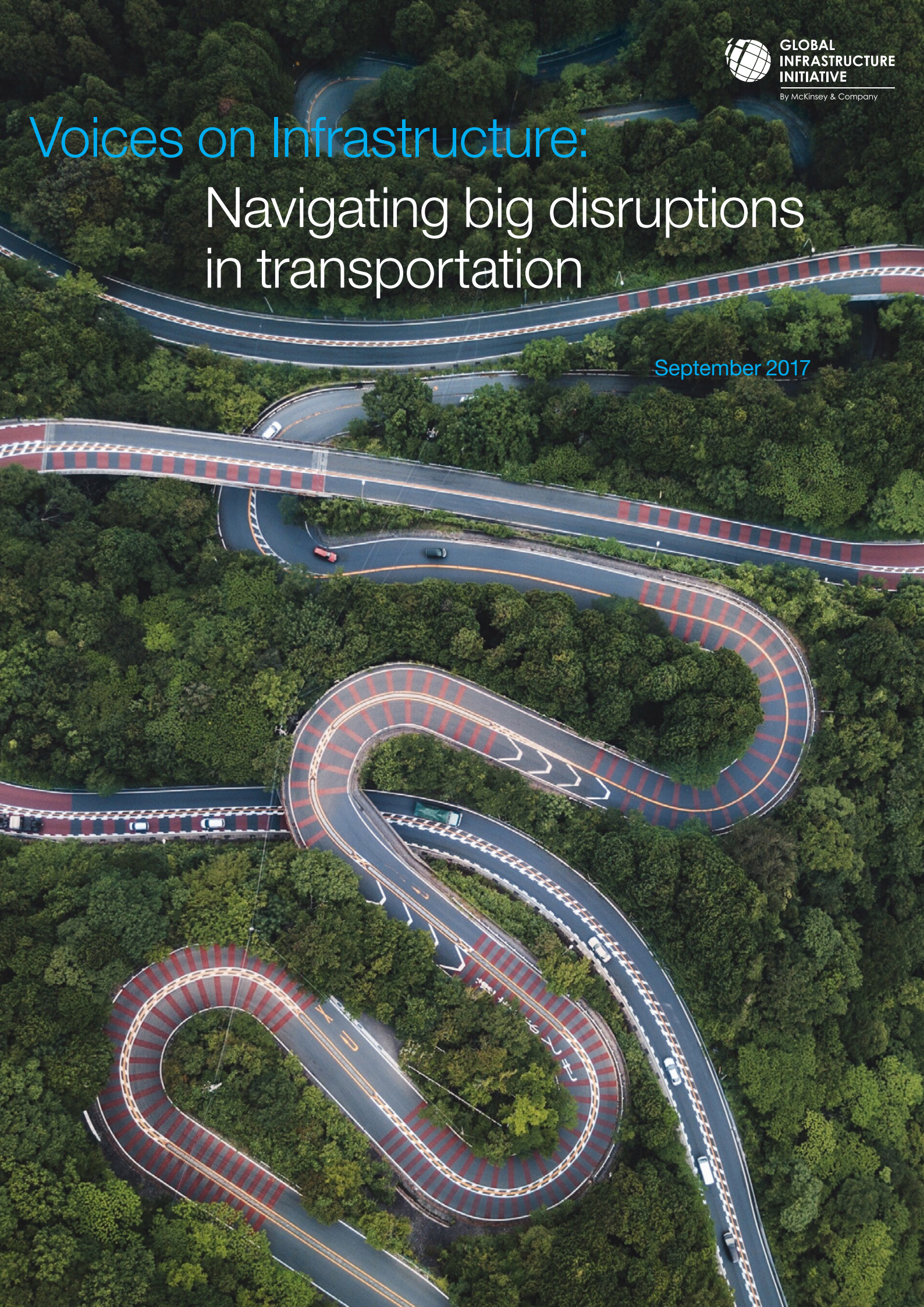


GLOBAL  
INFRASTRUCTURE  
INITIATIVE

By McKinsey & Company

# Voices on Infrastructure: Navigating big disruptions in transportation

September 2017







# Table of contents

03	Introduction
04	News from the Global Infrastructure Initiative
05	Disrupting transportation: We need to think bigger than cars
09	“A physical version of the Internet”: How Hyperloop could be the broadband of transportation
13	The department of transportation of the future
17	Electric road systems: The future of freight transport
21	Redesigning the public transportation experience: London’s contactless card system
26	Infrastructure for the evolution of urban mobility
30	Who’s at the wheel? Changing culture and leadership to support innovation in autonomous vehicles
34	Ports and shipping: The need for solutions that cross lines
41	Videos
	Capital project delivery
	Designing airport customer experience
	Investing in airports’ economic impact



# Introduction: Navigating big disruptions in transportation

Welcome to the September 2017 issue of *Voices on Infrastructure*, a compilation of insights from McKinsey and industry experts on **navigating big disruptions in transportation**.



**Tyler Duvall**

Partner, Washington, DC,  
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Today, our transportation systems are on the cusp of unprecedented change. These articles explore how new technologies are redefining mobility — and what they could mean for society as we sew these advancements into every aspect of our daily lives. These narratives coalesce around three key themes:

First, **our physical transport infrastructure** is seeing the deployment of new sensors that support safety, maintenance, and real-time communication with vehicles of all kinds. These smart technology advancements will redefine how we interact with the infrastructure around us and how we develop the vehicles and pathways that move both people and goods.

Second, **the way we power vehicles** is being transformed. Innovations range from electric vehicles — already increasingly the norm — to even more radical ideas as seen in Sweden. There, officials are experimenting with electrified roads and highways that, if deployed at scale, could dramatically reduce the environmental impacts of freight transport and serve as a model for others around the globe.

Finally, we are seeing **experiments that integrate new infrastructure technologies, new power approaches, and new vehicles** all in one. Hyperloop technology proponents, for example, promise an end-to-end transportation revolution in how we move, what we move, and what we're sitting in when we move.

With disruption playing out simultaneously across all three of these fronts (infrastructure, power, and technology), what are the implications for businesses, households, and governments? In this issue of *Voices*, our authors weigh in on how public-sector authorities, shipping stakeholders, and senior leaders can and must adapt to new, evolving norms. We hope these thoughts illuminate ways in which today's transportation leaders can adopt novel thinking on how to compete, succeed, and thrive. No one knows exactly how the future will play out, but it is clear it will look and operate much differently than it does today. 

# News from the Global Infrastructure Initiative



**Tony Hansen**

Director of the Global Infrastructure Initiative,  
McKinsey & Company

Mobility is central to our economies and essential for our way of life. Every day, billions of people and tons of goods move by road, rail, air, and water. Yet transportation has consequences—congestion, pollution, CO2 emissions, and a massive burden on state budgets to maintain and improve our transportation infrastructure. Due to a wave of new technologies, funding pressures, and an evolution in where and how we live and work, we are experiencing the beginnings of a major shift in mobility. How the future will play out is uncertain, but the implications for all stakeholders will be significant.

In this edition of *Voices*, we focus on how to navigate these major disruptions in transportation. Consistent with this theme, we are hosting a GII Stockholm roundtable on the future of mobility in September. Immediately afterward, we will visit Sweden's two electric road system (ERS) pilots on a [GII innovation site visit \(ISV\)](#). The ERS is a bold initiative by the Swedish Transport Administration (Trafikverket) to explore low-carbon transportation by combining the efficiency of rail with the flexibility of road transport. In this issue of *Voices*, Trafikverket shares their vision for this project and their approach to overcoming challenges faced along the way.

In case you missed it, the **Outcomes report** from our [2017 GII Summit](#) can be found [here](#). GII aspires to stimulate leaders to improve the way we deliver critical infrastructure and get more out of existing assets. Based on the insights shared at the 2017 summit, we believe we are making progress on this mission. We hope that [this report, capturing the summit's best ideas](#), will serve as a guide for the GII community in moving the industry forward. As progress is a collective effort, we encourage our readers to commit to implementing at least one of these ideas before we reconvene at the next GII Summit in Europe in 2018.

Spurred by the recent McKinsey Global Institute report [Reinventing construction through a productivity revolution](#), we will be hosting [GII roundtables](#) on the topic in Johannesburg in September, Paris in October, and Frankfurt in November. These peer-to-peer discussions will explore how digital technologies, collaborative contracts, and better on-site execution can help construction seize [a \\$1.6 trillion opportunity](#) by boosting productivity.

We are excited to announce that we have confirmed November 7–9 as the dates for our [ISV to King Abdullah Economic City \(KAEC\) and Jeddah megaprojects in Saudi Arabia](#). The topic for this ISV will be “Planning, financing, and delivering a new city.” The KAEC executive team will walk participants through what they are doing to keep this \$100 billion megaproject moving, and participants will get a sneak preview of some of Jeddah's most exciting megaprojects under construction. For more details on upcoming events, visit [our website](#) or contact us at [info@giiconnect.com](mailto:info@giiconnect.com).

Our forthcoming December edition of *Voices* will focus on smart cities—turning opportunity into reality. It will feature a fascinating selection of articles, interviews, and videos covering topics ranging from urban cyber resilience to smart utilities. As always, we welcome your thoughts on *Voices*, and we hope you enjoy the September edition. 🌐





Photo courtesy of Siemens

## Disrupting transportation: We need to think bigger than cars

Connectivity could dramatically change the commute of the future.



