

A close-up, high-angle view of the front left corner of a bright red sports car. The car's sleek, aerodynamic lines are highlighted by the lighting, showing the headlight, hood, and part of the windshield. The background is a dark, textured surface.

# Autonomy: Enabling trust for the masses

**Holistic technology governance of  
the smart mobility ecosystem will  
pave the way**

[kpmg.com](https://www.kpmg.com)

# Barriers to mass autonomy

**Holistic technology governance**—a framework for directing, controlling, and overseeing the behaviors and actions of disparate participants in the future mobility ecosystem—will help spur mass-market adoption of fully autonomous self-driving vehicles. By implementing policies, rules, and standards for participating in the system, and enabling the exchange of data between numerous different technologies and platforms, it will be a key driver of safe, reliable, and efficient usage of self-driving vehicles on a mass scale and the future of transportation overall.

## Executive summary

Since 2012, KPMG has tracked a technological revolution: the rise of autonomous vehicles. We've studied the incredible impact it is already having on people, businesses and cities, and we've predicted how the future will continue to unfold for all who are touched by the transportation ecosystem.

We've also focused in on one of the barriers to mass adoption of autonomous vehicles: trust. In the first paper in this series, [Trust issues?](#) we asked ourselves what it would take for us to sit in a car with an empty driver's seat. With no one at the wheel. With a machine in charge. With our lives at stake.

Trust is mandatory. We found that how we govern each technological component of an autonomous vehicle—including its hardware, software and data—is essential to gaining trust. And since each component relies on the next to operate, even more important is how we govern all of them as a whole. We introduced the concept of holistic technology governance, a framework for orchestrating the governance of the technologies inside autonomous vehicles that is essential to building the foundation of trust necessary for individuals to regularly use autonomous vehicles.

Now, as the autonomous age gets closer to reality, this paper takes the concept one step further to explore the role of holistic technology governance in the context of the early markets where autonomy first develops—what we call "islands of autonomy." In these islands, autonomous vehicle fleets, individually owned autonomous vehicles and traditional nonautonomous vehicles must harmoniously navigate the streets together, relying on numerous different technologies, including cameras, sensors, connected infrastructure, and wired and wireless networks. How?

Holistic technology governance is critical for islands of autonomy to develop and the autonomous age to arrive. Holistic technology governance sets policies, rules and standards for the behaviors and actions of all island participants, including government departments of transportation, automakers and suppliers, smart transportation and infrastructure businesses, and mobility vendors. This enables the exchange of data between numerous different technologies and helps ensure the safe, secure, reliable and efficient operation of the smart transportation systems through which island participants interact.

Read the following pages to uncover how holistic technology governance drives trust in the transportation systems of the future and adoption of autonomous vehicles on a mass scale.

## Autonomous vehicles (AVs) have arrived. You've probably read about them in the headlines. You might have spotted one next to you on the highway. Maybe you've even ridden in one. But they haven't yet reached the masses. Why?

From a technological standpoint alone, creating cars that drive themselves is one of the most complex scientific problems the world has ever attempted to solve. The pace at which self-driving technologies have evolved in recent years is quite astonishing, requiring billions in investment dollars, huge advances in artificial intelligence, and massive increases in processing power.

Yet, we are still very early in the technology development process. Using the Society of Automotive Engineers (SAE) definition of the levels of autonomous driving systems,<sup>1</sup> the self-driving vehicles you encounter on the road today are likely Level 2 or 3; they aren't "fully autonomous." These vehicles may automate specific functions, like steering, accelerating, or lane-centering, by monitoring the current driving environment. They may even handle safety-critical functions in certain conditions. However, a human driver must still be present and ready to take control and intervene.

Level 4 vehicles, which can "perform all safety-critical driving functions and monitor roadway conditions for an entire trip" are on the verge of entering the market. Companies like Uber and Google's Waymo are already launching autonomous vehicle mobility as a service (AV-MaaS) experiments individually geofenced cities that have been 3-D digitally mapped.

Level 5 vehicles are defined as those that perform as well as human drivers in any scenario and capable of operating *anywhere*. The key word to focus on is anywhere, and is most likely a ways off and may not arrive for 40 or 50 years. Why? The cost, time and investment, etc. for training algorithms from the highest mountain tops to all rural areas anywhere all the time, doesn't make a lot of economic sense, given the size of the country and lack of density of the required vehicle population in those areas.

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<sup>1</sup> Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (Society of Automotive Engineers, September 30, 2016)





What's more, given current production cost ranges, selling a Level 4 car at a price an average consumer can afford just doesn't make economic sense for automakers. Depending on the manufacturer, a Level 4 vehicle's "sensor stack"—containing lidar, radar, sonar, camera, and other detection technologies—currently runs anywhere from \$50,000 to \$150,000. The sensor stack is essential for full autonomy as it feeds data to the self-driving car's "brain," the deep learning algorithms that allow it to make increasingly accurate decisions and upgrade performance.<sup>2</sup> But when you add the sensor stack's cost to the cost of the engine, body, frame, tires and other traditional vehicle parts, it becomes clear that outfitting a mid-range car that sells for \$20,000 to \$40,000 with self-driving technology makes little sense. Only very high-end cars with premium purchase prices could overcome the price constraints of the sensor stack; vehicles intended for mass production cannot. Following Moore's Law—as well as trends in the growth and cost curves of numerous consumer electronics products—we expect the price for autonomous driving technology to drop significantly in the next five years. But today, economic barriers stand in the way of mass autonomy.

In addition, the autonomous vehicle ecosystem is an incredibly complicated challenge. It is this last point where we focus in this paper.

Within each individual market where autonomous vehicles first emerge, different systems, infrastructure, and people will need to harmoniously work together with an extremely low level of fault tolerance. Given the vast technological complexity of autonomous vehicles, numerous stakeholders and unpredictable environmental variables involved, bringing all the components of the autonomous vehicle ecosystem together—hardware, software, data, security, integration, and compliance—together in a harmonious system is challenging the transportation industry.

