

# THE MOBILITY REVOLUTION

A compendium of Oliver Wyman articles on  
the potential for disruption and opportunity



# FOREWORD

AS THE EARTH'S POPULATION grows and becomes increasingly urban, cities are contending with more traffic congestion, more air pollution, more noise, more demand for resources, and more difficulty disposing of waste. Our infrastructure is literally clogged with people and their possessions and needs, and to achieve any progress, we must get things moving again.

The world stands on the brink of a digital revolution in mobility, fueled in large part by artificial intelligence, the electrification of transport, the drive toward autonomous vehicles, and enhanced connectivity. Everywhere, solutions that were once the stuff of science fiction are being tested and readied for commercial expansion – whether it's a hyperloop project in France, flying taxis in Dubai, drone deliveries in Australia, unmanned cargo ships launched by Norway and China, or self-driving trucks on the road in the southwestern United States.

For businesses, the stakes are huge: By 2030, less than 12 years from now, the size of the autonomous vehicle market – including ground, air, and sea transport – could swell to close to €640 billion from €15 billion today, while electric-vehicle ownership is expected to balloon to more than 125 million vehicles from just over three million at the end of 2017. The drone fleet is also proliferating: In the United States alone, the Federal Aviation Administration anticipates the commercial fleet will reach 450,000 by 2022 and could exceed 700,000 with certain regulatory changes.

While there are exciting technological advances on the horizon, more progress needs to be made shrinking and amplifying batteries that enable electrification of vehicles. Both Boeing and Airbus have tested electric aircraft, but the goal of a totally electric regional jet that can carry 100 has not yet been achieved. Electric cars have been developed that can travel more than 300 miles without recharging. Yet, we haven't worked out how cities will provide the electricity necessary to power the growing army of electric cars, trucks, and buses.

Solutions for overcoming these hurdles are vital, not just to enable transportation expansion, but also to reduce greenhouse gases that are overheating the planet. The arrival of autonomous vehicles also will necessitate substantial changes to the road system, traffic management, and insurance coverage. New regulations and air traffic control are needed to handle the use of larger drones in populated areas.

Aware of what's possible thanks to artificial intelligence, digitized data, and enhanced connectivity, consumers are also driving change. As in so many industries, service on demand is quickly becoming the norm in transportation. Travelers want to see real-time updates on their trip door-to-door; they want transparency in pricing and reliable Wi-Fi while traveling. And they're even willing to pay more for these conveniences, according to our global surveys.

As this compendium of externally published articles emphasizes, the disruption is real, but so too are the business opportunities for those players ready to catch the wave.



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# THE LAST MILE TO AUTONOMY

Driverless vehicles arriving ahead of schedule appear to offer bigger opportunities than first imagined

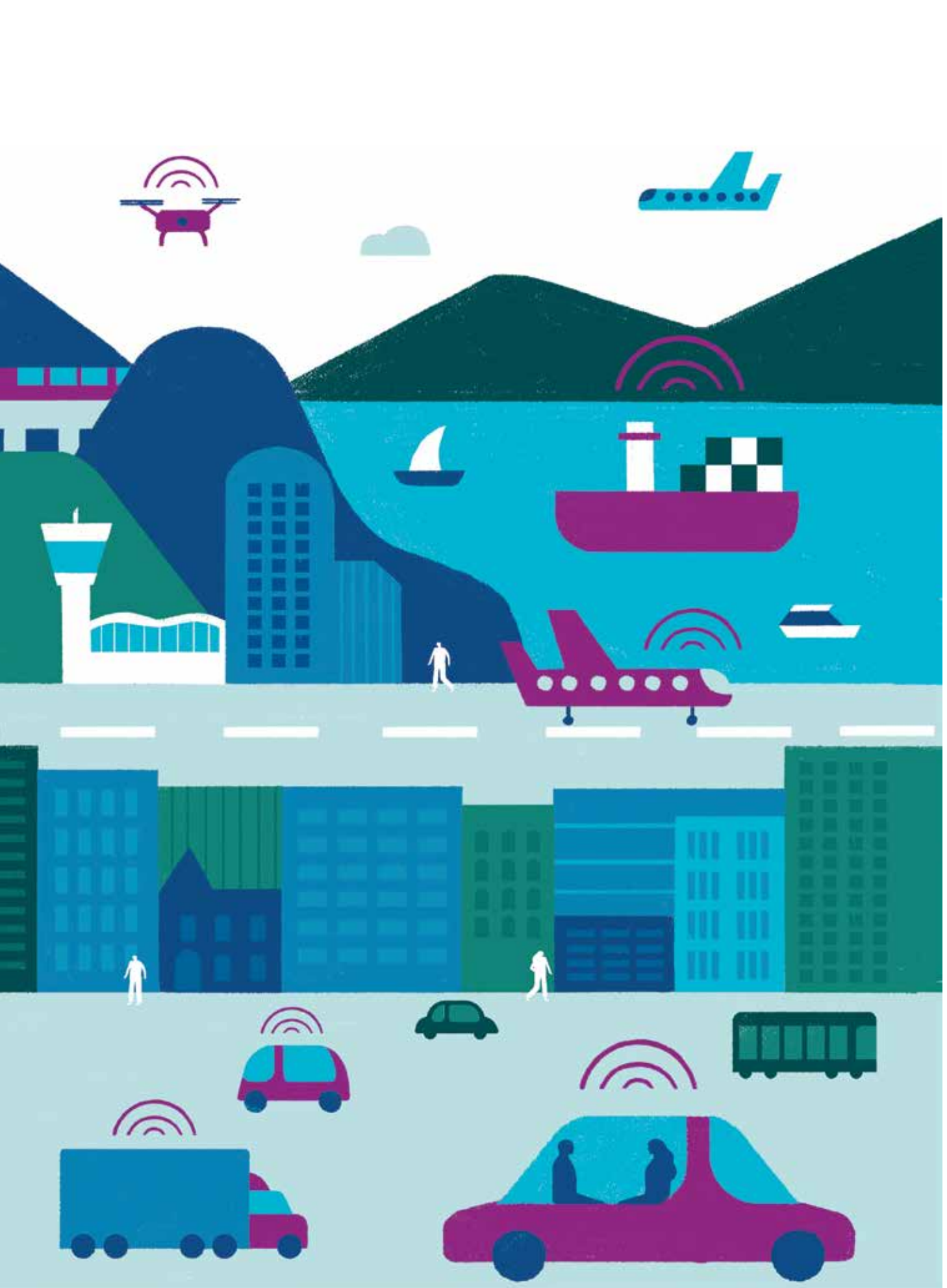
Guillaume Thibault • Hanna Moukanas

IN TRANSPORTATION, there is probably no word more widely used and simultaneously more of a mystery than autonomy. Although autonomy's exact implications for mobility are hard to fully grasp today, the industry recognizes the technology offers so much more than the novelty of the self-driving, flying taxis being tested in Dubai or even an immediate game-changer like the driverless trucks that haul Frigidaire refrigerators along Interstate 10 between Texas and California.

Consider autonomous vehicles alone. While today the market for autonomous vehicles consists primarily of unmanned military drones, our research shows that over the next 12 years it will transform into one that is 60 percent civilian; include ground, sea, air, and space transportation; and expand to €636 billion (about \$739 billion) – more than 40 times its current size. According to our calculations, autonomous vehicles will make up 20 percent of the total vehicle market by 2030, and three out of four of them will be used as ground transportation.

For the entire transportation and services sector – including public infrastructure; mobility [services](#);





traffic, fleet and data management; defense and security; and maintenance, repair, and overhaul – the arrival of autonomy means a fivefold increase in the market to almost €3 trillion. While the entire sector faces seismic shifts with the incumbent disruption, its players and myriad startups can expect outsized opportunities.

### THE NEXT INTERNET-SIZE DISRUPTION

Like the commercial effort to capitalize on the internet that began two decades ago, autonomy is changing the way we live – how we move from place to place, what we choose to own, and eventually the leaders in the transportation industry. With autonomy advancing more rapidly than initially predicted and now expected to reach a tipping point in 10 years rather than 20, General Motors Chief Executive Mary Barra got it right when she reckoned transportation would see more change over the next decade than in the last six.

In this transition, the value is moving from large, sophisticated, and expensive platforms to small, agile, and low-cost ones. For instance, 30 percent of the helicopter market will be threatened by small to midsize drones, such as the ones being developed by DJI, Delair Tech, and Parrot.

Rather than a plethora of new hardware, the emphasis will be on development of software, which will make up half of the systems on vehicles versus 30 percent today. Here, names like QNX, Nvidia, Intel, Google, Airware, and Kespri stand out. And finally, by 2030 shared ownership – a trend that will

be further encouraged with the arrival of autonomous vehicles – will be five times higher than today. To respond to the move away from ownership, major car manufacturers have been partnering with on-demand ride services like Lyft and Gett.

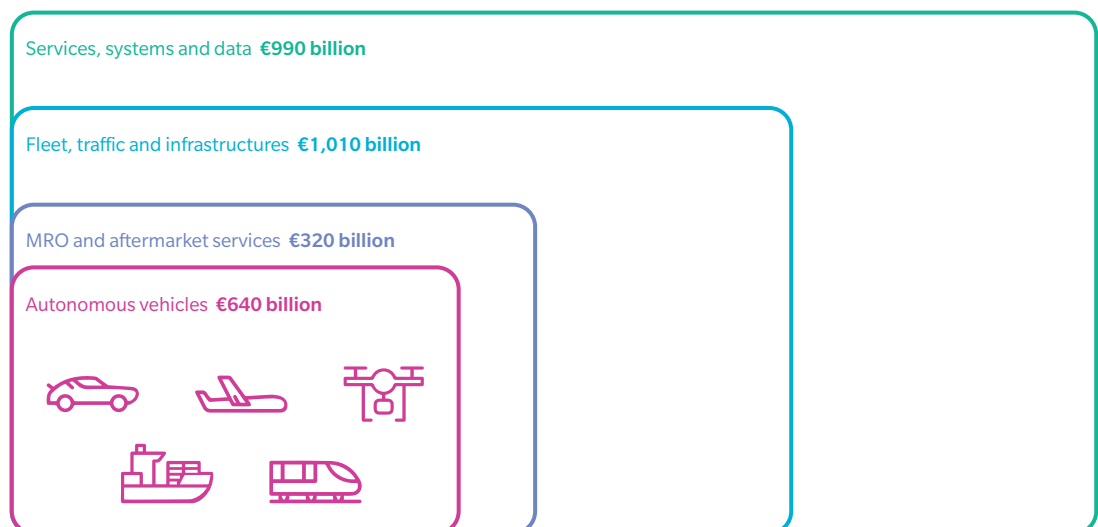
### BEYOND AUTONOMOUS VEHICLES

But vehicles are only a small piece of the transformation spawned by autonomy. In the services sector, there will be similar disruptions. Take traffic management. Today, there are 300,000 aircraft in the general aviation fleet and five million drones sold annually. Given that traditional traffic management tools don't detect small unmanned vehicles, the size of the potential challenge is clear.