**Roland Busch**

Chief technology officer and  
managing board member,  
Siemens

*Cities are becoming the switchboards of the globalized economy, and for many people it's exciting to live in them—except for traffic congestion and its emissions. Banning cars is now a frequently considered response, but this option doesn't actually support the development of cities. In fact, there's a much better solution: a transportation system that ensures that all its elements—cars, trains, trams, buses—run as efficiently as possible. Let's start to think systemically, not piece by piece.*

It's Monday morning, 8 a.m. A busy week is starting for millions of workers. But many of them can expect some downtime as soon as they leave home: the daily traffic jam. The number of hours we all spend in traffic jams continues to grow objectively and to annoy us subjectively. London faces acknowledged congestion issues; apparently its citizens are stuck in their cars for an additional 73 hours per year due to congestion.<sup>1</sup> But we all know it's not just London: being stuck in traffic happens to everyone, especially those of us who live in those cities that are growing and thriving the most.

In fact, the problem may get worse. The number of people living on this planet continues to grow; and precisely because of the opportunities cities offer, an ever-increasing number of them will move to urban agglomerations. A case in point: there were 28 megacities in 2014, and this number is expected to grow to 41 by 2030.<sup>2</sup> Traffic density and the demands on road infrastructure will increase accordingly, especially in fast-developing nations. China's fleet of vehicles, for example, has grown by a factor of five over the past decade, from more than 30 million in 2005 to more than 160 million in 2015.<sup>3</sup> And one forecast estimates that in 2017 alone, total vehicle sales in the ten Association of Southeast Asian Nations (ASEAN) countries will grow 8.1 percent.<sup>4</sup> In a joint study with Credo, Siemens estimated the loss of gross domestic product (GDP) in cities worldwide due to their citizens' unproductive commuting hours; the estimate ranges from 8 percent of GDP to nearly 30 percent!<sup>5</sup>

As a result, urban authorities are under pressure to prevent even more congestion. And that pressure is intensifying. In Germany, for instance, some cities find themselves forced to consider a ban of all but the most recent models of diesel-powered cars. At the same time, in Germany and everywhere else around the world, electric and driverless vehicles are being discussed.

But let's be honest: banning cars, especially in developed countries, is unrealistic. Studies have shown that if it's an option, people prefer to travel using their own car.<sup>6</sup> Alternative means of transportation, including biking and public transit, should be part of the transportation future of all countries—but they won't be a total solution to the problem. For example, public transport isn't a viable alternative for many commuters because they don't take them the “last mile”: the last stretch between the public transportation stop and home.

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1 INRIX global traffic scorecard, INRIX, February 2017.

2 *The metropolitan century: Understanding urbanisation and its consequences*, Organisation of Economic Co-operation and Development (OECD), February 18, 2015.

3 National Bureau of Statistics China.

4 Simon Roughneen, “Booming Southeast Asian vehicle sales drive urban congestion,” *Financial Times*, May 28, 2017.

5 *The mobility opportunity: Improving public transport to drive economic growth*, Credo and Siemens AG, 2014.

6 Alessandro Innocenti, Patrizia Lattarulo, and Maria Grazia Pazienza, “Car stickiness: Heuristics and biases in travel choice,” *Transport Policy*, volume 25, January 2013.

## A better solution

We need a better solution — and luckily, there is one. It's disruptive because it requires us to shift our perspective a bit: let's stop looking just at cars and how we can reduce their numbers, and let's look instead at the entire system, of which cars are just one part. What if there was a smart infrastructure that connected road, rail, and other modes of transportation in such a way that all of them worked together to serve the mobility needs of the modern urban population?

Let me explain in more detail what I mean by this.

All vehicles — cars, buses, trains, freight vehicles, and so forth — will communicate with the infrastructure, including roads, tracks, and traffic lights, using sensors. Vehicle-to-infrastructure communication will make the city function like a giant computer, with a central operating system that everything flows into. The information obtained in this way, after being compiled and analyzed by a central platform, will help us maintain the flow of and direct traffic intelligently, reduce congestion, and adapt the infrastructure to meet acute requirements. Smart traffic management systems have at least three major benefits. They make public transportation more reliable thanks to traffic prediction; they make it safer because assistance systems back up human reactions; and they make it more flexible because pulsing — for example, in subways — can be shortened during peak hours. They also facilitate intermodal travel, using different means of transportation in combination, which will help cover the “last mile” mentioned above. Only this digital interconnectivity can make the electrification and automation of transportation a practical option and the disruption of transportation a realistic feature of the urban future.

To some, this description may sound too futuristic. In fact, it's not. Technologies that point the way toward this shift of perspective are already up and running. One example: open, cloud-based Internet of Things operating systems exist today, and they allow infrastructure operators to easily connect their assets and perform data analyses without having to develop or invest in the requisite IT infrastructure. Singapore, for example, will be piloting MindSphere from Siemens to become a fully integrated urban ecosystem with a modernized infrastructure, optimized energy management, and transformed industries.

A related solution has made it possible for high-speed trains to run between Madrid and Barcelona with 99.98 percent reliability. It's called predictive maintenance, and it relies on algorithms that analyze the data submitted by the trains. The algorithm detects an anomaly, and a potential malfunction can be detected and prevented before it even occurs. That the trains between Madrid and Barcelona are now so reliable isn't just convenient for travelers, it also means that this rail link can now compete with air transport: more than 60 percent of passengers now choose to take the train.<sup>7</sup>

Yet another tool is the City Performance Tool Air, which also runs on the Siemens operating system for cities. It uses proprietary data on more than 70 transportation, building, and energy technologies to deliver detailed insights into potential CO<sub>2</sub> and air-quality

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<sup>7</sup> Carlos Márquez Daniel, “The AVE turns 25 years and already cost 1,118 euros to each citizen,” [www.elperiodico.com](http://www.elperiodico.com) (in Spanish only), April 20, 2017.



improvements. It also identifies new local jobs that each technology could create if the users were to implement the suggested measures.

### The commute of the future

Instead of sitting in traffic for an hour before starting the workday, the commuter of the future may get in her car on Monday, check the potential routes, and drive in a smooth traffic flow to a nearby train station, where she walks onto a train that departs just one minute later, getting her to work in half the time. In fact, the driving may even be autonomous, guided by a smart infrastructure that tells the car where it can find the fastest and safest route. Another day, she may drive the whole way in the same amount of time, guided on a new route by smart traffic lights. Fewer hours stuck in traffic jams and at public transportation stops means less stress, and relaxed people are more productive. Fewer hours alone in the car or in overcrowded buses and trams also means less CO2 emissions and more time with family and friends.

Governments stand to reap significant financial rewards when they find solutions to intractable transportation problems. McKinsey estimates that cities alone could stand to gain up to \$1.7 trillion per year in 2025 from applications in the area of transportation, public health and safety, resource management, and service delivery.<sup>8</sup> Ultimately, the goal is to ensure that navigating our streets and rail systems is convenient and safe—and that our cities remain exciting places to live. 🌐

Follow Dr. Roland Busch on Twitter at [@BuschRo](https://twitter.com/BuschRo).

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<sup>8</sup> “[Unlocking the Potential of the Internet of Things](#),” McKinsey Global Institute, June 2015.





Photo courtesy of Hyperloop One

## “A physical version of the Internet”: How Hyperloop could be the broadband of transportation

Proponents of the high-speed technology envision an end-to-end revolution in transportation.



**Nick Earle**

SVP of global field operations,  
Hyperloop One

**Initially put forth** by Tesla cofounder Elon Musk in 2013, the Hyperloop is a proposed mode of transportation that would use pressurized pods to move people, goods, and cars at speeds of more than 700 miles per hour through an evacuated tube system. This system would reduce the travel time between Los Angeles and San Francisco to 35 minutes—a journey that currently takes six hours by car.

While the first production system, which could be in Dubai, is a few years from full operation, Hyperloop One—the company developing this technology—has already constructed a 500-meter proof-of-concept test site in Nevada, where it ran a successful test this past May. In this interview with McKinsey, Nick Earle, senior vice president of global field operations at Hyperloop One, discusses the scale of the system’s potential to collapse time and distance, as well as disrupt transportation, commerce, and housing—and the challenges of delivering on these prospects.

**McKinsey:** *Describe the problem that Hyperloop is trying to solve and the opportunity for disruption.*

**Nick Earle:** We spend a significant portion of our lives stuck in transit. And as the population grows, so do problems.

While digitization has dramatically transformed most parts of our lives, public transportation is arguably the biggest exception. Incremental improvements are not enough to solve our current and future transportation problems. We need disruptive innovation that transforms the travel experience to fit the world we live in: more connected, faster, and on demand.

I lived through the thick of the data revolution. Think of how not very long ago paper was the primary way we transported data, point to point telephone lines were the way we carried voice, and passing around physical recordings of a picture or film was the way we transported images. Thanks to digitization we can now do all three on a digital packet-switched network that can handle data, voice, and video transportation at very high speeds simultaneously. That has transformed our lives. Transport today is like human communication 20 years ago—separate slow networks incapable of seamless interoperability.

The peak speed of the Hyperloop will be twice that of today’s fastest bullet train, but our true time savings will be five to six times greater compared with typical high-speed rail, depending on the route, because every journey is nonstop to your destination, and departures are continuous. What’s more, Hyperloop can transport passengers, freight, and cars simultaneously. One of the big lessons of the Internet era was that open interoperability is vital. We’re designing the system to accept any autonomous vehicle (AV) that is summoned to pick people up from their home or office, travel long distances, and then complete the last mile of the journey. AVs and drones could do same-day delivery across vast distances without distributed warehousing. Freight could work the



same way. One investment collapses separate networks into a single, more efficient network. That creates an explosion of productivity and mass disruption of business models.

**McKinsey:** *How does Hyperloop fit into a broader vision for the future of mobility and how we plan and build smart cities?*

**NE:** The world's largest cities grew by scaling their core transportation systems. Chelsea, Fulham, and Highgate used to be satellite towns but are now part of London itself because the expansion of the London Underground enabled people to live in one place and work in another—but it led to problems such as overcrowding, longer commuting times, pollution, and higher housing costs.