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<sup>2</sup>I see. I think. I drive. (I learn.): How deep learning is revolutionizing the way we interact with our cars (KPMG LLP, 2016)



- /Autonomous
- /Sensing
- /Communication
- /Battery
- /Navigation
- /Mirrorless
- /Ecology

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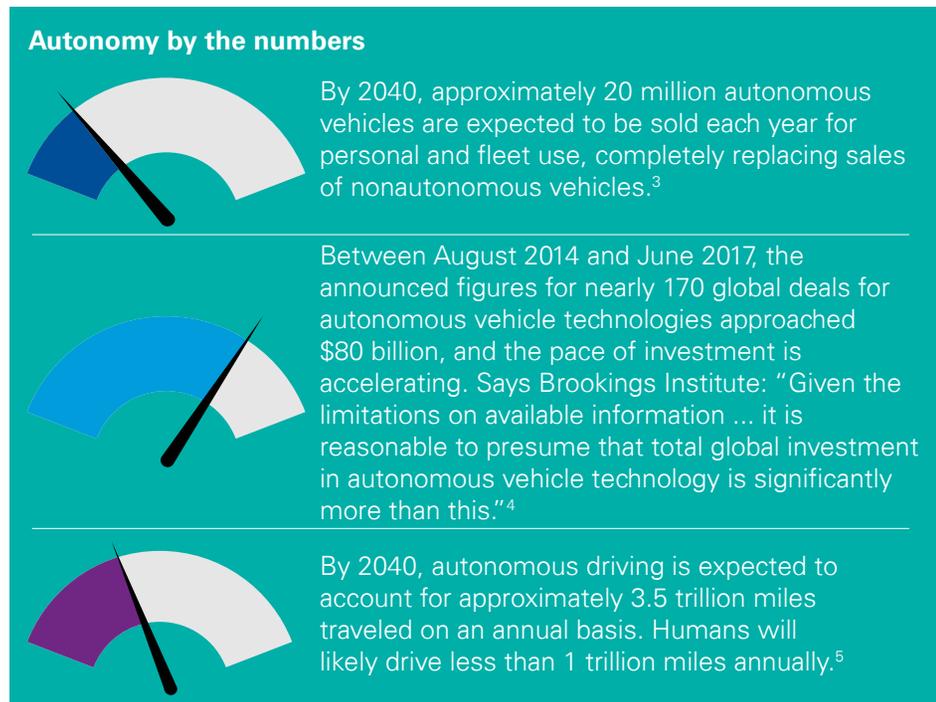
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# Driving conditions for widespread autonomy

The first automobile was invented long before Henry Ford's revolutionary assembly line. People called it a "horseless carriage" and it only caught on initially with the very wealthy. But Ford's process and unique approach to production drove down the cost and spurred mass-market adoption.



<sup>3</sup> Islands of autonomy: How autonomous vehicles will emerge in cities around the world (KPMG LLP, 2017)

<sup>4</sup> Gauging investment in self-driving cars (Brookings, October 16, 2017)

<sup>5</sup> Islands of autonomy: How autonomous vehicles will emerge in cities around the world (KPMG LLP, 2017)

<sup>6</sup> Ford installs first moving assembly line (PBS.org)

<sup>7</sup> Self-Driving Cars Could Save 300,000 Lives Per Decade in America (*The Atlantic*, September 29, 2015)

<sup>8</sup> TomTom Traffic Index

<sup>9</sup> Smart Cities—What's in It for Citizens? (Juniper Research, March 11, 2018)

The technology wasn't the problem. The factories were state-of-the-art. The workers were skilled and motivated. And there was no shortage of demand for faster, safer, more reliable, and more comfortable transportation.

The real innovation was not the car itself but Ford's transformation of automobile manufacturing processes and its supply chain to mass produce cars, faster and cheaper, than anyone ever thought possible. It was Ford's innovation that made automobiles affordable enough for practical mass adoption—and forever changed how the world moves.<sup>6</sup>

## Autonomy benefits

- **Fewer traffic fatalities**

The vast majority of car crashes are caused by human error. When self-driving cars are the norm, studies show that the frequency of automobile accidents may drop by 90 percent, potentially saving 300,000 American lives per decade.<sup>7</sup>
- **Less road congestion**

Autonomous vehicles can synchronize with one another, allowing for optimized speed and braking. Smart traffic systems can adjust traffic light phasing to smooth traffic flows, alter routes away from congested areas, and direct vehicles to the nearest available parking space. Add-on benefits include improved air quality, less public transit overcrowding, and freed up public space.
- **More free time**

According to the TomTom Traffic Index, Los Angeles has the worst traffic in America, with commuters wasting 44 minutes per day and 170 hours per year for extra travel time.<sup>8</sup> Another study estimates that smart mobility projects have the potential to give people across the world back nearly 60 hours per year—hours previously spent navigating in traffic.<sup>9</sup>

## Where will driverless vehicles become commonplace first?

Across the world, a trillion-dollar market is developing around driverless mobility. But human-driven vehicles won't just disappear overnight. The adoption of autonomy will not be immediate and everywhere.

As our recent paper, *Islands of Autonomy*, describes, the transportation market is about to change from a national one to 150-plus unique local markets—metropolitan areas with their own distinct consumer demands.

Autonomous vehicles will likely arrive first in certain locations with specific characteristics, such as urban environments, dense populations, geofenced streets, and strong wireless coverage. First, mobility service providers will require network density afforded by cities in order to affordably meet customer demands for 2- to 3-minute response times. Second, early autonomous cars will likely operate most effectively in geofenced city centers, where they can make frequent observations of the driving environment they will need to gather data and improve performance.

What does this mean for players in the mobility ecosystem? For automakers, what's the winning product and service mix? At the government level, how will departments of transportation support the change from a safety and infrastructure perspective as well as identify new opportunities for monetization?

These new markets will have huge implications for the transportation sector, including the mix of vehicles that serves each market. There is plenty of money to be made in the mobility marketplace of the future. But the value chain will be entirely different than it is today. Everyone in the ecosystem will need to reassess how to participate to compete.

Now, Level 1, 2, and 3 autonomous vehicles are here. The first self-driving cars arrived nearly a decade ago,<sup>10</sup> and today they can be seen cruising through rush-hour traffic in Silicon Valley, navigating downtown Washington, DC, and testing out new capabilities on smart highways in the Midwest.

We may be at the brink of a tipping point for mass deployment of self-driving vehicles. At KPMG, we have tracked how investment focus in the automotive industry is changing due to advances in mobility, connectivity, and autonomy. As greater autonomy options translate into different consumer buying behavior—less of a need to own—KPMG calculates an impending massive decline in personally owned sedans in the United States, dropping from 5.4 million units sold today to just 2.1 million units by 2030.<sup>11</sup> But this doesn't mean travel will decrease. In fact, we expect the opposite. Based on in-depth, demographic-based focus group research on consumer demand for mobility, we anticipate consumer behavior will change dramatically in the autonomous world, and miles traveled per capita to soar. By 2050, our model projects an increase of 1 trillion or more personal miles traveled, and, depending on occupancy rate, 3–4 trillion additional vehicle miles traveled.<sup>12</sup>

Accompanying this trillion-mile surge, our calculations also show that by 2030, a new mobility services segment worth well over \$1 trillion will emerge for products and services related to these three emerging trends.<sup>13</sup> It's no wonder many industry analysts (including KPMG) predict a world in which autonomous vehicles replace human-driven vehicles is inevitable—and probably not all that far off.<sup>14</sup>

But some things have to happen first. We won't experience a major societal shift—driverless cars won't become as ubiquitous as those commanded by human drivers—until a similar revolution like Ford's assembly line occurs.