While discussions so far have focused on creating dedicated roadways or corridors for autonomous vehicles, NASA and Google have also been working to develop traffic management systems that would allow for the coexistence of manned and driverless vehicles. And besides traffic, there will be an array of other infrastructure overhauls required to accommodate autonomy – from parking, to servicing, to airports, to mass transit systems.

So who will be among the winners? We've already seen some companies that have positioned themselves astutely for the coming wave of autonomy. For instance, given that electric cars lend themselves to autonomous operation, Tesla – with its electric cars, emphasis on software and data collection, and remote upgrades

### AUTONOMY WILL GROW TO ALMOST €3 TRILLION BY 2030 VEHICLES ARE ONLY A PORTION OF THE MARKET



Source: Oliver Wyman analysis



and repair – has an advantage moving forward over car manufacturers that haven't strayed from internal-combustion engines.

## CHALLENGES AHEAD

But even as more autonomous prototypes make their way toward commercialization, obstacles still exist. We're already seeing progress in battery technology, but more is needed. Still, the biggest roadblocks may be regulation and ultimately how comfortable the public is with cars driving themselves or pilotless aircraft. There was one survey that said only 17 percent of people would fly in a plane without pilots.

Gaining the certification to ensure the safety of the vehicles, as well as securing public infrastructure investment from debt-encumbered governments, will also be high hurdles. No doubt, there also will be pushback from labor in jeopardy of being replaced as well as from some incumbents uncomfortable with the pace of adoption.

Ultimately, autonomy and artificial intelligence are forces too big and too game-changing to be stopped.

And we are already seeing companies capitalize on the opportunities. As Charles Darwin once said about another immutable force, "it is not the strongest species that survive, nor the most intelligent, but the most responsive to change." Autonomy may not give business the choice of not changing.

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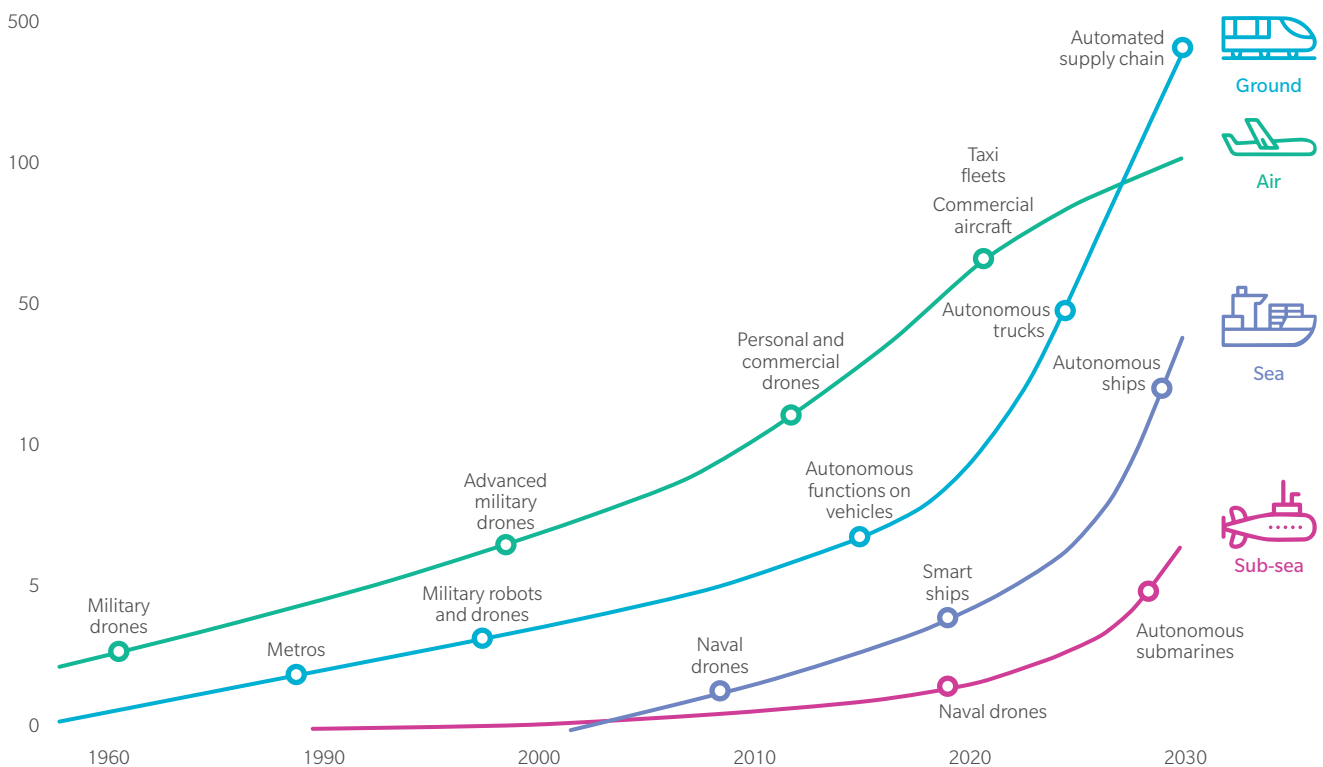
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## WITH EACH NEW GENERATION, THE AUTONOMOUS VEHICLE MARKET SIZE GREW

ALGORITHMIC SCALE IN BILLIONS OF DOLLARS



Source: Oliver Wyman analysis

# MAKING THE RIGHT CONNECTIONS

Passenger rail can travel a path to more ridership and revenue through high-speed digital connectivity

Gilles Roucolle • Jean-Pierre Cresci • Sebastian Janssen • Tilman Apitzsch





CONVENIENCE, COST, AND COMFORT used to be the three C's that explained why passengers chose one transportation option over another. In the 21st century, there's a fourth C that may trump all the others – connectivity. Today, many people can barely go five minutes without being connected to the internet whether through their smartphone, smartwatch, tablet, or laptop. Why should their time traveling be any different?

When it comes to transportation, consumers want more than just uninterrupted online access: They also want the ability to work, shop, text, tweet, tag, stream, or catch up on the news while cooped up in a train, plane, bus, or car – just as they would when not on the move. Because they're traveling, they especially want fast, flexible, door-to-door trip planning and booking, as well as real-time travel information – any service that will save them time and make their journey more productive and enjoyable.

It should come as no surprise that the future growth in ridership and revenue will go to the mode of transportation that proves best at providing what travelers want in connectivity and digital services. And while passenger rail has often trailed aviation, automotive, and bus rivals in offering internet, some of its leading brands – along with some key technology players – are starting to invest in strategies that should help trains get a bigger share of the smart-mobility wave.

## CONNECTIVITY AND 5G

No doubt, rail – whether intercity, commuter rail, or urban transit – faces a challenge providing dependable wireless as trains travel at high speeds through tunnels, underground, and areas with few mobile broadband towers. During rush hours, railcars can carry densities exceeding those of typical offices, which means a lot of competition for bandwidth. All this has often left rail passengers restricted to texting and sending emails, forgoing activities like streaming that become fraught with annoying buffering.

Today, rail manufacturers and operators, often in partnership with technology companies, are testing possible solutions – even though some contend things won't really improve for rail until the arrival of ultra-high-speed, ultra-high-capacity wireless 5G networks. In the United Kingdom, networking hardware giant Cisco has been working with ScotRail on what is billed as the world's fastest train Wi-Fi. The pilot program on the Glasgow-to-Edinburgh line has reportedly reached 600 megabits per second in trials.

Virgin Rail trains are trying to get around this problem by offering BEAM service, a free app that

allows passengers to use onboard servers to stream television shows and movies and access newspapers, magazines, and games on smartphones and laptops. That’s an improvement, but not a long-term solution.

French railroad SNCF has installed about 18,000 antennas on a fleet of 300 trains, along with 4G towers every three kilometers, to provide coverage for much of its high-speed TGV passenger rail network. It is also in the process of rolling out 4G on regional and suburban trains.

But 5G may not be that far off. In Japan, 5G is already being tested on high-speed trains in preparation for the 2020 Olympics in Tokyo.

### NO DIGITAL SERVICES, NO GO

Ultimately, given the importance of digital services and connectivity to travelers, passenger rail services will have no choice except to upgrade to full internet access. In a recent Oliver Wyman five-nation survey to assess how far travelers would go for access to a wide array of digital services, consumers indicated they would willingly switch from their current means of travel and even pay more for the convenience. (See “The World Wants Smart Mobility” on page 26.)

Why not? Online access and digital services make the time on the train more productive for working passengers and more enjoyable for everyone. Following

through on that concept, Deutsche Bahn has created an “Idea Train” (Ideenzug) that features a fitness studio, meeting space, and gaming consoles. This vision for rail suggests that trains have the potential to become extensions of office and home – like what Starbucks coffeehouses and internet cafes represent to younger generations and workers who freelance or work remotely.

Offering these kinds of experiences, especially to millennials and Generation Z passengers who are less interested in cars and driving than their parents, could create a competitive edge for trains over planes, given aviation’s time-consuming security and periods in flight when cellular devices must be turned off; over buses, given the ability on a train to walk around and its higher degree of comfort and amenities; and over cars, given the current requirement that drivers focus on the road. While a future of autonomous cars may portend a threat to rail ridership, driving – even hands-free driving – still means the hassles of car ownership, traffic congestion, and parking.

### FAST PAYBACK

While a new image for rail won’t come easy or cheap, the investment in connectivity is likely to elicit a quick return from increased ridership and new sources of revenue – either from the direct sale of digital services

## RAIL COMPANIES AND MANY OTHERS ARE LINING UP TO SUPPLY SERVICES

BASED ON RESULTS IN FIVE COUNTRIES FOR OLIVER WYMAN’S MOBILITY 2040 SURVEY

	Global	Germany	France	USA	Italy	China
Financial/Insurance services						
Multimodal door-to-door travel planning						
First/last-mile services						
Safety						
Real-time information						
Entertainment						
Work and education						

Transport operators   
 Digital giants   
 Financial institutions   
 Media providers   
 Innovative startups   
 Not sure

Source: Oliver Wyman Mobility 2040: Smart Mobility survey; Oliver Wyman analysis

onboard or from the ability to maintain profitable ticket pricing made possible by these new services. In Australia, the Victorian government's Regional Rail Connectivity Project expects to roll out mobile signal boosters across the V/Line Vlocity train fleet and is building 35 mobile towers, in partnership with several telecoms. While the project is costing AU\$18 million, the enhanced connectivity is projected to add AU\$20 million annually to the state's economy.