When you can travel 500 kilometers in 30 minutes, you can redraw the boundaries of your city. People can live in Leeds, where house prices are much lower, and get to work in Canary Wharf as if they were riding four stops on the tube. You can build greener cities, and you can shift manufacturing plants and warehouses far outside the city, where costs are lower. It would have dramatic effects on the way people work and their quality of life.

The value a Hyperloop system unlocks could give governments the ability to reduce their share of the cost. Consider land value capture: the differences in the cost for land and housing inside and outside the city can be up to ten times. That creates tremendous opportunities for private real estate investment (and a broader tax base) in remote locations, as well as opportunities to build smart cities from scratch, on sites that are not constrained by prior construction. The more you consider the wider economic benefits, the more you realize the significant business opportunities possible—and that attracts both public and private investment.

**McKinsey:** *Aside from the technology needed to make Hyperloop operational, what challenges do you foresee in asking governments and private-sector players to change the way they operate? What are the barriers to pulling Hyperloop off at scale?*

**NE:** First we must prove the technology works and at scale. We're working on that; we've already shown that we can achieve around 200 miles per hour in a 500-meter vacuum tube at our DevLoop test site in Nevada, and we will continue to improve on this. We've shared those results with government officials and private-sector players. We need to partner with early adopters willing to work with us to implement the first operational systems—which we'd like to have done within five years. This undertaking will require funding and construction, as well as regulatory approval, especially around safety.

There is huge value in creating the right regulation for the Hyperloop in parallel with building the systems. In Dubai, we're working with the Roads and Transport Authority to codesign the solution to meet their regulations. They benefit by becoming one of the leading world experts in creating Hyperloop regulatory frameworks, while we benefit from their input on how to design the system. This will also create a significant number of new jobs and high-tech capabilities to help transform their economy.

**McKinsey:** *One of the initial value propositions of Hyperloop was it would be cheaper than building a high-speed rail system. Given the R&D needed, how are you keeping costs down?*

**NE:** Based on the costs we have seen in building our working prototype, we expect capital expenditure per mile to be less than two-thirds that of high-speed rail—and in many cases much less than that. Operational costs will be significantly lower than high-speed rail as we only use motor power for 10 percent of a journey; after that, the vehicle glides in the near vacuum environment for the rest. And with no friction in the system, total lifetime costs, including maintenance, will be much less than that of high-speed rail.

We are also reducing our costs and increasing the speed of our innovation by using a methodology implemented by aerospace manufacturer SpaceX. Instead of working serially, we're working on different components in parallel—integrating them, testing them, tweaking them. We're doing daily iterative loops on that process: designing, building, testing, analyzing data, and then designing the component again. It's a standard methodology for accelerating software delivery; we're using it for both software and hardware.

**McKinsey:** *What is your long-term vision for the impact of Hyperloop?*

**NE:** When you think about the Hyperloop, it starts to look a lot like physical broadband. When the Internet first came out, the industry focused for the first few years on line-speed improvements. With broadband transmission rates now up to 100 gigabits and 4G going to 5G, network operators are focusing more on what new consumer experiences can be created and how they can disrupt business models to gain competitive advantage.

We have the same vision for Hyperloop. We think it will transform the lives of billions of people by giving them back time and convenience; radically disrupt supply chain models by allowing same-day delivery of goods across continents; create a new wave of high-tech companies and skills; and change where we live and where we work, triggering regional transformation in a way we can only imagine.

The fundamental question we should ask is whether we continue investing in incremental improvements on decades-old technologies or whether we embrace the possibilities of moving atoms in the same transformative ways we're now moving bits.

It's going to be an exciting next few years. 

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Photo credit: Getty Images

# The department of transportation of the future

Transportation will be dramatically different in ten years.  
To adapt, public entities and stakeholders must act today.



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**In ten years**, transportation in the United States will look far different than it does now. Already, vehicle-sharing and electrification are widespread; and autonomous vehicles (AVs) and the Internet of Things are poised to make even bigger waves.

Physical infrastructure will evolve to reflect this. For instance, roads could be stacked with lanes dedicated to specific types of traffic, such as commuter cars, commercial vehicles, AVs, and bicycles. Drones will deliver goods to homes and businesses, and the number of charging stations constructed for electric vehicles will surge.

These changes are imminent—and they have sweeping implications for the entities that govern transportation infrastructure. If the face of transportation will change in just a decade, and large transport infrastructure projects can take more than a decade to complete, then departments of transportation (DOTs) have little more than three to five years to adapt. Those DOTs that focus on older travel models will be unprepared to serve new kinds of demand. They will also be slower to convert growing data sets into actionable plans and projects that further support these changing trends. Conversely, those that proactively embrace change have the opportunity to shape the future of transportation as well as urban, suburban, and rural development.

Adjusting to these rapid advances and providing effective, next-generation solutions requires agility and radical innovation. This kind of disruption can challenge the culture of DOTs—many of which are required to focus on compliance and reducing risk, not encouraging experimentation. Furthermore, DOTs rely heavily on their legislatures and stakeholders to deliver on their plans. A lack of support from these stakeholders affects their funding and operating model. These challenges make it difficult to adapt quickly or act decisively to execute broad transformation.

Yet transformation will be necessary for DOTs to deliver safe, reliable, and integrated infrastructure. No blanket solution exists, as each DOT is organized and governed differently. However, we see a shared vision and set of guiding principles that all DOTs can aspire to follow in paving their own path.

### **The current plight of the typical DOT**

While some DOTs are already adapting to impending change, it's possible that some are still primarily focused on meeting their present budgetary needs and securing funding to solve traditional transportation problems such as maintaining highways or building bridges. These DOTs may not have the capacity to invest in new innovation. Similarly, public stakeholders such as metropolitan planning organizations (MPOs) are just as central in the overall planning process as the states and often have different priorities.

One key reason for favoring conventional solutions is that the DOT workforce, although changing, is still heavily dominated by civil engineers. While this talent will always be critical to the success of large civil works organizations, there is always a risk of groupthink when an organization is mostly composed of people with similar training and problem-solving approaches. Additionally, many DOT functions operate in silos.



The life of a project—from planning to finance to engineering to right-of-way and permitting to construction—is excessively linear. Each group manages its own portfolio with too little cross-function integration. The combination of these factors can limit a DOT’s ability to evolve beyond its existing model.

## A road map to the DOT of the future

To acquire the necessary skills and transform its practices, a DOT must implement changes to five core capabilities: strategy, portfolio planning, its resources model, project planning and delivery, and performance measurement.

**1. A strategy that supports funding priorities and enables agility and innovation.** DOTs must work closely with their partners—such as MPOs and local municipalities—to educate and inform the public about the impending changes to the world of transportation. This will serve two purposes: to garner broad support and to instill urgency in public officials to unlock funding for programs needed to propel DOTs through this evolutionary process. DOTs can also partner with other public and private organizations to gather and fund innovative ideas.

One leading DOT created a technology task force to uncover new tools and strategies that would enhance the state’s transportation system while positioning the state as an economic and technological leader. The task force consults with industry experts and leading institutions to identify impactful emerging technologies, while conducting research to build a fact base that informs change.

**2. Portfolio planning that includes scenarios for all potential transportation solutions, not just conventional roads and bridges.** The problem of congestion creates a particularly urgent need for new scenario planning—one that is felt most acutely in cities. This planning is not just about building more roads or wider lanes; it’s about envisioning scenarios that incorporate specific new solutions such as AVs, bicycles, and ride sharing.

DOTs would benefit from an integrated portfolio that allows stakeholders to see, track, and understand all the work being funded, enabling real-time decision making. This portfolio could improve scenario planning, allowing funds to be used more efficiently to find the best solutions to current and future problems. DOTs could also work more closely with their cities and MPO partners to develop a clearer understanding of the city’s overall socioeconomic priorities—bolstering the logistics industry, for example, or preventing suburban flight—and how transportation can inform and achieve those goals.

**3. A resources model that creates the human engine to fuel innovation.** DOTs will have to evolve from a predominantly engineering-focused culture to one that integrates classical engineering, new engineering skills, technology capabilities, general problem solving, and financial acumen. To succeed, they’ll need a talent acquisition and development plan that speaks to a generation of innovators interested in making a positive impact on their communities. Of course, these innovators will still need traditional engineering teams. But DOTs of the future will rely heavily on data scientists that analyze disparate information streams and develop solutions that incorporate AVs and other emerging mobility trends.

They may also create teams of programmers that develop apps to communicate live traffic information to drivers' cars and mobile devices. The key will be for DOTs to provide the right organizational structure that successfully blends new skills with the old to drive fruitful outcomes.

**4. Project planning and delivery that produces effective solutions quickly.** For today's DOTs, delivering on time and within budget is at times simply an exercise in managing contractors and getting plans out the door. Technology will change this process with digital solutions that develop more accurate cost and schedule estimates, incorporate data analytics from hundreds of other similar projects, and codify on-the-ground experience into true organizational knowledge. Digital tools can also monitor equipment and crew efficiency, which in turn will transform contractor management and boost productivity. Embracing these technologies may seem daunting for some of today's DOTs, but those that do so will reap significant value.

While full digital transformation is not yet a reality for many DOTs, some are moving in the right direction. One DOT launched a portfolio and project management initiative that consolidates multiple management systems into one standardized platform. Moving from disparate systems to a single repository of information creates efficiency, accuracy, and transparency that improves the agency's decision-making and forecasting abilities. Such a system can also lay the foundation for future integrated solutions and apps, equipping DOTs to embrace long-term digitization.