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<sup>10</sup> The WIRED Guide to Self-Driving Cars (WIRED, February 1, 2018)

<sup>11,14</sup> *Islands of autonomy: How autonomous vehicles will emerge in cities around the world* (KPMG LLP, 2017)

<sup>12</sup> *The clockspeed dilemma* (KPMG LLP, 2015)

<sup>13</sup> *I see. I think. I drive. (I learn.): How deep learning is revolutionizing the way we interact with our cars* (KPMG LLP, 2016)

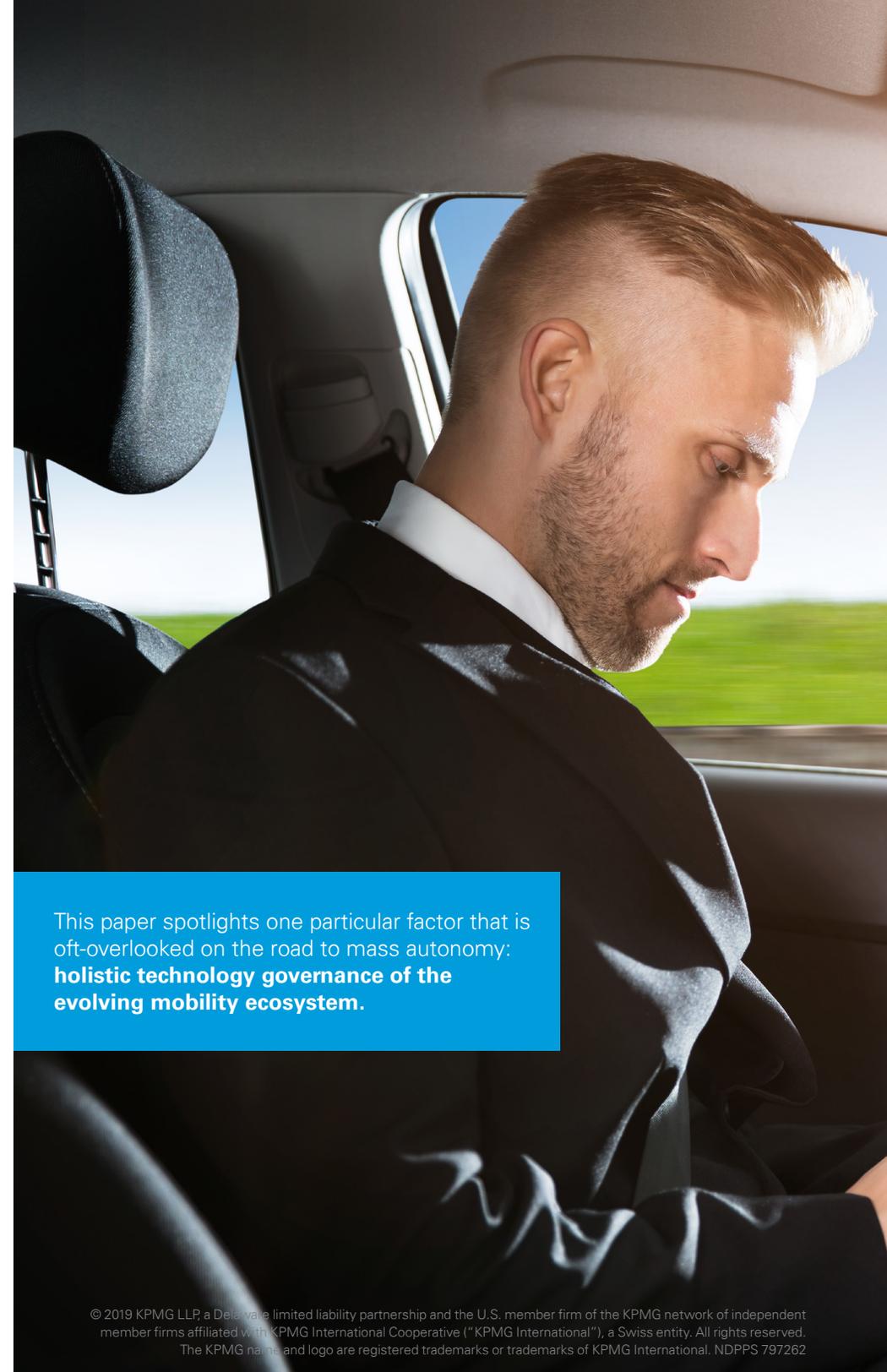
There are numerous factors that have thus far slowed widespread consumer adoption of self-driving vehicles. For one, like the first custom-made automobile, autonomous vehicles need to become affordable, attainable, and readily accessible for the average person for widespread adoption to become commonplace. In fact, due to the exorbitant cost of individual self-driving car ownership, KPMG predicts the first widespread rollout of self-driving cars will occur under the AV-MaaS model as opposed to personally owned vehicles. When autonomous vehicle fleets provide mobility services to a population of users rather than a single owner, each vehicle's utilization rate will increase greatly.<sup>15</sup> A self-driving car in the fleet may drive 50,000 to 100,000 miles per year, as opposed to perhaps 12,000 for one owned by an average consumer for personal use. At a rate of \$1 to \$2 per mile, a single autonomous car providing mobility services could generate as much as \$200,000 in revenue. That pays for a lot of sensory equipment and makes the economics of self-driving car production work.

Second, cities need certain characteristics for mass autonomy to spread. As we assert in KPMG's recent thought leadership, "[Islands of autonomy](#)," autonomous vehicles will not emerge everywhere, all at once. AV-MaaS offerings will likely come first, and they will initially pop up in bounded urban and suburban areas that are densely populated, have high consumer demand for mobility services, are technologically advanced, and are easy to map and navigate. Pockets of AV-MaaS will likely develop imminently in individual island markets and their number will likely increase exponentially beginning as early as 2020, until 100+ unique islands of autonomy exist. Looking ahead another decade, the costs of autonomous vehicle technology will likely drop to the point that personal ownership of autonomous vehicles will be able to emerge and grow in these islands.<sup>16</sup>

Other factors come into play, too. Governments and regulators need to support the growth of autonomous vehicles. Cities need to become smarter and more connected. Everyday people need to accept them as safer, cheaper, and more convenient than their other mobility choices. All of these factors (and many others, both known and unknown) will be crucial to getting us to the point where fully autonomous vehicles are the norm, not the exception.