Apps offer another quick-turnaround potential for rail as operators begin digital engagement with customers – even though it's increasingly difficult to secure real estate on customers' busy mobile devices. Besides making life more convenient for travelers, apps provide a constant feed of data to the company about consumer preferences and behavior.

Although Deutsche Bahn is primarily a rail company, it cleverly helped start Quixxit, a popular train, bus, and flight planning app. In France, SNCF is realizing new revenue from its mobile app, which lets passengers book connections and trips as well as reserve taxis and rental cars before reaching the station. Onboard food and drink can also be ordered up from the train's bar-restaurant.

Not surprisingly, tech competitors recognize the possibilities. One of the most potent rivals is Moovit, an urban mobility app that provides real-time, crowd-sourced transport information. Among its investors: Intel and BMW.

Collaboration and partnerships between rail and non-rail players, such as telecoms, tech startups, retailers and e-commerce companies, are also part of this transformation. Even the same car-sharing services that are partially responsible for the drop in urban transit ridership are likely partners. For example, Amtrak, the US intercity passenger train operator, is partnering with ride-share company Lyft to help passengers get to and from stations, using Amtrak's app to book the car. Train operators could also pair up with entertainment companies to provide on-demand movies or educational institutions to offer courses or lectures.

## SPECIAL DELIVERY

In this vision for trains, stations become integrated transport hubs, using smartphone apps to facilitate door-to-door travel options. Train stations in several cities are working with a Deutsche Bahn subsidiary that is testing on-demand, driverless shuttle buses for passengers traveling to or from the station.

Making train stations convenient and fun destinations – with top-tier retail, restaurants, and even cultural events – could help push up ridership. SNCF, for example, is partnering with e-commerce giant Amazon to add smart lockers at 980 French train stations, allowing busy commuters to place an order

one day and pick up their packages the next. And London's magnificently renovated St. Pancras station provides everything a traveler needs in one spot. Its St.P app offers real-time travel info, directions to station and city attractions, and exclusive, targeted retail deals for travelers.

In the end, the passenger rail industry should be prepared to make investments and look beyond its traditional role. First and foremost, rail must figure out how to get hyper-connected today if it ever wants to be the first choice of travelers.

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# THE GAS STATION'S DIGITAL FUTURE

Self-driving autos, mobile apps, and connected vehicles disrupt oil and gas' retail business

Irfan Bidiwala • Eric Nelsen



CAN YOU PICTURE a day when you never have to pump gasoline at all at the service station? You won't even have to get out of the car. It's not because they've hired more gas station attendants. It's because the pump and the car can communicate with each other, work together to select your preferred fuel, and fill the tank without the driver being involved. Like gliding through E-ZPass, you'd be paying with a cloud-connected app that, by then, may be standard on most autos.

If your vehicle is self-driving, you should be able to be happily ensconced in your bed or at your computer while your car buys the gas without you even being there.

## A NEW RELATIONSHIP WITH THE AUTOMOBILE

This is the future for service stations and gasoline consumers. Today, comparison apps may seem high-tech for your neighborhood favorite, but within the next decade or two, the gas station around the corner will likely be serving everything from hybrids, to autonomous cars, to electric vehicles, to car shares – and selling them a lot more than just regular and premium.

Like so many industries disrupted and transformed by technology, the iconic gas station will soon undergo what will be a pretty substantial digital makeover that connects it not just to the consumer but the car itself. It's not one trend pushing the change; it's a multitude of disruptions that are overhauling our relationship with the auto and the way gasoline is sold. And with all these things in transition, the business model for the service station must ultimately begin to reflect the new reality.

Gasoline demand has begun to decline in more mature economies and will probably continue to, as a growing number of people don't dream of owning a car the way previous generations did. According to the US Census, the number of no-car households increased



**APP-ENABLED ON-DEMAND FUELING**

The gas station that comes to you at your house or wherever



**EVOLVING CONSUMER SEGMENTS**

The digital evolution of the auto influenced by new technology and a sharing economy



**MODERNIZED STATIONS WITH UNIQUE SERVICES**

Making a digitally enabled gas station into your personal concierge



**CONNECTED CARS**

“Smart” next-generation autos with constant connection to the cloud



**SELF-DRIVING AUTOS**

Cars that take themselves to the gas station and fuel up



**DIVERSITY IN THE FUEL OFFERING**

The challenge serving conventional cars, electric cars, driverless cars, and people with no cars



**PERSONALIZED FUEL MIX**

Ability to custom-mix additives to create your own fuel



**MOBILE AND SMART-CAR APPS**

Enhanced selection and seamless interaction between customer and site



**ANALYTICS AND ON-SITE MARKETING**

Developing customized promotions for individual customers



**AUTOMATED FUELING AND PAYMENT**

No need to leave the vehicle with connected, self-driving cars

Source: Oliver Wyman analysis



slightly in 2015, perhaps in part because more people want to live in cities, and of course the well-documented lack of interest in car ownership among millennials.

## COOL SERVICES, A VARIETY OF FUELS

The gas station of, say, 2030 will not only have to do things differently; it will have to do different things to be profitable. For instance, one futuristic vision is to have short-distance drones deliver pre-ordered snacks or packages while the driver waits in the car.

The gas station of the future is going to have to mirror the diversity of its clientele. Given the rising popularity of hybrids and electric cars like Tesla, perhaps the gas station will have to consider having charging stations, as some now do in Europe. Or perhaps the demand is for compressed natural gas or liquefied petroleum gas. Already, gasoline and diesel generate less than 30 percent of the profits at the average gas station, and that figure may continue to decline, not necessarily from low demand but because the gas station is selling so many other services and products.

Of course, we're used to the convenience store aspect of gas stations, changing them into personal fueling stations – and that service is expected to become more ubiquitous and more sophisticated over time. But the gas station also will likely be a place where you can pick up your order from Amazon after it was delivered to the station by drone. Or maybe you pick up groceries that you ordered or your dry cleaning. In essence, your gas station becomes a giant post office box or a personal concierge – a convenient one-stop shop for the sharing economy as it blossoms.

## 2 A.M. GASOLINE CALLS

The change may go beyond the services the station offers; it may involve when it offers them. The busiest time for the gas station of 2035 may be at 2 a.m., when autonomous driving cars are programmed to take themselves to the station to fill up for the next morning's drive to the office.

The transactions may not even take place at the service station as on-demand fuel services begin to pop up. With an app, consumers can type in their order and have it delivered to their office parking lot or their driveway.

Stations also will deal with more wholesale purchasers, as car-sharing services like Lyft and Uber grow. Rather than sell to individual drivers, service-station franchises may only maintain long-term

contracts with the companies that employ drivers. Manufacturers of autonomous autos also may decide to develop long-term fuel programs for their buyers.

## ANTICIPATING THE FUTURE

While the potentially painful disruption is not entirely welcome news for the legions of independent gas stations and their owners, it represents an opportunity for early adopters, ready to embrace and anticipate change. Already, we're seeing service stations experiment with predictive analytics and other technology-driven innovations like mobile payment. For instance, one US convenience store-gas station chain is cutting gas prices by up to 10 cents per gallon for customers paying via app-enabled direct debit.

By 2022, cars are expected to have enough internet connectivity to allow drivers to simply ask their cars for recommendations on where to go for gas and then rely on the car to seamlessly pay for it. In the United Kingdom, Jaguar and Shell are piloting advanced capabilities for site interaction with such web-enabled vehicles.

The digital revolution has already compressed product cycles and brought disruptive innovation to a range of industries. Like it or not, the traditionally conservative gasoline industry appears to be among its next targets. What's not clear is which enterprises will be early movers and which will go the way of the drive-in movie.

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# HOW SMART SPEAKERS WILL REINVENT TRAVEL

The winners will be those who recognize early the technology's power and consumer appeal

Scot Hornick • Shri Santhanam • Scott Boland-Krouse • Alex Hill



MARRIOTT RECENTLY TEAMED UP with Amazon to offer a hospitality version of the e-commerce giant's Echo devices in select hotel rooms. Now, when guests want to order room service or housekeeping, they can simply ask Alexa, the voice of their disembodied personal concierge. Travelers with an Alexa device at home can book a car rental or hotel through Expedia and Kayak. Similarly, Google Assistant, which can be used via Google Home devices, smartphones, or smartwatches, can track flight prices and status, suggest nearby restaurants, convert currency, give directions, and provide same-day updates on traffic to airports. People can even book flights through voice-enabled Google Search.

On many fronts, artificial intelligence-powered smart speakers and apps seem poised to become the world's virtual travel agents. Virtual personal assistants like Alexa are moving rapidly from nifty gadgets for techies to household appliances and mobile devices ingrained in everyday life. The adoption of smart speakers is even outpacing that of smartphones a decade ago: An NPR-Edison Research study found that 18 percent of adults in the United States, or 43 million people, now own a smart speaker. Worldwide, ownership exceeds 100 million units and is projected to reach 225 million by 2020.

If consumers start turning regularly to smart speakers for their travel needs, they could end up interacting less and less with traditional airline, hotel, and even online travel agency brands. Or, if travel companies are paying attention, such voice-enabled devices could provide brands with a new front door to the customer. As happened with the rise of the internet and mobile apps, winners and losers in

the age of conversational AI will be determined by whether companies recognize its potential early and act on it.

## MOST VULNERABLE

Possibly most at risk in the travel community are some of the most digitally savvy players in the space – online travel agencies like Expedia and Booking.com. Several have already established partnerships with Amazon, and they all have relationships with Google through search. Their first move will be along the lines of what they did when mobile emerged as a powerful channel – they created apps and acted quickly to make sure consumers followed them onto the new device. Yet, more so than traditional travel providers, these companies face possible disintermediation by smart speakers, which will be capable of aggregating potential travel options on command. Virtual personal assistants may be able to do this even better than online agencies, given the amount of personal data about customers that the big tech companies will have at their disposal.