**5. Performance measurement that supports the vision.** Performance management today is often too focused on tracking engineering errors, cost overruns, and delays. To support long-term evolution and growth, the sector will need to move away from these metrics and consider the broader goal of a better transportation system. For example, DOTs should be evaluated against the efficacy of their solutions, not the money they disburse, and chief engineers should be rewarded based on their improvements to road networks and other transport solutions. A number of DOTs are already at the forefront of this evolution, but much more needs to be done.

## Looking forward

Today, a United States without interstate highways seems unimaginable—but it was not long ago that DOTs were preparing for and acclimating to nationwide transformation. Radical innovation will be challenging; yet it has been done before, and it can be done again. DOT leaders should acknowledge that the imminent changes to transportation are about to redefine their existing structure and models. They should be visionary, pragmatic, bold, and courageous in the years ahead, and stakeholders must coalesce to support them in their transformation. With these measures firmly in place, DOTs can act today to establish a sturdy foundation for the future. 🌐

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Photo courtesy of Trafikverket

## Electric road systems: The future of freight transport

How electrification is helping Sweden meet its environmental sustainability goals.



**Lena Erixon**

Director general,  
Trafikverket

[According to the Intergovernmental Panel on Climate Change's Fifth Assessment Report](#), the global transport sector is responsible for 23 percent of total energy-related CO2 emissions, 72 percent of which is attributable to road transportation. As part of its climate protection strategy, Sweden has committed to having a transport sector independent of fossil-fuel vehicles by 2030. One potential solution is to implement an electric road system (ERS). In this Q&A, Swedish Transport Administration (Trafikverket) director general Lena Erixon elaborates on the reasoning behind investing in ERS, the challenges along the way, and the future of freight transport.

**McKinsey:** *Why did Sweden invest in the ERS program?*

**Lena Erixon:** A crucial element of a sustainable society is a well-functioning freight transport system, capable of moving goods efficiently, safely, and sustainably. But the fossil fuel–dependent road freight transport systems of today do not fulfill these criteria; these fuels are limited, their availability is not guaranteed indefinitely due to geopolitical concerns, and they have been proven to harm the environment and human health. In Sweden, road traffic accounts for one-third of carbon emissions, one-fourth of which is attributable to heavy-duty freight traffic.<sup>1</sup>

We analyzed Sweden's road freight transport sector from the perspective of the International Energy Agency's Avoid-Shift-Improve policy—that is, urban transport solutions “that allow travel to be ‘avoided’; those that ‘shift’ travel to more efficient modes; and those that ‘improve’ the efficiency of vehicle and fuel technologies.”<sup>2</sup> Viewed through this lens, it became clear that Sweden's road freight transport sector must, to a large degree, focus on the “improve” lever. Road freight traffic is unavoidable (and expected to grow significantly<sup>3</sup>), and the ability to shift to other modes of transport is limited: Sweden's publicly funded road network is 15 times longer than the publicly funded railroad system, and the coastal maritime transport is limited for inland destinations.

We determined that ERSs could be implemented with relatively minor improvements in the road network compared with the major investment that would be needed for completely new infrastructure. And it has the potential to reduce energy use, lower greenhouse gas emissions, and improve air quality.

**McKinsey:** *How did you initiate this program?*

**LE:** As with many other research, innovation, and development projects, the Swedish ERS program began with a dedicated analysis of the existing options, industry players, and maturity of ERS technology. In 2013, Trafikverket together with the Swedish Energy Agency and the Swedish Innovation Agency launched what was, at the time, the largest pre-commercial procurement (PCP) project in Europe. The goal of the project is to

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<sup>1</sup> [National inventory report: Sweden 2017—Greenhouse gas emission inventories 1990–2015](#), Swedish Environmental Protection Agency, 2017.

<sup>2</sup> [“A tale of renewed cities: A policy guide on how to transform cities by improving energy efficiency in urban transport systems.”](#) International Energy Agency, 2013, p. 8.

<sup>3</sup> [Prognosis for freight transports 2040](#), Trafikverket (in Swedish only), April 1, 2016.



generate knowledge, experience, and decision data that is conducive to the creation of a platform for the electrification of larger transport routes in Sweden.

The PCP consisted of different qualification steps, and, over the course of two years, the initial 11 applicants were reduced to the two most viable technologies. The two vendors we chose approached the ERS from different angles—one using an elevated line, and the other using a rail in the roadway—and we embarked on a demonstration project with each. The first electric road for heavy-duty vehicles on public roads was opened just one year later, on June 22, 2016.

**McKinsey:** *How do the two pilot technologies work?*

**LE:** Both technologies allow vehicles to charge as they drive using conductive transfer. One, implemented along a stretch of highway E16 in Sandviken, involves overhead electric lines, and the vehicle connects with these lines using a pantograph. The pantograph can reach the height of the overhead lines and obtain electricity through a collector on the roof. The collector feeds energy to a hybrid electric motor.

The other, implemented as a dedicated lane on Road 893 near Arlanda, charges electric vehicles using a rail in the roadway, connected via a moveable arm under the vehicle. This technology can be accessed by both heavy- and light-duty vehicles.

**McKinsey:** *Based on your experience to date, which are the most promising technologies and why?*

**LE:** Each ERS technology has its own advantages and disadvantages. An ERS based on an overhead line can, to a large degree, use mature overhead lines developed for rail applications. This system also leaves the roadway intact but is limited to heavy-duty vehicles that can attach to the overhead lines. Meanwhile, the road-bound ERS must be installed in the roadway, creating some additional maintenance needs such as surface renewal and snow clearance. However, the advantage is that it can connect with light-duty vehicles as well as heavy-duty ones.

For the road freight transport sector, there are many potential solutions such as biofuels, electrofuels, and various forms of electricity and efficiency improvements. We can't expect one single technology to replace all fossil fuels, thus they all need to exist, develop, and mature in parallel.

**McKinsey:** *How have the ERS pilots managed to navigate regulations and safety requirements?*


**LE:** In Sweden we have been working on Vision Zero—that is, no loss of life is acceptable—for road safety for years. Therefore, safety is essential for the ERS, and one important challenge for the two pilot projects was to construct an ERS within the existing legal

framework. The safety risks have been evaluated by comparing the ERS to similar systems and by explicit risk estimation and testing. It has been important to address each ERS technology—that is, each potential solution—at its current maturity level. This evaluation has resulted in different time schedules and deliverables for each project to ensure a working, safe, and reliable ERS on the public road.

**McKinsey:** *What are the next steps, and where do you see this technology going?*

**LE:** Overall, ERS technology is in its infancy and needs further development to fully mature. In the years to come, we should test and demonstrate these and other ERS technologies in relevant operational environments. Further development and demonstrations could also increase the competition between and within ERS technologies—ultimately leading to better products. Today, each ERS technology could be considered a monopoly with a single technology supplier, which makes public procurement challenging.

The two current demonstration projects are largely focused on ensuring the technology works and that government approvals, regulations, and procedures are in place. An important next step would be to have a project that includes all actors in the value chain, from the freight owners and haulers to technology and service suppliers. Key stakeholders for this to happen are the regional authorities who can establish a commitment from the regional business community and act as hubs for all stakeholders involved. Such a pilot should be at least 20 to 30 kilometers and preferably include a large portion of shuttle-like transport operations with several freight owners, haulers, and original equipment manufacturers.

So in the near term, the focus will be on further developing and maturing the ERS markets. Within 10 years, we will hopefully have some individual and independent commercial or semi-commercial ERS systems in Europe and plans for transnational freight corridors. 

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Photo courtesy of Transport for London

## Redesigning the public transportation experience: London's contactless card system

The journey to a ticket-free transit system—and the path ahead.



**Shashi Verma**

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**Buses, trains, and roads** have long been the staples of passenger mass transport. However, the tasks of measuring their usage and collecting traveler fares have changed dramatically over time. In the mid-19th century, transport authorities around the world began to move away from cash transactions—prompted by the inevitable pilferage that came along with it—by introducing the bell-punch ticket, a strip of paper with holes punched to show how far passengers could travel on a given fare. This simple invention revolutionized the bus industry, and it endures in some places today.

As technology evolved, cities rolled out ticket machines, fare collection gates, metal tokens, and magnetic stripe tickets. The introduction of smart cards in the 1990s further drove costs down and efficiency up. London’s Oyster cards are a prime example; because individual users could decide how many trips to buy at a time, and when to queue up to buy them, lines at peak hours vanished. Boarding speeds on buses improved as users simply had to touch a card on a reader rather than engage in the full cycle of buying a ticket.

But most passengers still need to buy tickets at some point in their journey. And regardless of progress, ticketing remains inefficient, from the perspective of both passengers and operators. Passengers who struggle to find the time to buy tickets ahead of time or keep track of pre-purchased physical tickets may have the option to buy them on board—but the process always includes some sort of transaction. And most public transportation operators end up spending between 10 and 15 percent of their revenue just in collecting fees from passengers in the form of tickets. That’s a huge loss of income—and an unnecessary one.

The advent of pay-as-you-go provoked a profound idea: what if users didn’t have to buy tickets at all? What if we could combine the speed and convenience of smart cards with something passengers already had in their pockets—like bank cards? In 2006, Transport for London (TfL), the public body responsible for organizing all of London’s transport, set out to answer this question. The resulting innovation—a contactless, ticketless card system—is helping to change the face of public transportation in London and offers a model for other cities.

### **Developing a new system**

TfL’s new, ticketless card system means that passengers no longer need to buy tickets in advance or even load transit cards with available funds. They simply tap a credit or debit card on fare collection gates and bus fare card readers, and the fee is automatically subtracted from their account or charged to their card.

Fortunately for Londoners, TfL is a revenue-generating agency that additionally receives direct grants from the government, culminating in an annual budget of \$10.5 billion. And in terms of large infrastructure projects, the \$68 million it cost to research and deploy the new system was minimal—especially because of the model’s promise to reduce operator costs and increase transit efficiency. Having conducted customer surveys before embarking on the project, and with the simultaneous rise of contactless systems in retail environments, TfL knew travelers were likely to embrace the change.