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<sup>15,16</sup> [Islands of autonomy: How autonomous vehicles will emerge in cities around the world](#) (KPMG LLP, 2017)



This paper spotlights one particular factor that is oft-overlooked on the road to mass autonomy: **holistic technology governance of the evolving mobility ecosystem.**

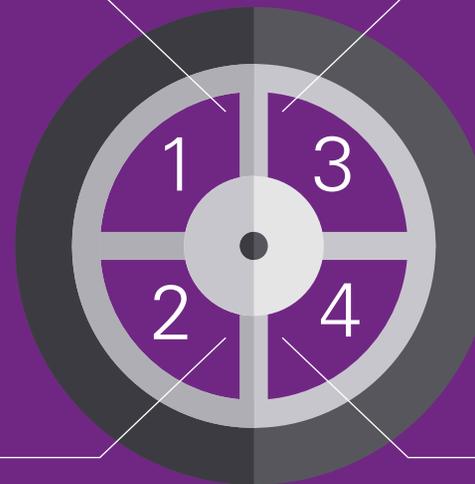


## What's inside?

The following pages examine the concept of holistic technology governance of the evolving mobility ecosystems in each island of autonomy, a key factor on the road to mass autonomy.

### Explore:

The foundation of next-generation mobility ecosystem: A shared technology platform that supports interactions across the system



Holistic technology governance, a method for managing the platform to guarantee the mobility ecosystem's integrity

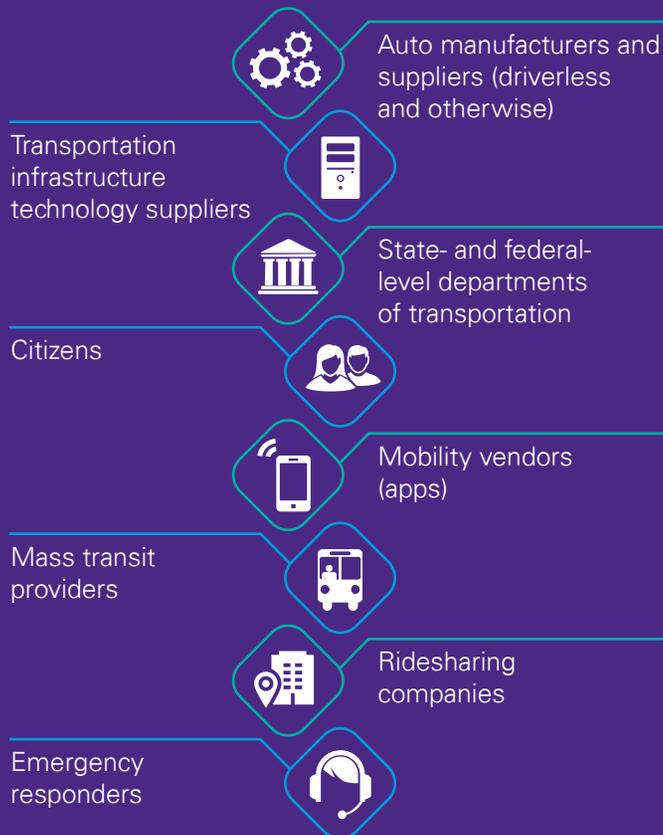
The pivotal role of data sharing—enabled by the platform—in the future world of mobility

Advice for establishing a holistic technology governance framework fit for the autonomous age

# Mobility as a platform

## Mobility ecosystem participants

As the autonomous world emerges on a citywide basis, the mobility sector will evolve and expand. It will include a wide array of entities involved in production, manufacturing, logistics, operations, and services for the mobility ecosystem. That's not to mention the people moving about the world in both driverless and human-driven modes of transportation, and likely a wide array of participants that will emerge to fill needs that don't even exist yet.



Think back to ten years ago. The year was 2008—the year Barack Obama was elected president, the Twilight novels hit the big screen... and Apple introduced the App Store.

It was this last development that relates to the topic of this paper. You see, Apple released the first iPhone in 2007. But it wasn't until the 2008 addition of the App Store—which enabled developers to sell their own apps to millions of iPhone owners—that the iPhone became a mass-market phenomenon, transforming from a phone into another appendage.<sup>17</sup> The App Store sparked the growth of an integrated network of other innovations around the iPhone and created an environment in which each participant in the network increased the value of owning an iPhone for the rest.

Like the iPhone, the rise of autonomous vehicles may depend on a similar network effect, driven by the establishment of a unifying technology platform that drives participation and growth in an autonomous world.

**We believe the cornerstone of the autonomous future in individual island markets will be a shared technology platform that supports interactions across the broad mobility ecosystem.**

Made possible by the new era of connectivity we find ourselves in today, the platform will facilitate communication between a wide array of transportation technologies and nurture relationships between the people who develop and use them, including software and technology vendors, auto manufacturers, service providers, governments, and citizens.

San Francisco serves as one example of how such a platform might work. The city's future mobility vision is to develop a shared technology platform that integrates and supports a wide range of mobility options, including services from on-demand ridesharing companies, traditional taxi services, and other vendors, while also handling pricing, routing, booking, and payment. (One day, these services could be completely autonomous.<sup>18</sup>)

<sup>17</sup> The WIRED Guide to the iPhone (WIRED, February 1, 2018)

<sup>18</sup> Smart Cities—What's in It for Citizens? (Juniper Research, March 19, 2018)

# Data, not oil, will drive our cars

Data is at the heart of future mobility. Each market's smart mobility ecosystem is a living, breathing thing, with numerous sources of data interchanging information at all times. In fact, the ecosystem will be incredibly reliant on data.

Predictions conservatively point to autonomous vehicles generating close to 4 terabytes of data a day<sup>19</sup>—and that's just the data necessary to make the car function and drive itself. Autonomous vehicles will only be as practical and capable as their environment allows.

## Technologies of autonomy

Transportation of the future will be tech-driven. A wide range of innovations will converge to create a mobility ecosystem that's smart, connected, and ultimately, automated.