For airlines, hotels, rental car agencies, and the like, the challenge should not prove as disruptive, unless we foresee the rise of Google airlines or Amazon hotels – prospects that, while possible, are unlikely to generate the returns on capital that the tech giants are used to. The hurdle for traditional providers will be defending their margins, brand, and relationships with customers – challenges they already have had to battle at the hands of online travel agencies. Below, we examine three strategies that should not only keep traditional travel companies connected with customers, but which also may lead to a healthier industry and a better travel experience overall – partnering with Amazon and Google, leveraging loyalty programs, and adapting content while protecting branded search.

## STRATEGIC PARTNERSHIPS

Considering the speed of smart-speaker adoption, travel providers have a relatively small window in which they still have the leverage to negotiate common ground with the likes of Google and Amazon. Participating in the earliest wave of partnerships should be an advantage, as provider clout will be strongest before a substantial portion of consumers start using Alexa and Google Assistant to plan and book their trips. While tech giants already have some travel-related data from searches and purchase history, the more they can add to their databases over time through travel queries and transactions, the harder it becomes for travel providers to extract favorable terms.

Amazon and Google each offer different advantages as partners. Amazon, for instance, is the undisputed

leader in sales of personal assistants, with a 72 percent share of the market, according to a March Voicebot Smart Speaker Consumer Adoption Report. Google has its extensive search capability and a desire to catch up with Amazon. Both would like to supplant the online travel agencies as the go-to intermediary for travel.

Travel companies would like to increase brand awareness and reduce their exposure to escalating online agency commissions on bookings. Today, those commissions can range as high as 30 percent for smaller providers and others with less bargaining power to rates in the low teens for large brand-name hotel chains.

While travel companies could play one tech giant against the other to get the best deal possible, more likely they will conclude that working with both makes the most sense. In either case, travel providers need to keep two goals in mind: retain and enhance access to the customer and maintain control of the customer's data. For instance, even when using Alexa or Google Assistant to execute a booking, hotels and airlines should negotiate agreements that, for a referral fee, let them complete transactions through their in-house channels. While Google and Amazon may not embrace this enthusiastically in the case of smaller brands, the extra fee should allow larger brands to continue to directly serve customers.

## MAKE LOYALTY COUNT

Loyalty programs represent a treasure trove of data – one that travel companies are only beginning to exploit effectively to get closer to their customers. They also may provide airlines, hotel chains, and rental car companies more clout when setting up smart-speaker partnerships.

By offering special rewards and discounts to loyalty program customers through smart-speaker channels, travel brands could accelerate adoption of voice-enabled systems, making their partnerships valuable to Amazon and Google. The stronger the loyalty program – and the more trust customers have in the brand – the more leverage they gain with their members and in negotiations to maintain control over customer data and access.

As connoisseurs of data, Google and Amazon will recognize that loyalty programs produce substantially more detailed portraits of member preferences and behaviors than they can get from their miscellaneous purchases and searches. Still, travel companies should be cautious and carefully weigh the benefits of sharing data. It will be a delicate balancing act: While the inclination will be for travel companies to circle the wagons around their data, the more information they provide smart-speaker algorithms, the better they can fulfill a customer's query and the more satisfaction customers will derive from the new channel.

Smart-speaker companies may also create their own loyalty programs, à la Amazon Prime, in an effort to collect more travel-specific data on their own.

## ADAPT TO VERBAL SEARCH

Over time, smart speakers will be less about the device and more about the technology that allows consumers to talk to any device. Travel providers, like most consumer-facing companies, need to start thinking about crafting content that reflects that reality. For instance, travel companies should consider making their current Apple and Android apps voice-enabled or adding branded “skills” that can be loaded onto Alexa. Presumably, this means partnering with a provider of that technology – and the best choice may be the one that is the most mobile. Indeed, Apple already offers a Siri software development kit to allow app developers to tie into its smart assistant technology.

In the age of Alexa and Google Assistant, branded search terms could also become even more important than they are now. How many times does the waiter at your favorite restaurant get to the end of the specials, and you no longer remember the first one? Listening to a voice search can pose a similar challenge when you’re asking about hotel or flight choices. Google has found that online searches with branded keywords have a conversion rate – turning a search into a transaction – over two times higher than searches without them. So, encouraging branded voice search should become a priority. One can imagine hotel chains or airlines providing discounts or loyalty-point bonuses to customers who use a brand in a conversational AI query, such as “book me a flight on Southwest to Dallas Tuesday night.” Providing added inducements to use

voice channels and branded search should reinforce loyalty programs and the brand’s identity.

Smart speakers, still in the toddler stage as far as the development of the technology, mark the beginning of a new voice-enabled era of travel. Although travel providers have not led the pack on customer technology interfaces thus far, they now have another opportunity, with a particularly consumer-friendly technology, to change their image. They should seize it.

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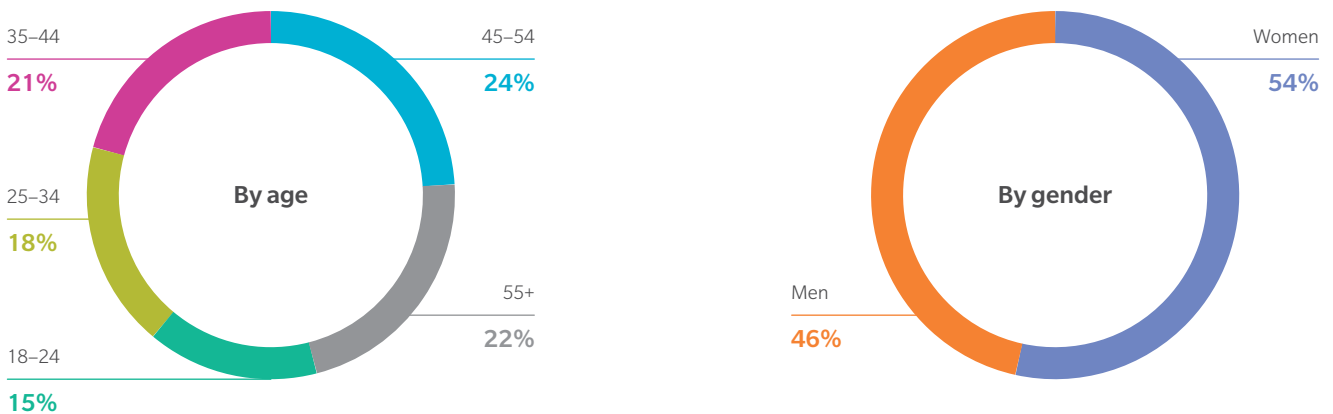
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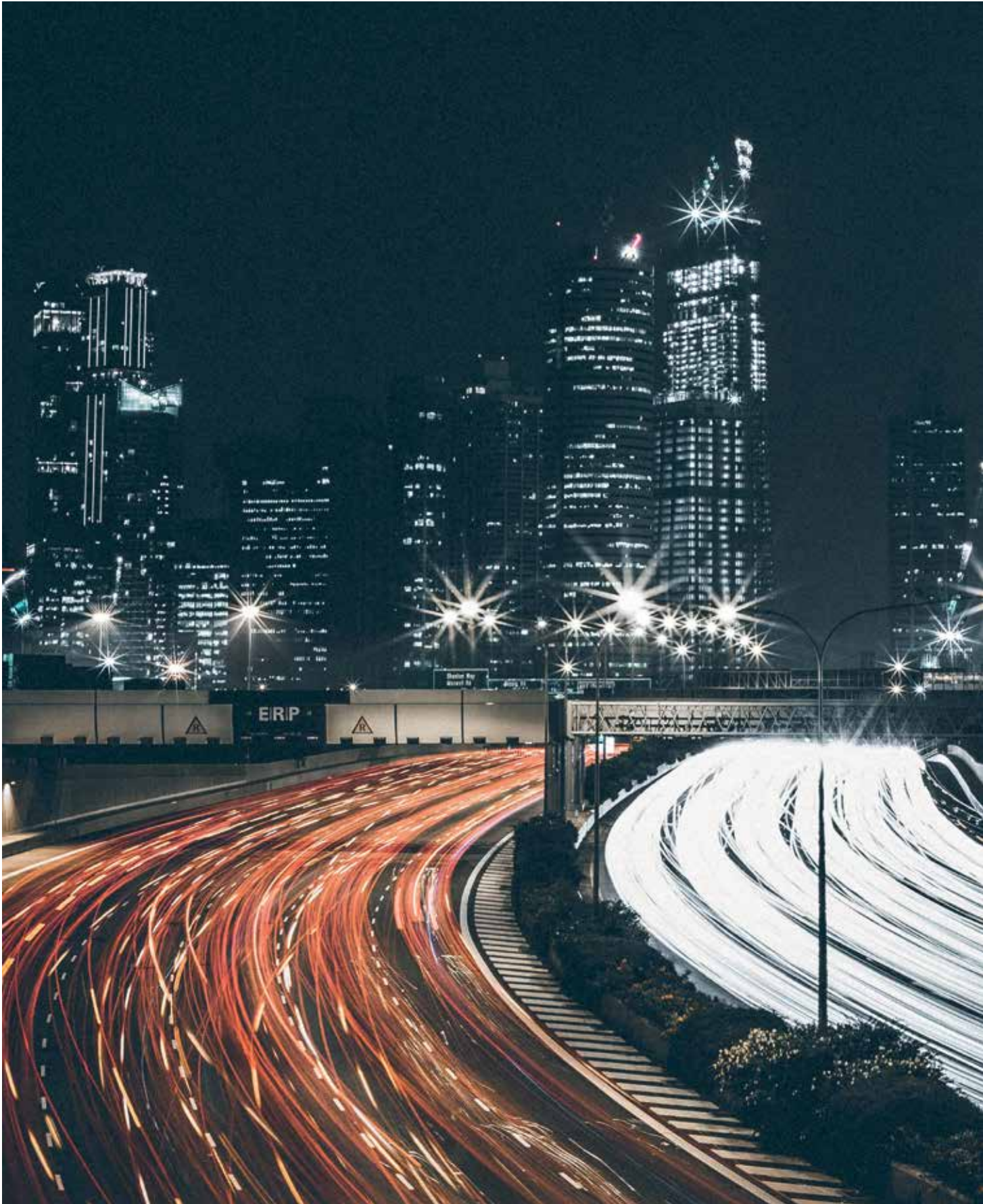
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## 43 MILLION ADULTS IN THE UNITED STATES OWN SMART SPEAKERS



Source: NPR and Edison Research





# PATENTING THE FUTURE OF MOBILITY

Google is racking up more patents than most automakers on connected and self-driving cars

Juergen Reiner • Andreas Nienhaus



WILL AUTOMAKERS OR technology companies put consumers behind the wheel of autonomous automobiles? Certainly, the car manufacturers have the edge on the hardware, but a small tug of war is brewing when it comes to the intellectual property that will ultimately make connected and self-driving cars a reality on the road.