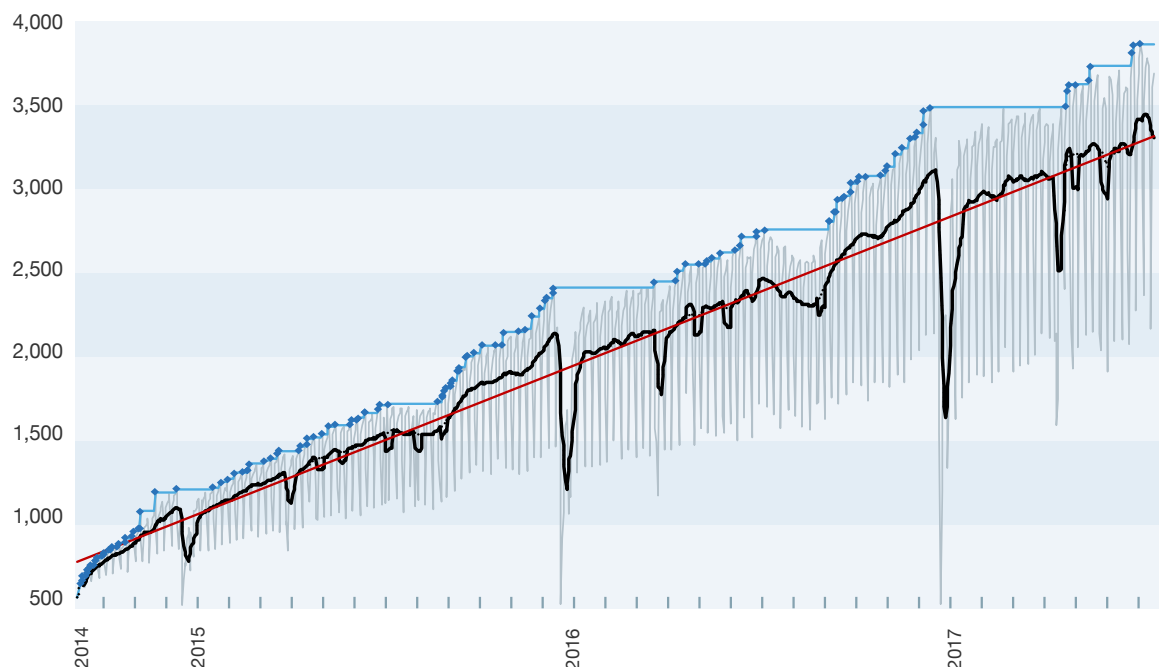


With funding covered, TfL began tackling the many logistical hurdles to implementation. To start, in most financial transactions the amount is known and the transaction consists of a single swipe of a bank card. In transport, very often both the start and end points are needed to determine the fare. In London, with a [system of daily and weekly capping](#), all use within a day or week needs to be assessed together to determine the fare.

## Exhibit 1 Number of transactions per day on all services

— Daily total — Weekly average — Max ◆ Record

Transactions per day, thousands



SOURCE: TfL analysis

Additionally, transactions need to be limited to less than half a second to maintain capacity at gates and keep bus boarding moving smoothly—restricting TfL from using traditional payment verification processes. It became clear that we needed to develop new global standards for transactions.

To overcome these and other challenges, TfL formed key partnerships with our suppliers. For example, we partnered with Cubic Transportation Systems, which developed hardware for the

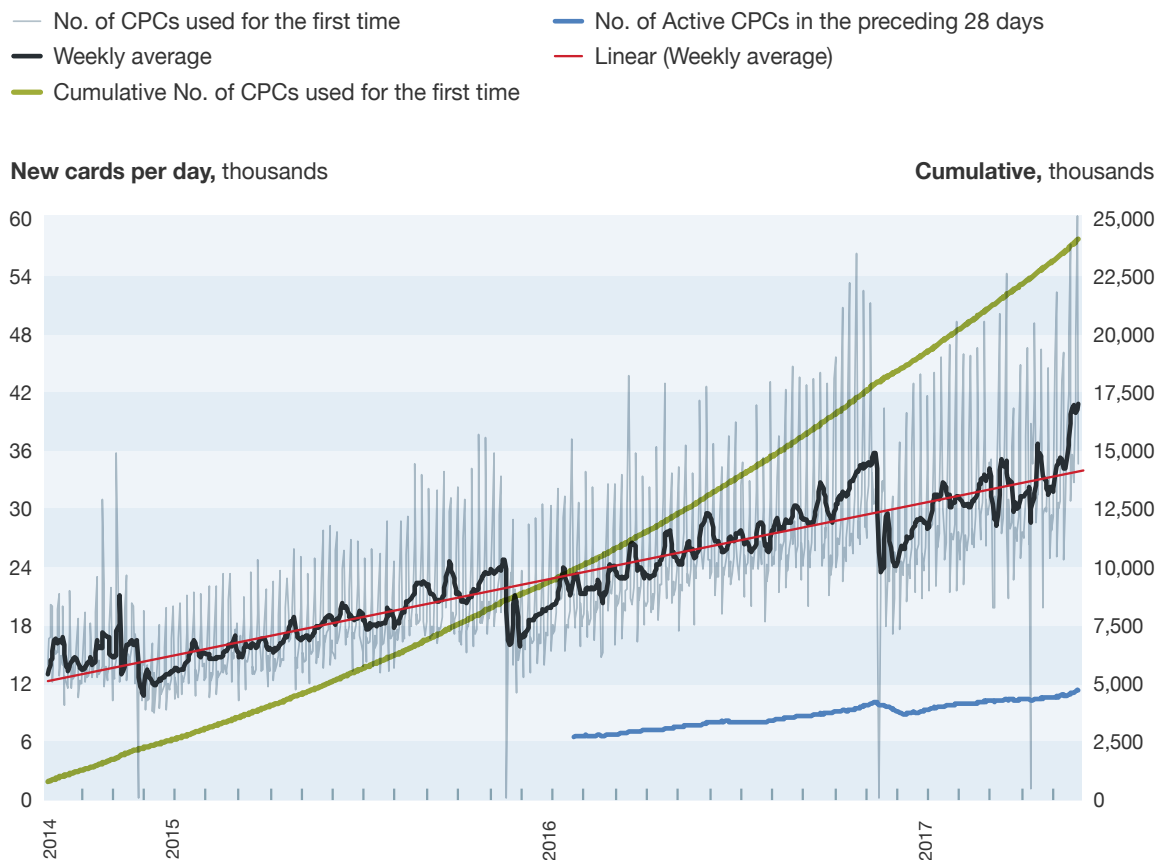
project, including card readers. But the software proved to be a barrier. TfL was inventing an entirely new transit payment model, and we realized that much of the development work could not be contracted out—no such contractor existed. As a result, TfL built much of the new software in-house, a task almost unheard of for public-sector organizations to take on. In many cases, TfL figured out how it wanted the system to behave as it went. And once the software was developed, Cubic helped to implement and deploy the new technology.

### Impact and the path forward

The contactless card system launched on buses in December 2012 and on the rest of the transport system in September 2014. Since then, usage has grown steadily. Its four million active customers make an average of more than two million journeys per day and have used 25 million cards since launch. Android Pay, Apple Pay, and Samsung Pay—the three leading mobile payment solutions—all launched with London's transport system, aiding in adoption of the technology. And more than 30,000 new cards are added to the system every day.

Exhibit 2

## Number of contactless cards used for the first time



SOURCE: TfL analysis



The system has also significantly reduced operator costs. The contactless card system, along with other initiatives, reduced TfL's costs spent on revenue collection from 15 percent to 8 percent, and TfL expects the share to drop to 6 percent as more and more passengers adopt the contactless system.

As cities expand their footprints and their populations grow, they will need to consider innovative ways to move people easily and affordably across existing infrastructure. One solution is to increase the efficiency of this infrastructure. Systems such as contactless cards remove friction, capitalize on systems already in place, and encourage easy adoption. It's an efficient model that cities around the world can follow—and many already are. 🌐

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Photo credit: Getty Images

## Infrastructure for the evolution of urban mobility

Self-driving vehicles, ride-hailing services, and other technologies are transforming urban mobility. To capture the benefits of the shift, cities will need sound infrastructure plans and investments.



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**The way that people get around cities** is changing dramatically. Technologies such as autonomous driving, electric powertrains, and mobile data connectivity are emerging alongside new transportation services, like ride-hailing and vehicle sharing, to form integrated mobility systems. Such systems will make it easier for city dwellers to use multiple modes of transportation, often on the same journey, and to get around town more cleanly, efficiently, and safely than ever.

McKinsey [estimates](#) that in 50 metropolitan areas around the world, home to 500 million people, the benefits of integrated mobility systems, such as improved safety, could be worth up to \$600 billion. Whether those benefits materialize, though, isn't a sure thing. The outcomes that cities experience will depend on the choices that officials make about public policies and investments—particularly those related to infrastructure.

With so much at stake, city officials can benefit from defining a vision for the future of their cities' mobility systems, and set out their infrastructure investments accordingly. Below, we describe how cities can accelerate the transition to integrated mobility in ways that also support their broader public goals.

**Vehicle electrification and distributed energy generation.** [Global electric-vehicle \(EV\) sales](#) have risen quickly, thanks to purchase subsidies, falling battery costs, fuel-economy regulations, and product improvements. From 2010 to 2016, battery pack prices fell about 80 percent, from approximately \$1,000 per kilowatt-hour to about \$227 per kilowatt-hour.<sup>1</sup> When battery costs drop below \$100 per kilowatt-hour, EVs should achieve cost competitiveness with conventional vehicles. [Renewable-power sources](#) could also generate a notable share of the world's electricity within the next 15 years, as their costs decline.