- Self-driving vehicles (cars, trucks, buses)
- IoT-connected public transportation infrastructure (smart roadways, smart traffic lights, smart road signs, smart parking)
- Mobility apps (mapping, traffic, routing, pickup)
- Telecommunications networks (4G, 5G)
- Cloud and edge computing

Today, each autonomous car tends to operate as a stand-alone entity—an island of sensors, inputs, and outputs. But for driverless vehicles to coordinate and maneuver safely and effectively in the real world, they must communicate in real time not just with one vehicle (driverless and otherwise), but with many simultaneously—and with the world around them, too. In fact, KPMG believes the interaction of the individual car with the fleet and ecosystem in which it drives is essential to autonomy. Connectivity will help ensure constant interaction with the network essential for mapping, routing, vehicle integrity, and data to feed the deep learning systems inside the cars.<sup>20</sup>

## Understanding driverless car data

- **“Inside-out” data** comes from the external environment, including other cars and smart infrastructure. It is generated from sensors and makes it possible for a vehicle to be autonomous. Inside-out data requires immense computing power to process and analyze and train the vehicles' machine learning algorithms.
- **“Outside-in” data** is human-generated data that the autonomous vehicle leverages to make the driving experience more capable, optimized, and enhanced.
- **Personal data** is data generated about the passengers of the car, including the number of people inside, the type of music played, the pickup and destination locations, and data generated from wearable technology.

<sup>19</sup> Intel CEO Brian Krzanich at AutoMobility LA 2017

<sup>20</sup> I see. I think. I drive. (I learn.): How deep learning is revolutionizing the way we interact with our cars (KPMG LLP, 2016)



In the long run, to improve safety and advance the number of geofenced areas, autonomous vehicles will need to send signals from sensors and camera and laser technology to understand their surroundings and synchronize with other driverless and human-driven vehicles in traffic. Smart infrastructure, such as roadside sensors and road signs, must exchange messages from passing vehicles to help them navigate their way around. Smart traffic lights must provide data on past and current road usage and conditions and orchestrate upcoming traffic pattern changes.

How do we coordinate and validate the complex interrelationships and data exchanges between all the technologies in the ecosystem, so they can cohesively “talk” to each other with some degree of trust? How do we protect the integrity of the communications to help ensure malicious actors don’t turn the system against us? How do we help secure the privacy of the data to prevent our actions from being monitored or exploited?

Achieving such an environment requires an overarching platform that enables nearly constant and instantaneous data sharing and connectivity between all ecosystem participants, including autonomous cars, smart infrastructure, and wired and wireless networks. It also requires governance over the platform to help ensure all users behave in accordance to set standards.

# Establishing the rules of the road

## Who governs and manages the shared mobility platform?

Setting and enforcing the “rules of the road” of participating in the mobility ecosystem should be a collaborative effort, led by departments of transportation, government regulators, and mobility vendors, but with engagement from all of the participants.

Ohio’s effort to create common standards for next-generation transportation projects serves as a representative example of the collaborative nature of platform governance. Ohio is home to numerous smart city and connected and autonomous vehicle projects, including a number of testing corridors, but each is advancing largely independently of the next. The state now seeks to establish a framework for governing IoT connected transportation technologies, such as smart road signs and lighting. Ohio aims to create standards to help address issues such as device interoperability and data management, create equipment specifications so cities can more easily start their own projects, and assess which technologies to invest in and where partnerships should be formed with private industry.

Source: Looking to create standards for smart state projects, Ohio selects a vendor (StateScoop, April 11, 2018)

We’ve asserted that mass autonomy in the island markets requires a shared platform that takes in data, verifies it, and exchanges it with the other technologies that need it to function and operate.

Now imagine this platform like the world’s busiest traffic circle and the exchanges of data across and around it like the cars maneuvering through the circle. To help ensure those cars don’t crash, stall, or go the wrong way, we have rules of the road. Governments set driving and traffic laws to dictate which way the cars go, when they stop and start, the direction they are allowed to travel, and more, so they can safely navigate from point A to point B.

The platform needs rules of the road, too. The platform’s work in facilitating data interchanges through the ecosystem is safety-critical, and it also has to be done at highway speed. Just like in the traffic circle, rules are vital.

In our metaphor, **the rules are set, implemented, and overseen through holistic technology governance.**

A holistic technology governance framework governs the behavior of the participants in the mobility ecosystem, setting standards in areas like technology quality, data privacy and security, technology integration, and compliance. The framework sets forth rules, policies, and standards for where, when, and how data moves through the platform between different technologies, ensuring there are no communications breakdowns and that data gets where it needs to, when it needs to, in its entirety—and without being lost, stolen, misused, altered, or otherwise compromised.

## The privacy question

Large cities may spend \$760 billion by 2020 on collecting and managing data to make their cities safer and more efficient. Likewise, autonomous mobility platforms will require huge amounts of data just to function, and more still to deliver additional value for users. By all accounts, data collection will be automatic and ubiquitous. But at what cost? If data is the lifeblood of next-generation autonomous mobility, clear privacy questions are sure to arise, which must be addressed through holistic governance.

- Is it possible to make data collection by autonomous mobility technologies and platforms optional?
- If people can opt in and out, how would that impact the operability of the network as a whole?
- Will privacy regulations that govern how data is collected and used halt progress? Or will they evolve, possibly at the expense of citizen rights?
- How will platform operators govern access to and the use of data? And who owns the data, anyway?

Source: Smart Cities – Not So Smart Privacy (*CPO Magazine*, February 16, 2018)

## Holistic technology governance spans six critical areas of the smart mobility platform in a fully integrated and tightly woven model:

**Data governance** to help ensure the quality and integrity of all data that potentially passes through the ecosystem as it moves to and from self-driving vehicles, smart infrastructure, vendors, citizens, government agencies, etc. Standardized guidelines for governing data will help platform users manage a vast array of data-related challenges, including how to prioritize conflicting data, how to merge data from multiple sources, how to assess data trustworthiness, and how to control and leverage data from master sources and owners.

1

**Software governance** to help ensure the platform's operating system works at peak performance and is updated regularly with the latest available version. Software governance will consist of rules and protocols for managing how applications connect to the platform, how new or patched software gets released and pushed out to prevent interruptions to the mobility network, how potentially dangerous software bugs or breaches are identified and fixed, and how new platform software is developed with security and privacy at its core.

2

**Hardware and firmware governance** to help ensure the physical engineering of the technologies that connect into the shared mobility platform and the software designed for that hardware—such as smart transportation technologies like IoT-enabled traffic lights and road signs, and self-driving vehicle mechanical and electrical components—meet certain requirements for safety, resilience, and compatibility. Hardware and firmware governance will focus on areas such as fail-safes, penetration testing, security and privacy by design, and supplier management.