Companies like Google, Facebook, and Apple are pouring enormous resources into a vision of mobility that focuses on the driver experience – so much so that they have the potential to take away some of the limelight – and profits – from the automakers many presumed would dominate car connectivity and driverless technology.

As personal computer manufacturers learned in the 1990s, controlling the hardware alone does not ensure

profitability. What makes Apple so smart – and still able to charge over \$1,000 for a laptop – has been its focus on the intellectual property. The bottom line for automakers: Keep pushing forward with research and development, and find the right technology companies with which to partner.

## PATENT RACE

The biggest tech contender in the mobility space is probably Google, which has been patenting intellectual property as fast as the leading car companies and once even considered building its own fleet. In 2016, Google parent Alphabet Inc. created Waymo, a company dedicated to commercializing Google's self-driving car technology, and began a hunt for partners. Recently, the Alphabet division entered a joint venture with car-sharing company Lyft.

Between 2012 and 2016, there were slightly more than 5,000 mobility patents filed by 12 leading automakers and global tech companies, according to research conducted by Oliver Wyman and World Intellectual Property Organization (WIPO). Of these, almost 3,800 were filed by six car companies – Audi, Daimler, General Motors, Volkswagen, BMW, and Tesla – that related to green car technology, including electric cars, batteries, fuel cells, and alternative fuel. In this category, the tech companies filed just seven patents.

A very different story emerges, however, in an analysis of patents involving connected and self-driving cars. Here, where technology tends to touch the driver more directly than in the green car area, there were almost 1,200 patents, close to one-third of which were filed by tech companies, led by Google. In fact, in the connected car and self-driving category, Google filed almost as many as the leader in the category

Audi – 221 versus 223 – and more than BMW (198) and Daimler (159) individually, and more than GM (141) and VW (75) combined. The other five in the non-auto group were Apple, Facebook, Microsoft, Amazon, and Uber.

## CAR-SHARING TECH

In the area of mobility services, which includes car-sharing and navigation technologies and app development, the tech companies actually filed more patents than the automakers – 55 versus 44. And, while one might expect Uber to be among the leaders here, it was dead last with only two patents. Google once again dominated with 30 patents, trailed by Apple (14).

The auto companies' preoccupation with green vehicles makes sense, given the anticipated increase in the regulation of emissions and the pressure to move to a low-carbon or no-carbon economy, particularly in Europe and China. Five of the manufacturers had the vast majority of their mobility-related patent work in the area of green vehicles. The only carmaker that did not have the majority of its patents in this category was the one fossil fuel-based US manufacturer, GM; 65 percent of GM's patents were in the connected car and self-driving category. (See Exhibit 1.)

This analysis leads to two overarching conclusions. First, the research and development activities of digital players like Google show how serious they are about becoming part of the mobility ecosystem. Where the number of mobility patents increased over the five years for tech players by 50 percent, the number actually decreased for the six automakers. The research and development budget rose 20 percent for the tech players and five percent for the car companies.

## LOOKING TO ENGAGE THE CUSTOMER

Second, by targeting only service-oriented and software-based mobility segments, the digital players picked areas with high levels of customer interaction and engagement. This allows them to pursue a strategy of establishing a new customer interface through mobility services with drivers, opening up the possibility in the future for the software and connectivity capabilities to become the point of differentiation rather than the hardware.

For auto manufacturers, this should be a wake-up call to develop a more focused mobility strategy. Rather than trying to compete head-to-head with players like Google in software-driven mobility segments, carmakers may need to limit investment to mobility services where they can dominate and partner with tech companies.

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>5,000

MOBILITY PATENTS FILED  
BETWEEN 2012 AND 2016



Recently, carmakers also have been teaming up with each other to push into areas like traffic monitoring and navigation services.

Securing customer access through partnerships and by integrating mobility service providers into their own platforms will help automakers to compete better with current and future digital disrupters in their ecosystem. Here, Tesla has an advantage, because its innovation model is based in part on an open-source system – a reason its patent numbers are low. That allows the electric car company to focus its research and development clearly. More than 70 percent of Tesla’s patent filings over the past five years have been concentrated in the area of developing batteries, charging, and electrification.

This is a turning point in automotive history. The automobile is undergoing a transformation, moving

from a means of conveyance to becoming a data center on wheels. For car manufacturers to maintain their leverage in the direction the auto will go next, they have to build alliances and concentrate research and development resources today.

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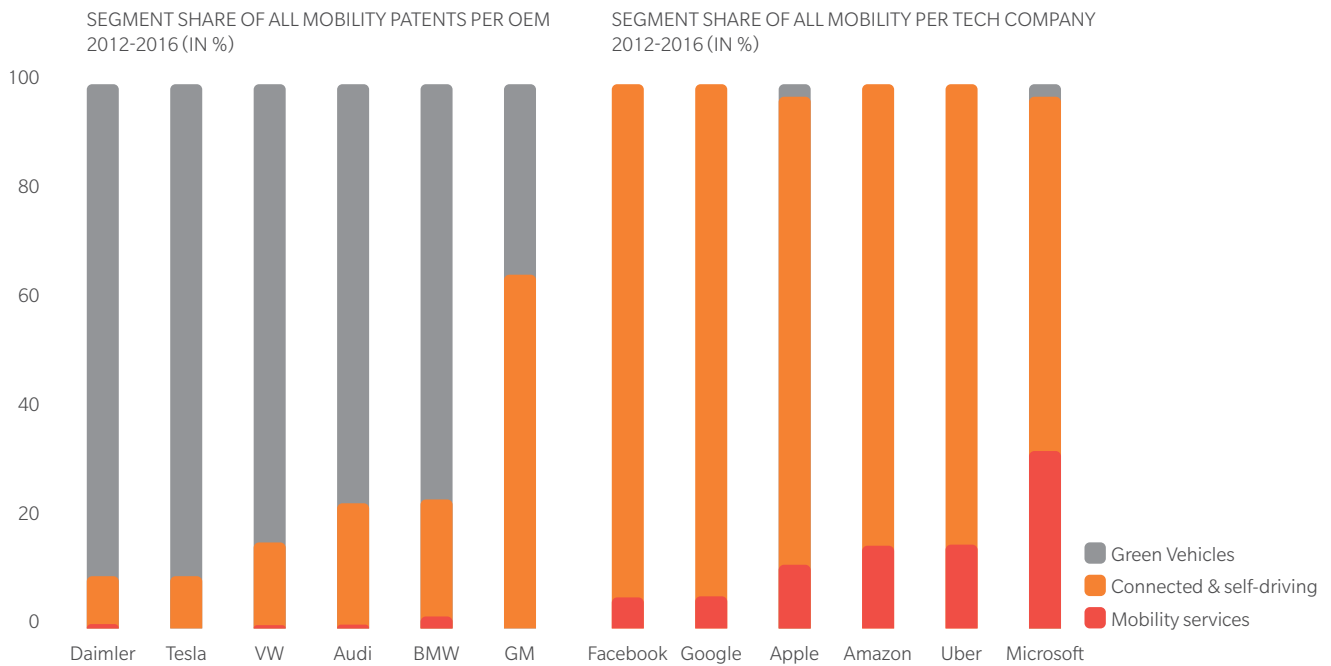
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*This article first appeared in Forbes on May 17, 2017.*

**PATENTING AND R&D STRATEGY OF INCUMBENTS VS. NEW PLAYERS**

CARMAKERS FOCUS ON PRODUCING HARDWARE FOR MOBILITY SERVICES, WHILE TECHS FOCUS ON SOFTWARE




Sources: World Intellectual Property Organization (WIPO), Oliver Wyman

# THE HURDLES DRONES FACE

Regulators grapple with the risks of autonomous flight as they work to incorporate drones into commerce and the airspace

Dave Marcontell • Steve Douglas • Guillaume Thibault • Robbie Bourke





THE WORLD OF AVIATION and aerospace is on the cusp of a revolution based on autonomous flight and drone technology. While today's drones are used for such tasks as inspecting tracks or power lines and assessing wildfires, tomorrow's larger models will transform industries like construction and retail by carrying heavy cargoes to hard-to-reach places. In less than a decade, traffic congestion and urban pollution could be eased by electric unmanned aircraft transporting people or products around cities.

Yet, reaching that potential will take new regulation and most likely advances in technology to enhance safe operation. Despite the business community's impatience with what is seen as a go-slow approach to drones, a failure to sufficiently test and validate these rapidly emerging technologies could doom that blossoming revolution with the first loss of life from a drone mishap. Before the technology can be embraced for extensive commercial use, the risks – especially from bigger drones – must be identified, and strategies to mitigate those hazards must be developed.

## A WORLD OF NO

Where do we stand today? In the United States at least, most federal regulations on drones restrict their use: Drones, or unmanned aircraft systems (UAS), cannot fly over most federal facilities or over people; drones cannot fly at night or within five miles of an airport without permission; drones must fly below 400 feet and at less than 100 miles per hour; with some exceptions, they must weigh under 55 pounds (25 kilograms); and they must yield the right of way to manned aircraft. Some states further prohibit the use of drones in hunting; in

California, drones cannot be used to record another person without getting consent. And in probably the most limiting regulation when it comes to the widespread commercial use of drones, they must be kept in the operators' line of sight at all times.

Recently, a congressionally mandated report from the National Academies of Sciences, Engineering, and Medicine chided the Federal Aviation Administration (FAA), the primary regulator for UAS, for focusing on the risks posed by drones instead of their potential benefits. "Fear of making a mistake drives a risk culture at the FAA that is too often overly conservative, particularly [with] UAS technologies," the National Academies report concluded.

Most drone proponents want regulation relaxed on flying small drones beyond the limit of sight. Here, the Academies' criticism may have some validity, as there can be no substantial commercial application if businesses must request permission from the FAA each time they want to fly beyond an operator's line of sight. Given that drones are essentially relegated to sparsely populated locations, the FAA could consider a partial relaxation in cases involving the typical under-55-pound drone.

## OPERATING BLIND AND BIG

Broader regulation mandating that all aircraft be able to see and avoid other aircraft, however, prevents the agency from a total elimination of the line-of-sight rule. Drones operate without human pilots, so they cannot comply. Currently, the Volpe Center, a research unit within the US Department of Transportation, is developing a radar system that would enable remotely

piloted aircraft to detect and avoid traffic at a level of safety equivalent to the see-and-avoid capability of manned aircraft. But until something like that is developed, an across-the-board repeal of the rule seems imprudent at best.