Cities that have prioritized reductions in local air pollution and greenhouse-gas emissions can encourage the shift toward EVs and low-carbon grid systems. Enabling the installation of residential solar and energy-storage systems would make it more economical to recharge EVs, and thus encourage EV ownership. These systems would also reduce grid loads, which helps to lower electricity prices at peak times and to free more capacity for vehicle charging. Officials can set the stage for these advances by working out the extent and makeup of the necessary charging systems, which remain unclear in many cities.

**Autonomous vehicles.** [Autonomous-driving technology](#) promises to lessen road-safety concerns, reduce the cost of transportation, and expand access to mobility. Autonomous vehicles (AVs) could also help ease traffic congestion, which costs more than 1 percent of GDP globally. Studies suggest that congestion is caused by a small proportion of vehicles. If those vehicles were automated, then traffic would flow more easily, which could mitigate the need for extra road capacity and free infrastructure funds for other purposes. Cities that expect to gain from the wide use of AVs can make plans to stimulate their uptake with physical infrastructure improvements, such as AV-only lanes, that work with autonomous

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<sup>1</sup> Russell Hensley, Patrick Hertz, Stefan M. Knupfer, and Patrick Schaufuss, *Electrifying insights: How automakers can drive electrified vehicle sales and profitability*, January 2017, McKinsey.com.



and connected cars to optimize traffic flows with intelligent [vehicle-to-infrastructure \(V2I\) transport systems](#). Maintaining roads well and posting clear signs should help AVs and human drivers to navigate effectively during the early days of AV adoption.

AVs should also give people more free time, from not having to drive. But this benefit might come with drawbacks. The low opportunity cost of spending time in an AV could encourage people to make more trips and live farther from city centers. Establishing incentives to steer AVs toward shared use can help curb demand increases and maximize the social returns from this innovation. Officials can consider using data-connectivity services to facilitate the pricing of infrastructure use. City planners can also influence the scale of investments in future infrastructure by setting standards for the density of urban development.


**Land and street management.** Changes in the number and mix of city vehicles will have important implications for how land is managed. Consider one easily overlooked land-use issue: parking. Parking space occupies up to 15 percent of public land in sprawling metropolitan areas. The smaller vehicle fleets required for integrated mobility should make it possible to put some parking space to more valuable uses, but a portion will still need to serve the transportation system. Cities where the use of [ride-hailing services](#) has increased quickly might consider easing the flow of traffic by turning some on-street parking spaces into curbside zones where passengers can climb into and out of vehicles.

Other mechanisms will be needed to manage the per capita increases in vehicle miles travelled that we have projected could take place in integrated mobility systems. Building more roads isn't enough: on average, new roads become congested within seven years. Cities may wish to determine whether dynamic road-pricing systems can lessen demand, while also offsetting potential losses of fuel-tax revenues as people switch to EVs. Other measures, such as installing traffic lights controlled by artificial intelligence and promoting the use of shared vehicles, can help cities increase the effective capacity of roadways.

**Transportation-mode mix.** Public transit, and mass transit in particular, is essential to preventing congestion. But if public transit is infrequent or slow or otherwise unsatisfactory, then city residents might opt to use private mobility services more frequently, thereby making traffic congestion worse. Given the extended timeframes involved in maintaining and improving public transit, cities can benefit from devising long-term infrastructure plans according to their future visions for integrating public transit, private mobility services, [bicycling](#), and walking.

In integrated mobility systems, infrastructure increasingly consists of physical components and software that enable greater use of mobility as a service. For example, cities could leverage the smart routing and dispatch algorithms of mobility providers to replace first- and last-mile bus services with licensed or subsidized ride hailing. Another approach would be to set up a public fleet of shared, self-driving, electric vehicles providing on-demand, door-to-door mobility at a lower cost than privately owned vehicles. Meanwhile, mass-transit rail systems, in combination with walking and cycling, would remain a vital part of the mobility system, offering unrivaled speed and capacity.

## Getting ahead of the mobility transition

[Advances in mobility](#) are already affecting the transportation systems of major cities around the world, though trends are unfolding at different rates overall and from one city to the next. Ride-hailing services, for example, have grown rapidly over the past few years and now compete in many markets with traditional car-sharing providers as well as public transit and private vehicles. Cities are mostly dealing with these trends in isolation. But they can gain advantages by considering the future of mobility in a comprehensive, integrated way that anticipates the dependencies and reinforcing effects among trends. This helps them understand the potential pace and impact of change, analyze trade-offs, and lay out sound infrastructure plans. Cities that do this well stand a better chance of shaping the future of mobility in a way that balances benefits with potential adverse effects, and thereby improves the lives of their residents. 

Download the full report on which this article is based, [An integrated perspective on the future of mobility](#), a joint report from Bloomberg New Energy Finance and McKinsey & Company, on [McKinsey.com](#).

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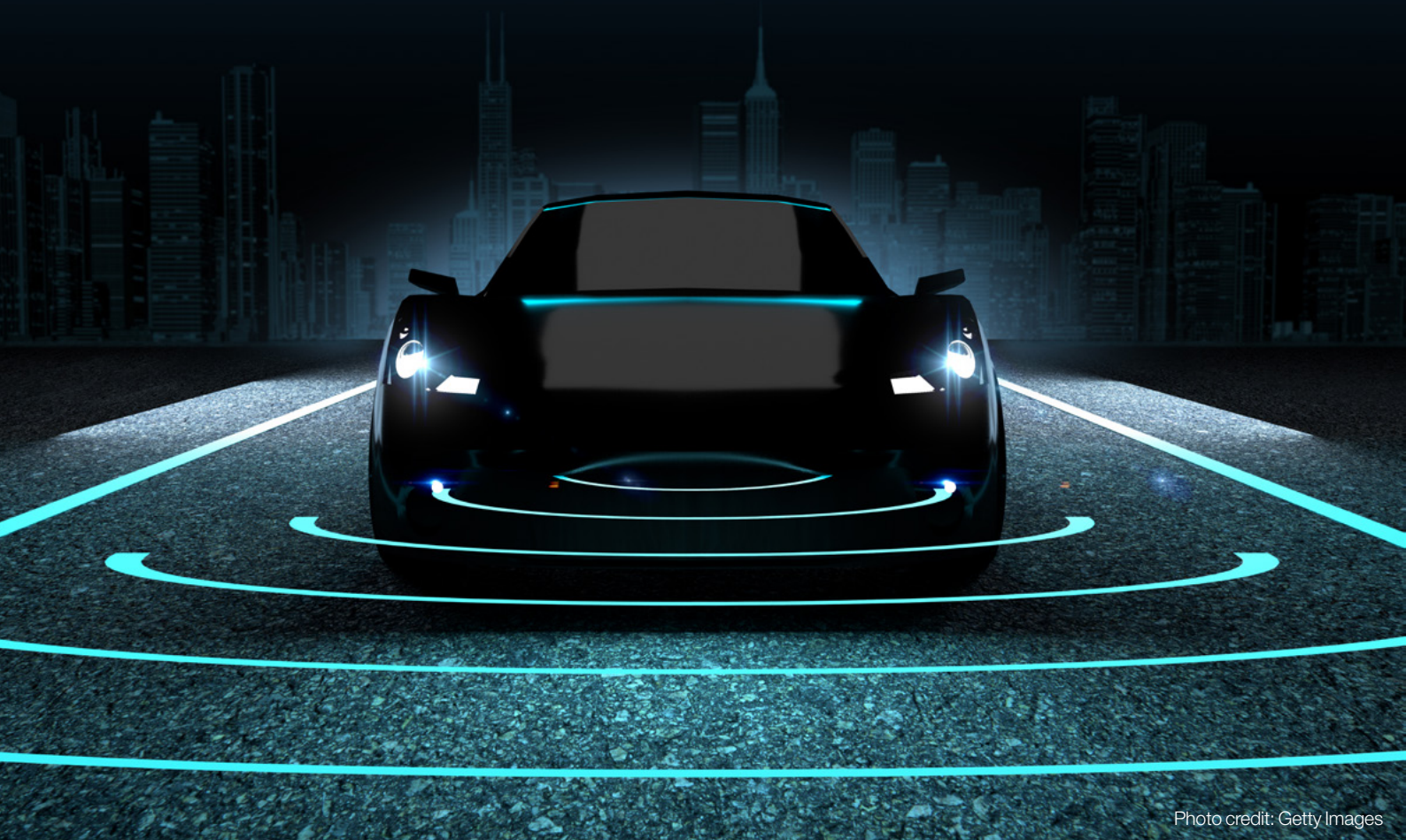


Photo credit: Getty Images

## Who's at the wheel? Changing culture and leadership to support innovation in autonomous vehicles

The new world of transport will demand different skills, capabilities, and culture.



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**The driverless car** was once heralded as an innovation even too futuristic for *The Jetsons*. Sure, George Jetson drove a flying car, but it still had a steering wheel, and he was clearly at the helm. A different future has arrived, and the days of an actual human getting behind the wheel and piloting a car may soon be as distant a memory as rabbit-ear TV antennae.

Supplanting human-driven vehicles are autonomous vehicles that drive themselves, and they're becoming more prevalent by the day. So the issue isn't if autonomous cars will arrive but rather to what extent they'll change the automotive industry; and, indeed, what effect they'll have on all of transportation.

To remain relevant, all automotive-focused and -related companies, from original equipment manufacturers to technology companies to materials suppliers, must develop a new approach to their business—especially regarding software, cybersecurity, and the integration of the Internet of Things. The difficulty, then, is finding the leadership that can align these areas with rapidly advancing and changing technologies. New leaders must be able to direct a vast degree of change and have the appropriate experience in the traditional automotive sector while also possessing the innovative vision and digital experience to drive this vast transformation. At the same time, this leader must be able to address the cultural issues that come with such a dramatic paradigm shift.