3

4

**Integration governance** to help the independent technologies of the smart mobility ecosystem function as a whole. Addressing critical issues related to technology compatibility and the exchange of data, integration governance involves establishing internal and external quality controls around the vast array of data, software, and hardware that interacts with the platform and each other. It will oversee the standard communication protocols and data sets that will enable autonomous vehicles to interact with the outside world. Integration governance will also be essential to ultimately developing an intercity, interstate, or even national-level mobility platform.

5

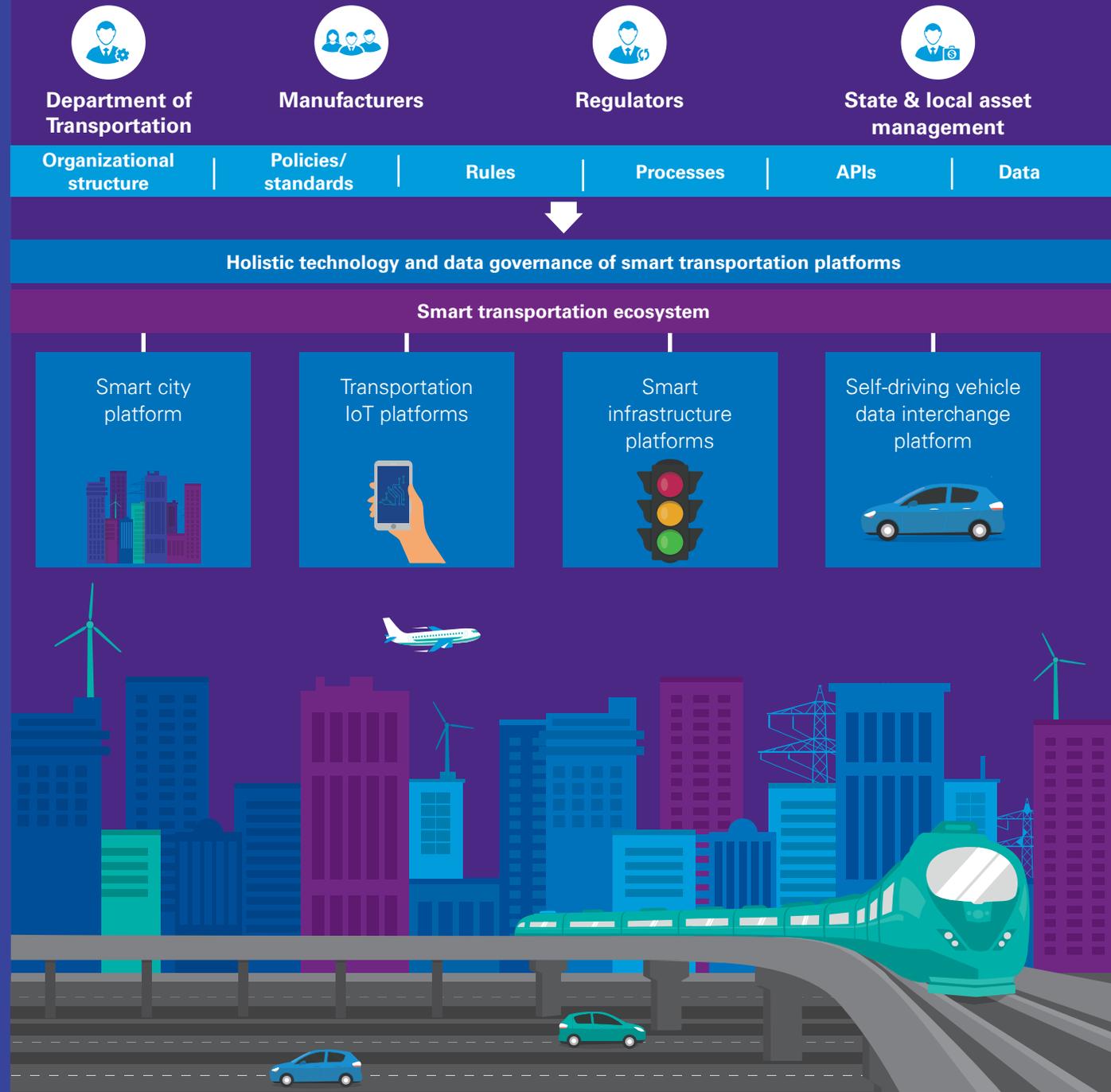
**Security governance** to help protect the platform (and its users) from cyber threats and to reduce the impact of an attack should one occur. Some of the key focal areas of security governance should be establishing guidelines for how participants can interact within the platform, how networks are segmented to make it harder for vulnerabilities to spread, how often security monitoring activities are performed to identify new risks, how security is prioritized within the design and development process of software and hardware, and how data is encrypted to prevent its loss or misuse. KPMG has written extensively about cybersecurity in connected cars. Read our latest report: [Protecting the fleet ... and the car business.](#)

6

**Compliance governance** to support shared mobility platform participants in adhering to relevant regulatory guidelines as well as shaping future legislation related to autonomous mobility. Priorities include policies for helping participants understand and respond to compliance requirements related to transportation safety, data sovereignty, data privacy, and cybersecurity of vehicles and transportation infrastructure.

## Overcoming the digital divide

The next-generation platform that will bring autonomous driving to the masses will be powered by a connected ecosystem of digital technologies. The vehicles and infrastructure will be a gigantic implementation of IoT while mobile phones will be the primary source of human input into the platform. These digital “things” will communicate with cloud-based systems to capture and process data, intelligent automation tools will be making on-the-fly decisions, and deep learning systems will be analyzing our every move. Perhaps even a blockchain will be utilized to process transactions across the network. Each of the digital technologies will play a crucial role in the autonomous mobility world, and organizations will need to work together to serve and protect the customer while governing the complicated technology stack in order to maintain a trusted digital relationship.