Another set of risks that the FAA and regulators worldwide must consider involves drone size. While there are a lot of interesting uses with sensor technologies and video on smaller UAS, drones almost certainly will have to grow well beyond 55 pounds to have any real commercial and logistical value. Yet, it would be unacceptable from a public safety standpoint to simply remove that prohibition without considering – and mitigating – the risks inherent with large drones.

If a small, battery-powered drone falls out of the sky, particularly now when they are barred from operating in populated areas, the risk is minimal. That will change dramatically if big UAS begin to travel long distances and run on fuel. To carry multiple packages for delivery services or move heavy equipment, drones will need to be similar in size to today’s military drones, which can weigh almost 5,000 pounds. At that size, a drone falling to the ground in a crash could destroy a building and pose a lethal threat to anyone in its way.

## AIRWORTHY ENOUGH FOR PEOPLE

There is also the inevitable question of human transport with drones. As urban areas expand and

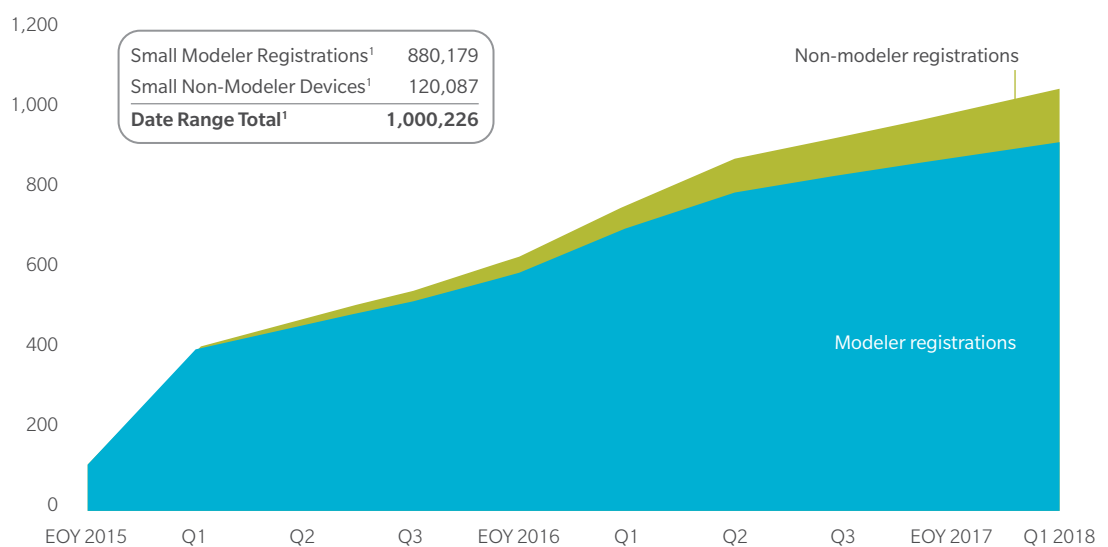
ground congestion intensifies, the economic case for pilotless air taxis gets stronger. Uber Elevate, among others, is pursuing this vision aggressively. Yet, a large drone carrying one or two passengers raises the risk factor exponentially.

It is not difficult to build an all-electric vertical takeoff and landing (eVTOL) aircraft that can carry passengers – there are about 50 prototypes of these air taxis worldwide. The challenge is figuring out how to raise drone design reliability standards to be more akin to those of commercial aviation, in which a system failure is tolerated every one billion hours of flight. Bigger drones raise questions of airworthiness and reliability that go far beyond the standards that apply in the consumer electronics world of drone hobbyists.

Current commercial drones have a significantly worse record for failure-free performance. For example, 15 percent of new micro-drones sold today have bugs that will ground them within six months. Regardless of the demand and potential for drones, regulators would be very unlikely to sign off on vehicles with such a low standard of airworthiness.

The history of urban helicopter commuting provides a lesson on the outcry that follows accidents. In 1977, a helicopter landing on the heliport atop the 59-story Pan Am Building in midtown Manhattan flipped over, killing four passengers waiting to board and a pedestrian on the ground. The crash led to the shuttering of the helipad, bankrupted the operator, and essentially doomed widespread urban helicopter transport ever since.

### BY THE BEGINNING OF 2018, TOTAL DRONE REGISTRATIONS WITH THE FAA HAD TOPPED ONE MILLION THE FAA EXPECTS REGISTRATIONS TO TOP THREE MILLION BY 2022 (IN THOUSANDS)



1. Cumulative FAA registrations of modeler (hobbyist) and non-modeler including commercial and research drones as of January 18, 2018

Source: US Federal Aviation Administration, Oliver Wyman analysis

Then, there is the possibility of cyber terrorism, which applies to both large and small drones. Like any digital system, drones and their control systems can be hacked, and the FAA will have to incorporate IT security and redundancy mandates to reduce the hackability of drones as part of any certification standards the agency develops.

## CONTROLLING PROLIFERATION

Finally, the FAA must consider how to regulate the various players using drones, preventing an operator, for instance, from flying a drone in airspace where it poses a risk to the public. For this, technology may need to be developed that could take control of a drone, if it flies outside approved air space, and bring it down in a controlled manner.

Even without a fully developed definition of how drones fit into the national airspace, they are rapidly proliferating. At the end of last year, the FAA registry for drones topped one million. More than 800,000 of these are registered to hobbyists, the rest to businesses. The FAA projects that by 2022, the number of registered drones will soar above 3.8 million. That makes for an increasingly crowded sky, substantially raising the risk of collisions.

Recently, 10 federally sponsored projects were selected to explore what regulations make sense for drones – testing everything from mosquito control in Florida, to medical equipment delivery in Nevada, to food delivery in California. For these projects, the FAA has waived current restrictions on drone use so the companies can provide it with data that will help shape a certification process and new rules. Among the companies involved in these pilot programs: Alphabet's Project Wing, Flirtey, Airbus, Apple, AT&T, Intel, Microsoft, and Uber.

That said, rulemaking is a slow, measured process. It may be five years before US regulations support the widespread use of drones in everyday commerce.

## MEANWHILE, IN THE EU

The economic stakes are high. In the European Union, research by the public-private partnership SESAR (for Single European Sky Air Traffic Management Research) shows that the rapidly developing drone sector could account for 10 percent of the EU's aviation market by 2050 – about €15 billion a year and 150,000 jobs. Currently, drones are regulated by the European Aviation Safety Agency (EASA) and various national regulators, depending on drone size. But the EU is working to unify its rules, as differences from country to country complicate cross-border trade and provide uneven levels of safety. Under a recent compromise, the European

Commission and EASA will take the lead in rulemaking for a European drone ecosystem, expected to be finished in 2019.

While the debate over drone regulation is in its early stages, there's little doubt there will be a Grand Canyon-size gap between what industry would like in certification standards and what the FAA and other regulators are willing to approve. As it is, tech companies and startups experimenting with drone technology have moved research operations out of the United States to places like Dubai where regulations are less stringent.

In the end, a new category of air operator may emerge – companies that are certified and approved to operate larger drones. Here, the numbers will not be in the hundreds of thousands but more likely in the hundreds. And that transition – from an open-access system of ownership and operation to one with similar controls and barriers to entry as aviation and aerospace manufacturing – may be tumultuous as companies vie for what is currently an elusive standard of certification.

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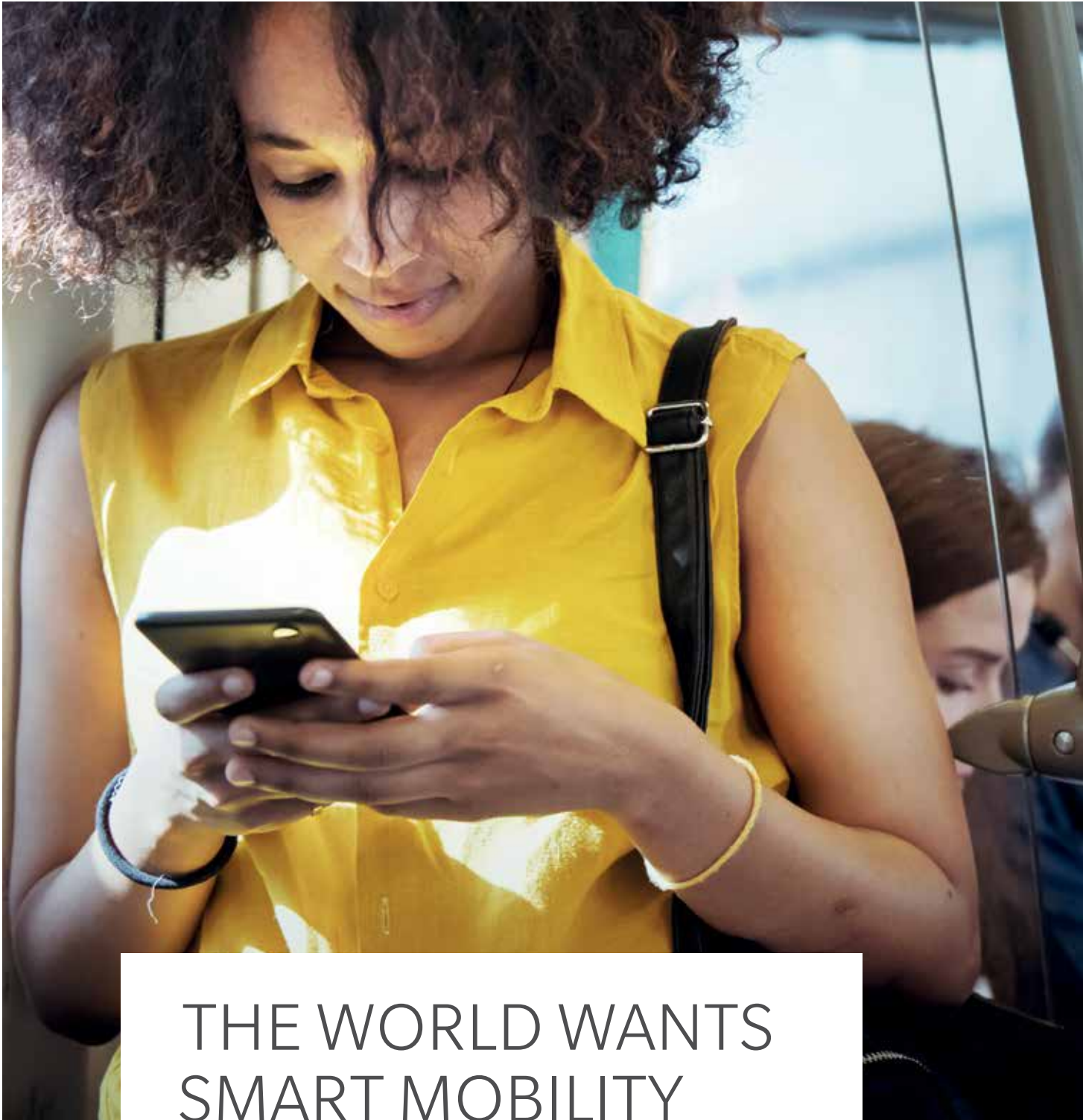
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# THE WORLD WANTS SMART MOBILITY

Survey says: Consumers would pay more and even switch modes of transportation to get seamless digital services

Joris D'Inca • Patrick Lortie • Anne Pruvot



THE FUTURE OF EFFICIENT, seamless, and personalized transportation gets closer to reality each year. Right now, it's seen in apps that order rides or book travel with a click or smartphone alerts that tell passengers how long until the next subway arrives. It's the apps that show drivers where to find parking spaces.