To lead the charge in the autonomous car realm and stay relevant within this changing landscape, automotive-manufacturer leadership will need a breadth of knowledge and capabilities that many don't currently have. Thus, finding these leaders will be key to revenue growth and success in the market going forward.

### **Challenges leaders must be equipped to tackle**

The move to driverless cars has implications for every system within a car—from navigation systems to brakes to steering wheels. Each of these elements will need to be redesigned, with many different considerations taken into account. Vehicle-to-vehicle and vehicle-to-infrastructure communication will be a key factor in how autonomous vehicles will function. And because competition will be fierce and modernization will be happening much more rapidly in this space, companies will have to be nimble enough to adjust their products and innovate on a consumer-electronics timetable.

Then there are the broader societal shifts that autonomous cars will bring. For instance, some believe consumers will largely stop buying their own cars, instead only using them on an hourly or as-needed basis. Urban landscapes, then, could be dramatically altered if the need for parking decreases. If these predictions prove true, companies will have to capture a far different consumer mind-set. And leaders will need vastly different skill sets to do it.

Leadership will need to be far-sighted enough to see the effects of this trend—not only within a company but also on the greater automotive ecosystem and society at large. They will need both tactical and strategic awareness. The knowledge base is continually expanding, so a capable leader must have expertise in a wide array of subjects or be able to build cooperative, cross-discipline teams. Education is crucial: 59 percent of

leaders working on artificial intelligence in the automotive industry hold a PhD, according to Spencer Stuart internal research. And experience with diverse and dispersed teams is highly coveted; companies increasingly seek executives who are used to having their team spread across the globe, so ideal leadership will also be able to lead and motivate across geographical borders.

An ideal leader in the autonomous car space would have a wide range of skills, including:

- The ability to lead across borders and build “something from nothing”
- Tactical and strategic knowledge
- A smooth cultural fit
- A nonlinear mind-set and the willingness to push a certain level of discomfort
- A deep knowledge—and love—of cars

Clearly, finding someone with such a wide degree of expertise is daunting.

### An alternative leadership approach

Since it can be difficult to find a leader who encompasses all these qualities, one option is to hire a leader specifically to oversee the transformation to autonomous vehicles or new mobility business models while keeping separate leadership of traditional business lines. This would essentially mean having a right-brain leader to help spur innovation and blue-sky thinking, and a left-brain leader to focus on traditional automotive functions such as foundation brakes or chassis systems.

So rather than fully integrating these groups, this approach would involve keeping them siloed. In this way, each group can maintain its culture, be it safety- and order-driven or learning- and purpose-driven. The more innovative leader is able to lead disruptive initiatives with others who are flexible and adaptive to change, while the more traditional leader can help provide an industry context and use processes and tools that are relevant, critical, and comfortable to the more traditional domains. Pursuing autonomous vehicle development in parallel with the traditional business allows the company to continue to meet the current demand with a supply of cars while also preparing for the future of the industry. This can be an expensive process, but competition will be intense and automotive companies will have to absorb this cost if they’re going to remain viable and agile enough to keep pace in the new market.

### Creating the right culture

More than any other single factor, an organization’s culture holds the power to drive sustained business performance—and it is especially important to consider culture during




times of change. At its best, culture unifies people and creates shared attitudes and behaviors that lead to the success of an organization. Left unattended, though, culture can become a limiting force and undermine the goals of the organization. According to a Spencer Stuart client survey, culture misalignment is a key factor in 68 percent of new-hire failures. When looking to hire a leader for autonomous vehicles or, really, in any industry, culture must be a key consideration.

Organizational cultures will likely need to evolve from logical and systematic to innovation- and enjoyment-driven for a transition to autonomous driving to be successful—or they must at least find a way to combine these divergent cultural and stylistic mind-sets. A crucial first step in evolving organizational culture is to understand the current culture. Then it is possible to define a target culture and the mind-sets, behaviors, and capabilities that will be needed for the future.

This evolution doesn't have to be overnight—and it likely doesn't have to happen throughout the entire organization. Ultimately, many automotive companies may conclude that they need to preserve the pockets of stable, process-driven manufacturing culture even as they encourage other parts of the organization to become more flexible and innovative. Organizations will need leaders able to bridge the cultural divide and embody the behaviors and mind-sets the company needs to be successful.

## Conclusion

The autonomous car promises to be a game-changing development—one that will lead to dramatic change within organizations and within society. Traditional automotive companies and suppliers will need to radically transform their operations to be successful in the future of transportation.

Companies realize the terrain is shifting and are developing leaders who can see the big picture. While the perfect leader may not currently exist, neither did the autonomous car a few short years ago. As the technology develops, and with intentional efforts, leadership will also evolve to be prepared for this new climate. 

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## Ports and shipping: The need for solutions that cross lines

Despite—or because of—low rates, service is bad and shippers are angry. The port-and-shipping sector must and can improve, not only for shippers, but also for the lines and ports themselves.



**John Murnane**

Partner, Atlanta,  
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**When you talk** about the health of the port and shipping sector, you start with volumes and growth. Growth is important to all sectors—but especially to this one, since so much of the total cost of production is tied up in large, expensive fixed assets. Volume growth leads to many good things: mounting revenues, high asset utilization, approvals for new investments, good pricing behavior among competitors, and win-win relations between management and labor. Bad things happen when you don't have growth.

Historically, the sector has done pretty well—with short-term cyclicalities but consistent expansion over time. In the 1950s, trade started to grow faster than GDP, and in the 1980s it really took off, growing twice as fast as GDP and sometimes faster. What we see now is different. Demand isn't increasing as fast as it was. GDP growth has slowed down, while the trade multiple—the ratio between GDP and trade—has fallen to one.

Economists debate whether these numbers embody the new normal or just the down phase of the latest cycle (which would suggest that the growth we saw for 30 years will eventually come back). The short answer: we don't know. It would be understandable if the shock of the most recent crisis—the biggest downturn since the Great Depression—required an unusually long recovery. But don't count on an easy return to the days when trade increased 2.0 to almost 3.5 times faster than GDP.

For one thing, the idea that the trade ratio has always been at least two isn't really correct. It was better than that in the 1990s but stood at 1.5 for much of the past century—and was 0.5 for a lot of the 1920s, '30s, and '40s (exhibit).

Further, the events that propelled the recent boom cycle were exceptional. China's reemergence was a unique event. A big global trade agreement signed in 1986 reduced tariffs across 123 countries by some 40 percent. The expansion of global communications facilitated the unprecedented globalization of supply chains. An extraordinary turn of events would be needed to get the trade ratio back above two.

Of course, the slowdown in growth isn't good for the sector. Returns have also dropped as a result of falling utilization levels, increased competition, and larger capital expenditures as carriers, first in Asia and Europe but now in the Americas too, buy more and bigger vessels. This isn't the most obvious thing to do at a time of slowing demand, but because the new, larger ships have such great economics, the math—for individual companies—does suggest that it makes sense to invest in them. To get the money for these vessels, carriers launch efficiency efforts that reduce staffing levels in customer service and support, and exit what they consider ancillary parts of the business (for instance, chassis). They bring together the volumes needed to fill the larger vessels by joining alliances to share services.

Ports, terminals, and port-service firms have responded to lower growth by investing in cranes, dredging equipment, and other things to accommodate the larger vessels. Some of the investments replace older assets, but mostly they increase capacity—or supply. Again, this makes sense for individual players but not for a sector facing softer demand. These port players have also taken on a lot of complexity to accommodate changes in the sector. As a result, port calls are clunkier, customers have different requirements for different



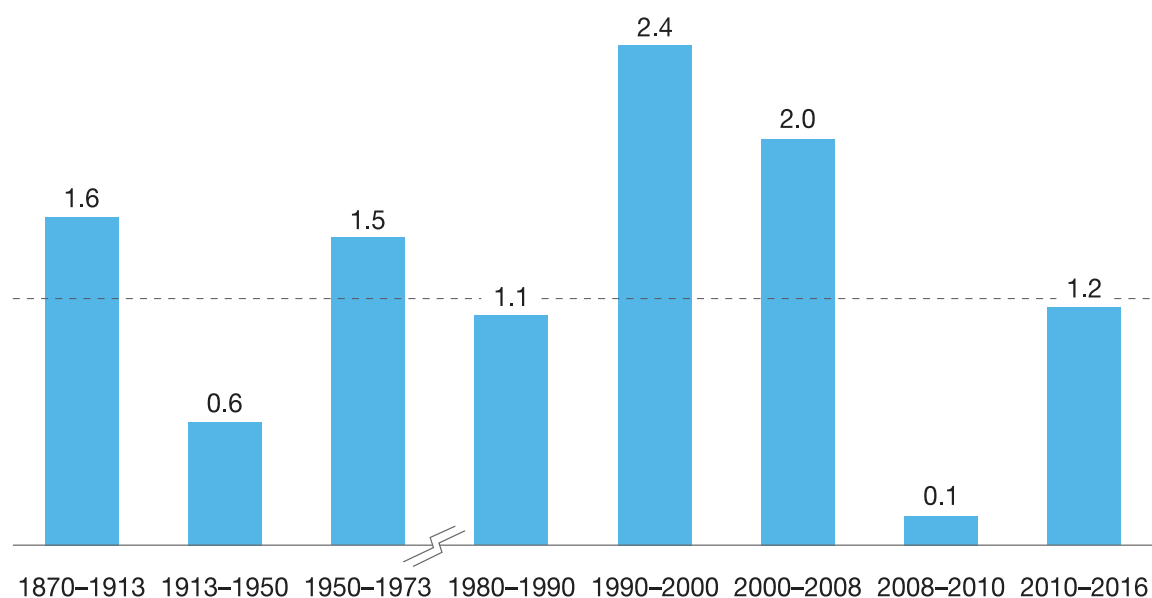
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Exhibit

The global trade multiplier has fallen back to levels last seen before the most recent wave of globalization.