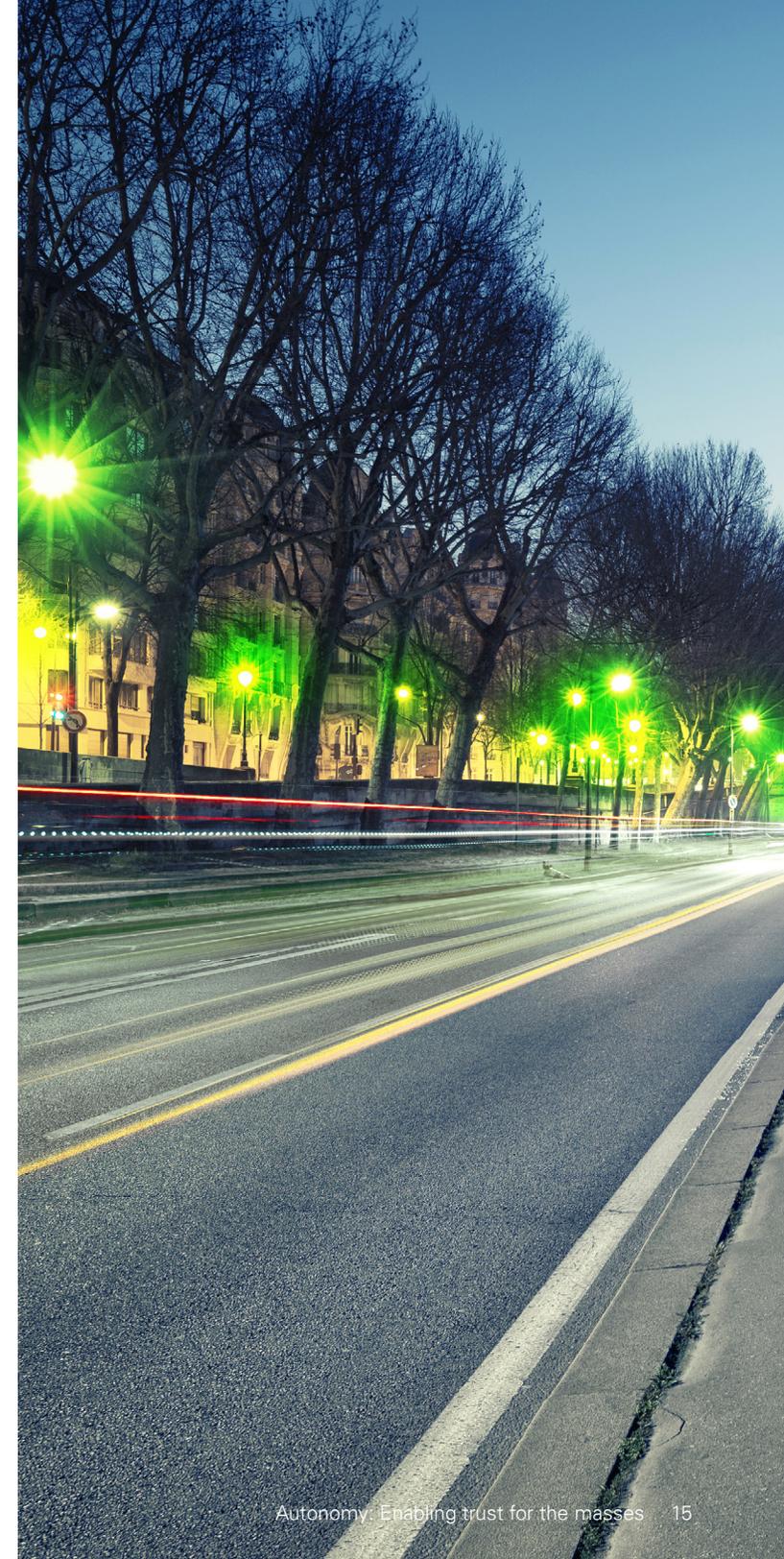
*\*Not comprehensive of all possible platforms or technologies that can integrate into the transportation ecosystem*

# Holistic governance: A green light on the road to the autonomous age

Holistic technology governance will be essential to ensuring the reliability and integrity of the shared technology platform at the foundation of each city's next-generation mobility ecosystem. Trust in the system will be essential to helping society reach each city's point where nearly everyone uses an autonomous vehicle.

Holistic technology governance will also allow the network effect—like what happened to the iPhone when the App Store launched—to take root in the autonomous mobility industry, creating new revenue opportunities for mobility players and driving its expansion and growth.

Because the ecosystem will be integrated through a governed, trusted, and shared platform, opportunities will likely arise to create services and applications that generate value for the others in the ecosystem. What's more, the roadmap to capitalizing on these opportunities will be informed by the huge volumes of incredibly valuable data in the ecosystem that will be harnessed by the platform and made widely available in a responsible way.



## Participants all across the ecosystem stand to benefit:

1

### Departments of transportation

For city departments of transportation, the platform will deliver the insights they need to start transforming how we move to be safer, faster, more convenient, and more affordable for everyone. (We touched on some of the public benefits of mass autonomy earlier in this paper.) In addition, a platform approach to governing mobility allows cities the flexibility to adapt to technology change and disruption, as the framework is agnostic of any specific technology. While we focused on the positive impacts of smart mobility and autonomy in this paper, governments (in partnership with industry) will need to make significant investments to develop and run the platform, potentially straining their budgets. They may also suffer initial revenue losses in the autonomous era, as they are likely to collect fewer fines for traffic offenses, fewer fees for driver licensing and car registration, and fewer fuel taxes as fewer cars maneuver the roads. However, the platform—rich with trusted data and insights—will enable them to adjust their operating models to stay current and generate value in entirely new ways.

2

### Automakers

For automakers—whose business models based largely on new car sales are being disrupted by the rise of autonomous vehicles—the platform will help them adapt to the changing market and flexibly respond to declining revenue streams by creating new business models centered on autonomous mobility ancillary services or mission-specific products. KPMG estimates a precipitous decline in personally owned sedan sales as self-driving vehicles and mobility services provide options that will reduce consumer desire to own cars.<sup>21</sup> We also predict the emergence of 150 or more unique and distinct transportation markets, which will each require a unique mix of vehicles to meet consumer needs in that market.<sup>22</sup> To compete, automakers must move away from a one-size-fits-all vehicle model and fundamentally rethink product, service, and investment decisions. Customer demand analytics will be critical to giving automakers the insights they need to understand and compete in each market—and the platform will be essential in providing those insights.

3

### Private companies

For private companies, the platform opens up opportunities to become a service provider to the entire population of mobility users. The platform will have significant access to passengers and will capture mass amounts of data about their desires and behaviors. Using these insights, companies should be able to offer value-adding services. Indeed, the platform will likely give rise to a new class of emerging mobility innovators who create products and services that have yet to be imagined, but will undoubtedly greatly enhance the autonomous mobility experience.