Not too many years from now, the same kind of centralized databases and platforms that make today's apps possible will give people access to driverless cars on demand and adjust the flow of city traffic, based on real-time data feeds. Commuters will be able to swap travel options on the fly, jumping from driverless ride-sharing to autonomous bus-train connections to avoid delay.

All this will be part of "smart mobility" – the future's digitally connected approach to today's travel problems. With smart mobility, digital platforms will be designed to manage the travel experience from end to end and allow consumers to plan, book, and pay for their trips through one outlet – even if several providers are required to complete the journey. Only a few clicks away, integrated travel services like route maps, real-time travel information, real-time seating choices, and advanced porter booking will be available.

## THE REWARDS OF BEING SMART

Right now, businesses are rushing to develop smart-mobility platforms and services, including travel operators like airlines and rail companies, digital giants such as Google and Amazon, and savvy technology startups. The rewards of unlocking smart mobility could be vast: Innovative mobility services are projected to see a fivefold increase in their share of travel spending by 2040 and generate an estimated \$270 billion in revenue and up to \$150 billion in profit for providers.

But are consumers ready to embrace smart mobility? Oliver Wyman conducted a survey of 7,500 consumers across Germany, France, Italy, China, and the United States, and it turns out the majority are ready to change their preferred mode of transportation and pay more to get access to these kinds of services.

The percentages of consumers who consider smart mobility important are overwhelming: In China, a stunning 98 percent of those surveyed ranked it as important or very important; in Europe, 93 percent; and in the United States, 83 percent. Among respondents 18 to 35 years old whose principal transportation is a private car, 97 percent said they would consider switching to public transportation to gain access to smart-mobility services. Even among those 65 and older, 76 percent said they would consider a change. For those who use public transportation, similar percentages would move to automobiles for smart-mobility advantages.

## CONSUMERS READY TO SPEND MORE

The survey also found that 84 percent of respondents said they would shell out an additional fee to use integrated smart-mobility solutions. That includes 89 percent of millennials and Generation Z travelers and 75 percent of senior travelers.

Among commuters, many said they were willing to add a flat fee on top of their current transit bill each month for a bundle of smart-mobility services, similar to the way they opt to add premium channels to monthly cable charges. On average, commuters said they would pay 4.1 percent above their monthly commuting cost for multimodal, door-to-door journey planning and 2.9 percent more for real-time travel information and rerouting to avoid delays.

People also are willing to pay more for long-distance travel that involves smart-mobility services. Long distance, in this case, is defined as a trip of more than 100 kilometers. With these trips, consumers indicated they would pay on average 3.3 percent more, and as much as 5.8 percent more, for multimodal, door-to-door journey planning, and 2.4 percent more on average for real-time information and rerouting.

home but quickly switch to a subway if real-time data shows traffic delays. Another example would be the smart sensors and analytical tools that can help a city ease traffic congestion.

Beyond travel services, smart mobility includes activities that can keep passengers occupied during a trip – browsing shopping sites, taking online courses, and enjoying movies or music, for example – as well as those that offer options for the end of the trip, such as sightseeing or dining. It also can tie in related services, such as purchasing theft, casualty, and travel insurance. Like travel services, these would be provided via a digital platform that completes transactions with a click or two.

Here again, survey respondents showed considerable interest in improved access, with the addition of insurance services being the most popular. On average, respondents said that for long-distance trips, they would spend 5.4 percent more for the opportunity to buy travel, theft, and casualty coverage as part of the end-to-end journey and 2.5 percent more to access e-commerce sites. Daily commuters said they would pay an additional five percent for entertainment and 5.6 percent for educational offerings.

## SEAMLESS CONNECTIONS

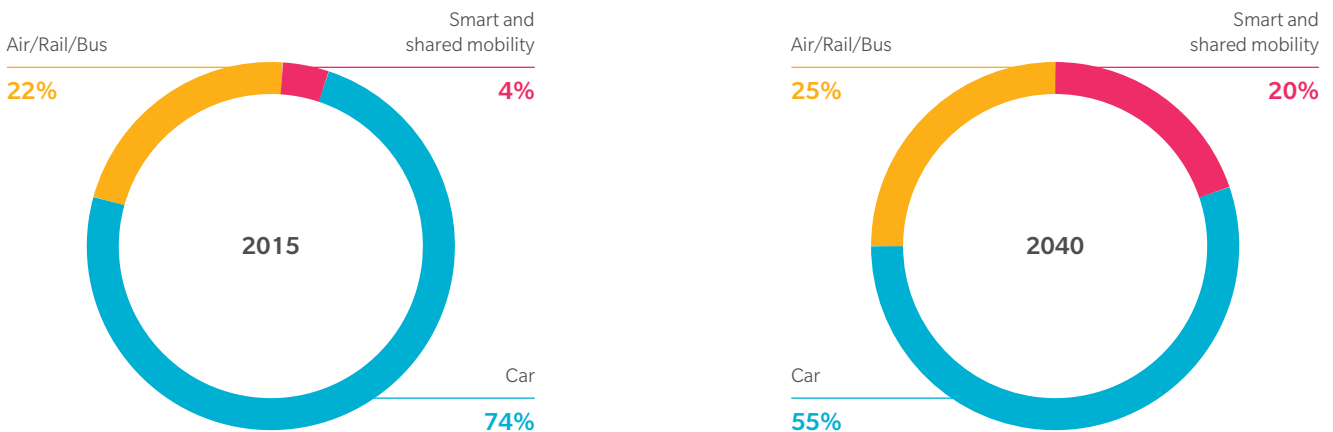
An example of a personalized, flexible, end-to-end travel service consumers say they want is the digitally connected multimodal hub that allows passengers to seamlessly transfer from one mode of transport to another. This could be created at a train station or airport where, using an app, a traveler can arrange a ride-share

## GETTING THERE FIRST

As autonomous and artificial intelligence technologies are increasingly incorporated into the daily lives of travelers, the race is on among travel operators, digital giants, and innovative startups to establish the first foothold and gain the advantage in smart mobility. The challenge will be to see which will develop more

## SHARE OF PASSENGER TRANSPORT SPEND WILL INCREASE FOR INNOVATIVE SERVICES

RELATIVE CHANGE OF TOTAL MARKET IN PERCENT FOR REPRESENTATIVE COUNTRIES



**Note:** Includes China, USA, Germany, France, and Italy. "Shared mobility" refers to the sharing of previously individual mobility options, such as cars. "Smart mobility" refers to services that provide real-time, seamless travel data and options.

**Source:** Oliver Wyman analysis



dynamic, personalized offerings and seize a competitive edge by controlling smart-mobility portals that seamlessly connect transportation options.

No doubt, access to personal data and the ability to analyze it are necessary elements for building customized smart-mobility options. Despite recent breaches and tighter regulation on data, consumers still show a willingness to share personal information for a quid pro quo: More than half of the consumers surveyed in the five countries – and 80 percent in China alone – said they would give providers their personal data and travel preferences in return for services.

Currently, travel providers hold a slight edge with consumers, according to our survey. But smart mobility is a fast-moving target, with some data-savvy digital giants already entering parts of the market and successfully dominating many of the services not exclusively linked to travel. To stay ahead, travel operators may opt to partner with digital giants and startups to access the data and technical expertise needed to power the next round of travel innovation. Meanwhile, agile smart-mobility startups attracted \$40 billion in investments from 2011 to 2016, with the funding roughly doubling year over year.

To be sure, not even smart mobility will eliminate urban congestion and all travel delays. But a transformation in travel is inevitable. The challenge for travelers and travel providers alike will be keeping

up with the ever-shifting landscape of transportation and technology options reshaping long distance and local travel.

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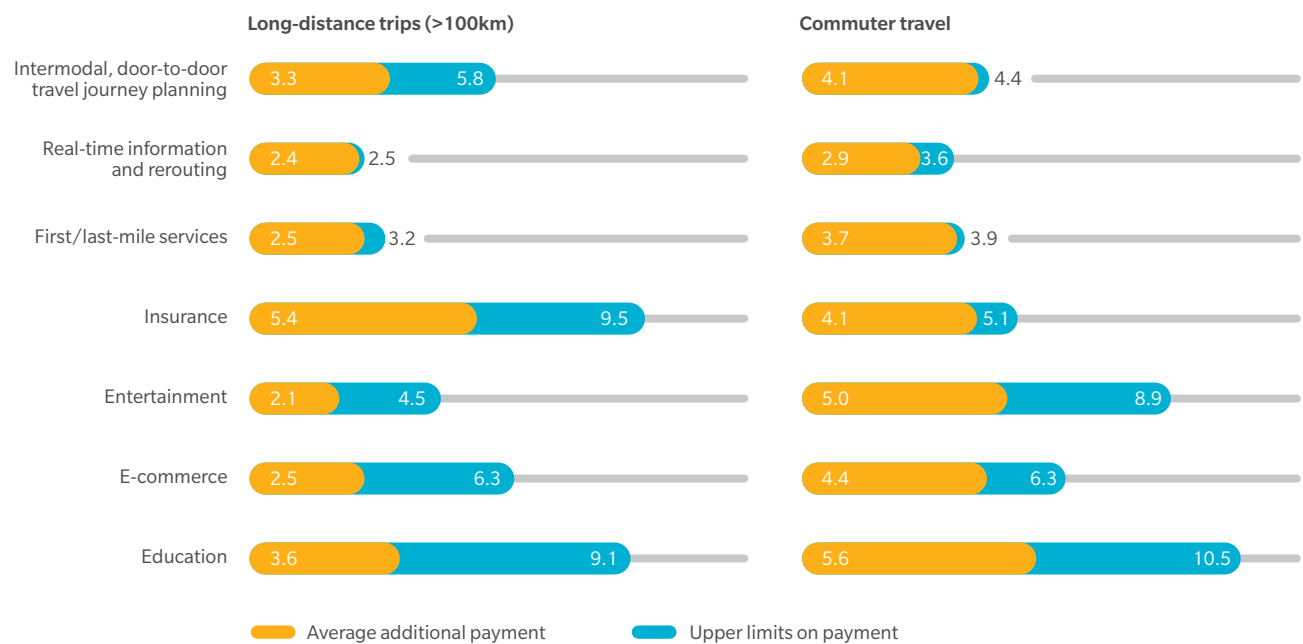
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For more information on this research, please see “Mobility 2040: The Quest for Smart Mobility” on [www.oliverwyman.com](http://www.oliverwyman.com). This article originally appeared in *Forbes* on August 28, 2018.