**Global-goods trade multiplier**

**Growth of real trade to growth of real GDP, constant dollars<sup>1</sup>**



<sup>1</sup>Historical Maddison data uses global exports; post-1980 multiplier based on global imports.

McKinsey&Company | Source: Maddison; Oxford Economics; McKinsey analysis

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sailings of the same service, and the entire process of managing chassis and equipment gets far more complicated.

Not surprisingly, such moves do very little, on balance, to improve the sector's economics. Fuel savings at sea are real—but they get passed on to shippers in the form of price breaks. Other costs just move from one kind of sector participant to another. And now, both the carriers and the port players suffer from moderate to dramatic oversupply, which makes for tougher negotiations and worsening economics.

**Complications**

What are beneficial cargo owners (BCOs) and shippers feeling and doing while all of this happens?

### Complication 1: Shippers are unhappy with the service they get

We spent time last year talking with all sorts of downstream participants in the shipping community, such as BCOs, forwarders, and groups like the National Retail Foundation. Thanks to rate reductions by ocean-freight providers, North American shippers enjoyed about \$23 billion in savings from 2010 to 2015. Despite this, they aren't happy; the service they receive frustrates them. Many said they would be willing to pay more in return for improvements in, for example, the availability of equipment, reliability, transparency, and communication. Some interviewees went out of their way to tell us that the carriers—not they themselves—had driven down rates.

Second, although ocean-freight customers have always been told that service disruptions stem from labor strikes, driver shortages, and the like, they are now beginning to believe that the problems also result from conscious decisions made by ocean-freight providers and port operators. This is, of course, a concern.

Third, the biggest theme (or felt need) of shippers is the importance of improved transparency and communication. The one thing we did not hear a lot of complaints about was scheduled transit times. Of course, transit times are important—especially for some industries and commodities. But we heard many more requests for reliable delivery dates and better transparency when things go wrong.

### Complication 2: Shippers are starting to act

In response to these complaints, shippers are making very significant investments. New players in the global transport and logistics space hope to improve cargo-monitoring services; one of them, Traxens, has already won backing from the Mediterranean Shipping Company and CMA CGM. Meanwhile, Amazon is investing massively in its own logistics network. It has an ocean-freight-forwarder license in China and just made another long-term lease commitment for planes. It has also actively bid on ports and recently looked to buy an airport in Germany.

Why is Amazon making all these investments? Of course, it wants its logistics costs to fall—removing the intermediary does have some value. But the logistics and freight markets have lots of excess capacity, so Amazon's principal motive probably isn't costs or leverage over suppliers. If the company's only goal was to lower the rates it pays for ocean transport or air freight, it could negotiate with the carriers. In fact, Amazon could probably get just about any rate it wanted in return for a long-term volume commitment.

We believe that the company has more important things on its mind than costs. We know it thinks that logistics and supply chains are strategic elements of the value proposition it offers to customers and therefore feels the need to be the world's best in that space. It also sees the huge waste of time and money at the intersection of all the

different elements—and believes it could eliminate that waste if it had more control over the end-to-end chain.

### What does all this mean?

Such realities discredit the fallacy that too many in this sector have accepted: the idea that all customers care about is the rate they pay—the price per container. I have heard countless executives complain that shippers will desert them for \$5 to \$10 a box, so that they need to do everything possible to lower their costs. This used to be true (and in some pockets of the business it still is), but the way customers look at costs is changing.

I have been in global logistics for nearly 20 years—in rail freight, air cargo, trucking, and logistics (see sidebar “How I got hooked on ports and shipping”). In the early days, many sales executives told me that the challenge of selling transportation was that nobody in the C-suite cared a fig about it. These sales executives, who were talking to logistics buyers with no responsibility for anything outside their control, could never get anyone to think about service. That is no longer true.

Costs are still very important, but they no longer mean simple things like a carrier’s freight rate per container or a terminal’s rate per lift. All of the transport customers I speak with complain about the dreaded procurement departments that manage complex requests for proposals and bidding events. Every one of these best-practice procurement efforts involves scrutinizing end-to-end costs to understand the total expense of any supply-chain solution. Not all shippers can play this game, but it is becoming the norm.

### Opportunities

As a result, we’re seeing organizations in the port space—authorities, operators, service providers, third-party logistics companies, and forwarders—doing more and more to improve the end-to-end supply chain. That’s what today’s customer wants, and that’s what helps freight lines and ports attract new cargo. We see three themes, or areas for improvement.

#### Theme 1: Improving the customer experience

When we spoke with shippers, most of what we heard concerned the quality of service. The pressing issues were reliability or consistency and the level of transparency and communication when things go wrong. Everyone is investing in this area.

To develop a truly differentiated service, liners and ports that make such investments should think about two dimensions. The first is ways to increase end-to-end transparency. Can you extend into rail? Can you extend into trucks? For inspiration, look to Antwerp. All the sector participants in and around that port joined together to establish a data-sharing company and build a full digital ecosystem. They plan to have complete, end-to-end sharing of data—from ocean to pilot to berth to yard to gate to rail to truck to BCO and back again.

The second area to think about is the use of big data and advanced analytics to make predictions and guidance more reliable. One of the problems in tracking containers, for



example, is that information is only as good as what trucking companies or carriers supply.

In the past, predicting the arrival of vessels in port was difficult—it mostly involved asking carriers when they thought their ships would come in, and too often they simply relayed whatever they heard from their captains. This process is often inaccurate: the average difference between a captain’s estimate and the actual time of arrival was 13 hours. But new tools combine publicly available GPS data on the current position of vessels with the latest machine-learning techniques. Such tools can estimate the deviation between the current and scheduled position of a ship and therefore provide a better estimated time of arrival for any port on its route.

Obviously, many other things could improve the customer experience—new crane technology, better communication, collaboration with stowage plans, and so forth. But don’t overlook transparency and communication, the biggest felt need among shippers.

## Theme 2: Commercial excellence

Serving the needs of existing customers is one thing, finding new ones quite another. So is getting your customers to pay for the premium services you provide, which isn’t easy. I see three opportunities.

1. *Micromarket planning.* Slowing GDP numbers and falling trade multiples are only averages. Nobody competes in an average market; what’s important is the actual trade growth and the actual trade multiple for the industry you support. Those numbers vary greatly by industry, by commodity, by origin, and by destination. The best B2B companies work hard to canvass the market for areas of growth. When sales teams shift focus to that goal, we see 20 percent increases in port volumes, for example.
2. *Joint sales and marketing efforts.* Shippers no longer care much about the individual prices of the individual components of a logistics solution. Their real preoccupation is the quality of the end-to-end solutions that get products where they need to go. Yet most sales calls in the port-and-shipping sector still involve one-on-one interactions: shippers talking to carriers, carriers to terminals, terminals to ports. These efforts must become more integrated—which is already starting to happen. We’ll see a lot more of this in the years to come.
3. *Tiered pricing.* Last year, some of my colleagues wrote an article explaining the opportunities to use pricing to increase productivity and remove waste in the joint supply chain.<sup>1</sup> The basic premise was that current pricing mechanisms in the port-and-shipping sector are too simplistic. In general, there’s no additional expense for peak berthing windows. Carriers don’t pay ports more for poor stowage plans. There’s no explicit extra charge for larger vessels, which disrupt schedules

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<sup>1</sup> Timo Glave and Steve Saxon, “How to rethink pricing at container terminals,” December 2015, McKinsey.com.

because they take longer to pilot, berth, load, and unload. The full adoption of a more robust pricing scheme could help the sector eliminate \$2 billion to \$3 billion of waste by putting the responsibility for it in the hands of the guilty parties.

Some of these ideas are hard to implement. However, the hard part isn't the math but rather getting all the different stakeholders to work together. Ports are seeing a real, positive impact when they start to implement these kinds of ideas: for example, increasing the utilization of machinery by 3 to 5 percent when they charge different prices for day and night operations and by an additional 12 to 15 percent when they introduce fines for unattended truck windows.

### Theme 3: End-to-end collaboration

One of the trickiest things about this sector is the need to work across so many stakeholders. But that necessity provides not only challenges but also enormous opportunities. One recent example of what I have in mind involves the Greater Toronto Airports Authority (GTAA), which is working to develop an integrated strategy to meet the growing demand for air travel in the area. Seaports differ from airports, of course, but parallels abound—particularly the need for cooperation among stakeholders.

Every time the authority tried to develop a strategy, it ran into roadblocks—some constituency or other wasn't aligned with the plan and would offer an alternative that eroded its force and value. The GTAA therefore decided to initiate a major effort, working with all the other stakeholders to form a strategy for southern Ontario.

During an 18-month effort, GTAA built a robust fact base about the area's current and future economic, demographic, and ground-transportation needs to estimate the sources of aviation demand. The authority spent months sharing its fact base with stakeholders throughout the region, taking feedback from them and building on their perspectives. Working with regional airports, the provincial and federal governments, and industry experts, GTAA then led a process to develop an integrated strategy to accommodate the expected growth. There is still much to do, but the stakeholders now work as a team around an aligned set of facts and a shared perspective on what's needed.

The challenges are significant, but so are the opportunities and potential. Capturing your fair share of them will require new thinking. It will require investments and trade-offs. Most important, it will require solutions that cross functional lines, company lines, public-versus-private lines, and industry-versus-environment lines. Let's start crossing them now. 🌐

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