<sup>21,22</sup> Islands of autonomy: How autonomous vehicles will emerge in cities around the world (KPMG LLP, 2017)

# Ready, set, go

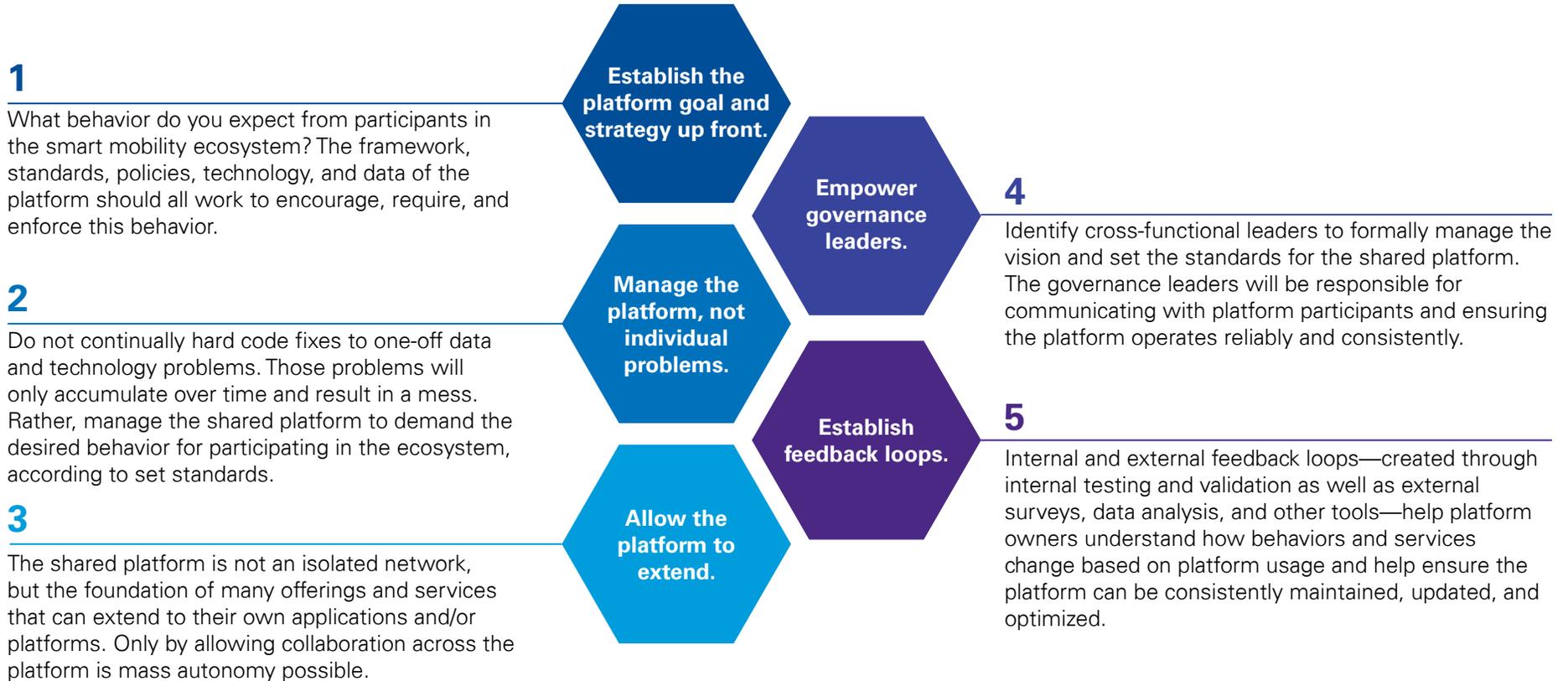
Mobility platform governance is crucial to driving mass autonomy. The ultimate goal will be enabling citywide interoperability of self-driving vehicles and all of the value-adding services that will develop around them.

However, developing such a far-reaching technology governance program is not like cruising the final straightaway on an open road. It's a long path with many twists and turns, and with many vehicles navigating it all at once.

We think the starting point will be the cities and states that are currently embarking on next-generation smart mobility projects.

These leaders—collaborating with IoT providers, software developers, automotive manufacturers, and other participants—are likely to incrementally put governance around key areas, such as data management, and build from there. Over time, they are likely to iteratively expand the governance program to include additional policies and standards to guide the growth of a trusted, capable, and scalable smart mobility ecosystem.

We offer five tips for government and transportation leaders to reduce obstacles on the governance journey.





# How KPMG can help drive trust in the autonomous future

Whether you're operating a fleet of self-driving vehicles, providing and managing smart transportation assets, or selling a mobility product or service, every participant in the coming autonomous age will need to evolve how they govern the technologies that are driving the revolution.

We can help government departments of transportation, automakers, and other private companies in the mobility space develop and implement a leading-edge approach to technology governance that will help build the foundation of trust required for autonomy to spread on a mass scale.

Our services span from strategy to implementation, including assessing current governance capabilities, setting a new vision, and developing and acting on an improved holistic governance strategy that is actionable throughout the lifecycle. We can also assist you in managing and integrating data, information and connected technologies in a way that drives greater security, resilience, interoperability, agility and compliance—and sets the stage for ongoing value creation in the new world of autonomy.

# About KPMG's Data & Analytics services

Across industries, geographies, and functions, businesses are aiming to turn data into insights and insights into real business value. KPMG's information management services within the Data & Analytics practice help clients organize, retrieve, secure, and deliver the right information to the right people at the right time, so they can take full advantage of the potential that resides in their data. With our professionals' deep understanding of enterprise data requirements, data management, and data governance as guideposts, our clients are able to focus in on the insights that drive performance.

# About KPMG's Automotive services

KPMG's Automotive team understands the complexity currently flowing through the industry. We leverage our deep industry insight and our hands-on experience to help automotive companies shape a successful future while strengthening performance today. Using a cross-functional approach, KPMG's Automotive team helps empower the world's leading manufacturers, OEMs, and suppliers achieve their goals. We put our breadth of experience and industry-specific knowledge to work for our clients, guiding them to make better decisions today to potentially create the greatest impact tomorrow.





# About KPMG's Government practice

In the face of budget constraints, expanding demand for services, and information-security challenges, governments and other public sector organizations at all levels are being challenged not only to do more with less, but also to do so effectively while transforming to serve the evolving needs of their diverse constituents. For more than 100 years, KPMG has assisted governments, higher education, research, and not-for-profit organizations adapt to new environments by working with them to transform their business models, leverage data, increase operational efficiencies, and help ensure greater transparency. Our more than 1,600 dedicated partners and professionals possess the knowledge, insight, and awareness of pertinent legislation and regulatory implications needed to address the special needs of the government and public sector.

# About the authors



Gary Silberg is the national automotive leader at KPMG, as well as the global lead partner for Delphi Corporation and Ford Motor Company. With more than 25 years of business experience, including more than 14 years in the automotive industry, he is a leading voice in the media on global trends in the automotive industry. Gary advises numerous domestic and multinational companies in areas of strategy, mergers, acquisitions, divestitures, and joint ventures. For the past five years, he has focused on the intersection of technology and the automotive industry, with groundbreaking research on self-driving cars, connectivity, and mobility-on-demand services.



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