**CONSUMERS ARE WILLING TO PAY EXTRA FOR SERVICES**

PERCENTAGE ABOVE BASIC TICKET PRICE FOR LONG DISTANCE TRAVEL AND MONTHLY COMMUTING



Source: Oliver Wyman Mobility 2040: Smart Mobility survey

# AUTONOMOUS TRAFFIC JAM

The newest technology may not save trucks from highway congestion, potentially benefiting rail over the short haul

Patrick Lortie • Rod Case • Alexandre Lefort

THE TRADITIONAL COMPETITION between freight railroads and trucks in North America is about to escalate as new economic and technological forces come into play over the next several decades. The development of connected and autonomous vehicles (CAVs) could substantially reduce truck operating costs, making trucks more competitive with rail just as the economy is shifting toward more truck-favorable goods.

Trucking companies are already testing new technologies through “platooning” – in which two or three wirelessly connected vehicles with advanced driver assistance systems travel together. This allows for much closer spacing between trucks, reducing fuel costs. The next step will be multiple driverless trucks that follow a lead truck with a driver. Together with other technology improvements, overall truck operating costs could drop 40 percent in the next 10 to 15 years.

New Oliver Wyman research suggests, however, that there is one problem for trucking that technology won’t solve for at least the next two decades at least: Highway congestion is going to continue to increase – particularly in and around large urban areas. This will have an outsized impact on trucking, possibly leading to service deterioration and supply chain disruption. It will also create an opportunity for rail.

## THE CAPACITY CONUNDRUM

Vehicle traffic, including truck volumes, are projected to rise steadily through 2045, as more Americans





establish homes in cities and suburbs and e-commerce increases freight volumes. This means that as the number of cars and trucks grows, roads are going to get a lot more crowded in the near term.

What impact will autonomous vehicles have on all of this? Thanks to tighter spacing, more stable speeds, and safer vehicles, commercial truck platoons should make more room on the roads for cars and smaller trucks. As cars also get smarter, even more highway capacity will be created.

That said, this won't matter if smart cars and trucks end up being on the road a lot more. Will people abandon public transit and carpooling for longer single-person commutes? Will "fleet" autonomous vehicles endlessly travel the roads between pickups? Will automated trucks take up highway capacity 24/7, essentially creating a "rubber-tire railroad"? As of now, it's simply too early in the game to answer these questions with certainty.

### FUTURE SHOCK

Still, it is possible to consider potential scenarios for the impact of CAVs as a guide toward competitive and public policy decision-making. To this end,

Oliver Wyman recently developed a range of scenarios for key highways in several states and metro areas through 2045. These scenarios consider various assumptions about traffic growth and the timing and penetration of autonomous cars and truck platoons.

As shown in the accompanying maps, our most likely scenario found that significant peak hour congestion will spread out from the central cores of big cities like Los Angeles and Atlanta to encompass much larger areas. While highways outside of metro areas will be less affected, popular connectors, such as State Highway 114 between Dallas and Fort Worth, will see much higher peak-hour congestion.

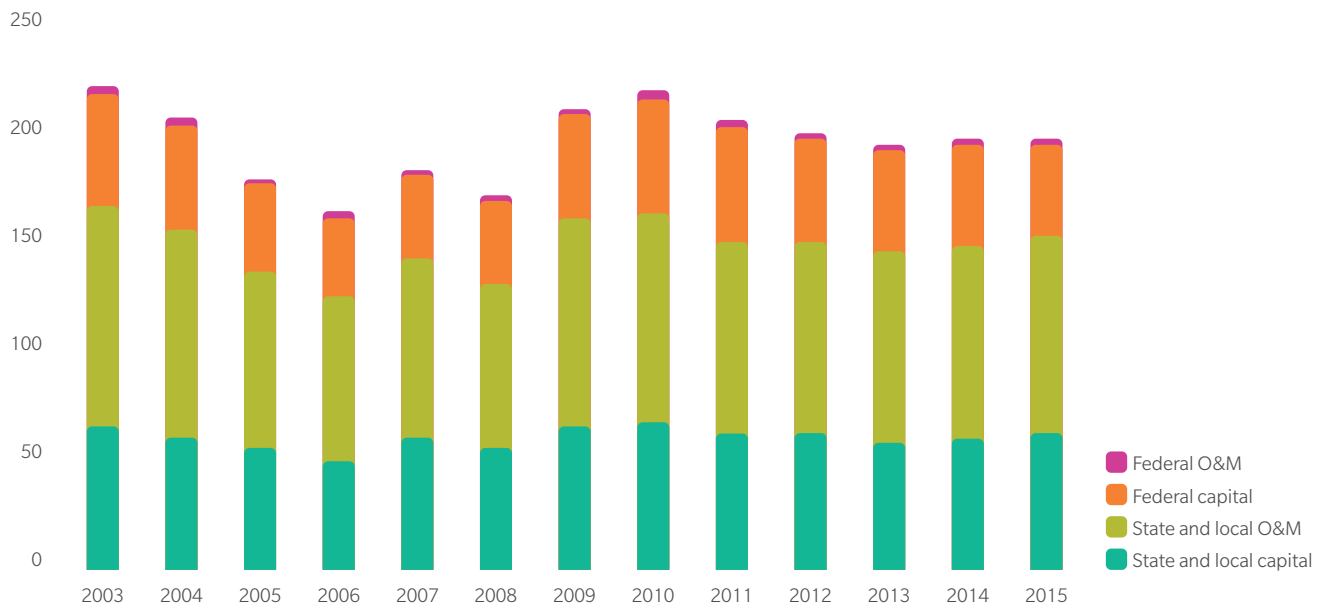
For the sampled states, Oliver Wyman estimates that truck vehicle-miles traveled on roads already above capacity will rise from 4.7 million in 2016 to 52.2 million in 2045 – an eleven-fold increase.

### THE NEED TO TAX

More cars and trucks mean more wear-and-tear to on the nation's highways and roads. Meanwhile, federal and state governments have been unable to keep pace with highway infrastructure investment needs. Federal

### MORE POTHOLES ARE LEADING TO MORE CONGESTION

GIVEN THE INCREASE IN TRAFFIC, GOVERNMENT ISN'T SPENDING ENOUGH ON ROAD REPAIR (2015, IN BILLIONS OF US DOLLARS)



Sources: Federal Highway Administration, Highway Statistics, various years, tables HF-10, HF-10A, FA-5, SF-2, and LGF-2; Federal Highway Administration, National Highway Construction Cost Index (NHCCI) 2.0; and Oliver Wyman analysis

and state per-gallon fuel taxes – which pay for highway maintenance and upgrades – have barely increased. The federal fuel tax hasn't risen since 1993; state fuel taxes have gone up, but not enough to make up the shortfall.

Commercial trucks benefit from the failure of government to raise taxes: The industry already pays less in fuel taxes than the cost of the damage that its trucks do to highways. By contrast, US freight railroads privately fund nearly all their infrastructure.

With an ever-widening gap between fuel taxes and investment infrastructure needs, lawmakers are forced to consider funding alternatives, such as direct highway user fees. Tolling is one option: From 2005 to 2015, state toll road mileage increased 18 percent for interstate roads and 23 percent for non-interstate roads.

A second option would be a tax on vehicle-miles traveled, which a few states are researching. While the tax is likely to ease the current investment shortfall in highway infrastructure, getting it passed would be a heavy lift politically.

## RAIL'S OPPORTUNITY

As more and more trucks compete for space on congested roads, rail could prove to be an attractive alternative for some shippers, especially for containerized freight. Oliver Wyman estimates that if congestion results in a diversion of 20 percent from truck to rail of the 43 million annual non-bulk truckloads that travel at least 500 miles, this would equate to an additional 8.5 million rail intermodal shipments per year, a 33 percent increase over current projections.

Rail has a couple of advantages, compared to trucks facing highly congested road conditions: Trains can move through many intermediate urban areas faster than trucks, and many rail intermodal terminals are in urban areas. That means shorter truck hauls from terminals to customers, the final leg of the trip. Railroads could further capitalize on this situation by opening more terminals in areas where increased congestion is likely. Where they have enough space next to the rail line, railroads could even create truck-only roads to speed up deliveries to customers.

There are two caveats, however, for rail. Once the penetration of self-driving passenger cars becomes high and the number of non-CAV cars on the road falls, the freed-up highway capacity will stop the growth of congestion, most experts believe. Under such conditions, rail could see a decline in intermodal volumes or have to reduce prices to prevent that.

Second, even if railroads are able to divert intermodal truck traffic for a time, their overall market share of transportation will still drop over the next 25 years; the only question is by how much. That's because the

overall economy is accelerating away from the traditional low-value, bulk goods that favor rail, such as coal. The fastest-growing commodities will be lightweight, high-value electronics and consumer goods. Shipment sizes and distances will continue to shrink as well, as customized items drop ship on demand directly from manufacturers and artificial intelligence-based predictive inventory practices move goods automatically from local distribution centers to customers.

If the rail industry is to continue growing and thrive into the mid-century, the longer-term outlook indicates a need for rail to evolve in tandem with the changing economic and transportation landscape. These changes need to be groundbreaking, involving adaptation on multiple fronts, from a more aggressive focus on resilience and better use of the rail network to productivity improvements and long overdue technology innovation.

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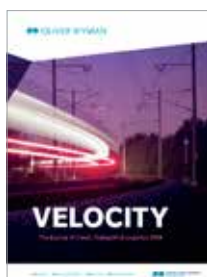
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