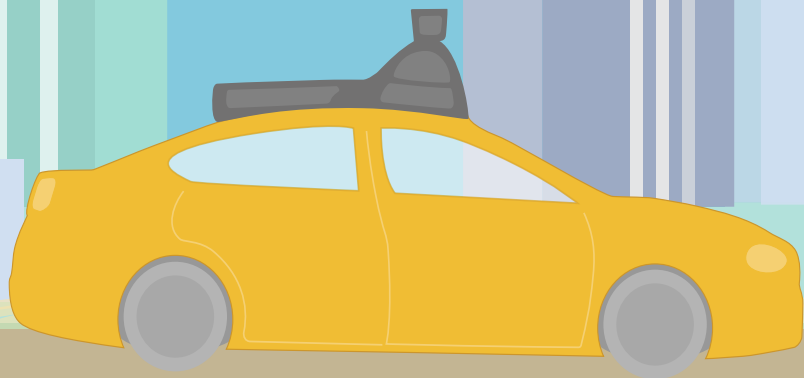


Autonomous Vehicle Pilots Across America



ABOUT THE NATIONAL LEAGUE OF CITIES

The National League of Cities (NLC) is the nation's leading advocacy organization devoted to strengthening and promoting cities as centers of opportunity, leadership, and governance. Through its membership and partnerships with state municipal leagues, NLC serves as a resource and advocate for more than 19,000 cities and towns and more than 218 million Americans. NLC's Center for City Solutions provides research and analysis on key topics and trends important to cities, creative solutions to improve the quality of life in communities, inspiration and ideas for local officials to use in tackling tough issues, and opportunities for city leaders to connect with peers, share experiences, and learn about innovative approaches in cities.

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Autonomous Vehicle Pilots Across America

NLC NATIONAL
LEAGUE
OF CITIES

CENTER FOR CITY SOLUTIONS

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INTRODUCTION

Cities need to be in the driver's seat as we transform from the current mobility environment to our autonomous future.



The unstoppable forces of automation and artificial intelligence are rapidly changing the way we move through, work in and design cities. Technological advancements are transforming the mobility environment as a wide range of companies continue investing billions of dollars to develop, test and deploy autonomous vehicles. As a result, cities nationwide are now hosting autonomous vehicle pilots that are being developed in a multitude of ways, with different choices and approaches instituted by city and state governments. Before long, autonomous vehicles will be ubiquitous on roadways, but the full story has not yet been written — cities need to be in the driver's seat as we transform from the current mobility environment to our autonomous future.

This municipal action guide is meant to give cities the ability to better understand and approach the impending rollout of autonomous vehicles in their cities. We hope to lay out the current typologies of how cities and other levels of government are working together with the private sector to begin to integrate self-driving cars onto the roadways.

Within this action guide we provide the reader with:

- Analysis of the current legal/regulatory structure
- The state of AV pilot programs
- City approaches to AV pilots
- Best practices from cities throughout the country
- Action steps on city leadership to move forward

The autonomous future is already starting to unfold, but city leaders have the opportunity to play a more informed, active role in shaping it. This is why at the National League of Cities we have developed — and continue to work on — a series of research reports and analyses to help city leaders prepare for these shifts. Since our last report on the subject (the Future of Equity in Cities, released in 2017) the number of large cities planning for autonomous vehicles has climbed substantially. Some 50 percent of America's largest cities are preparing for these self-driving vehicles in their long-range transportation plans.

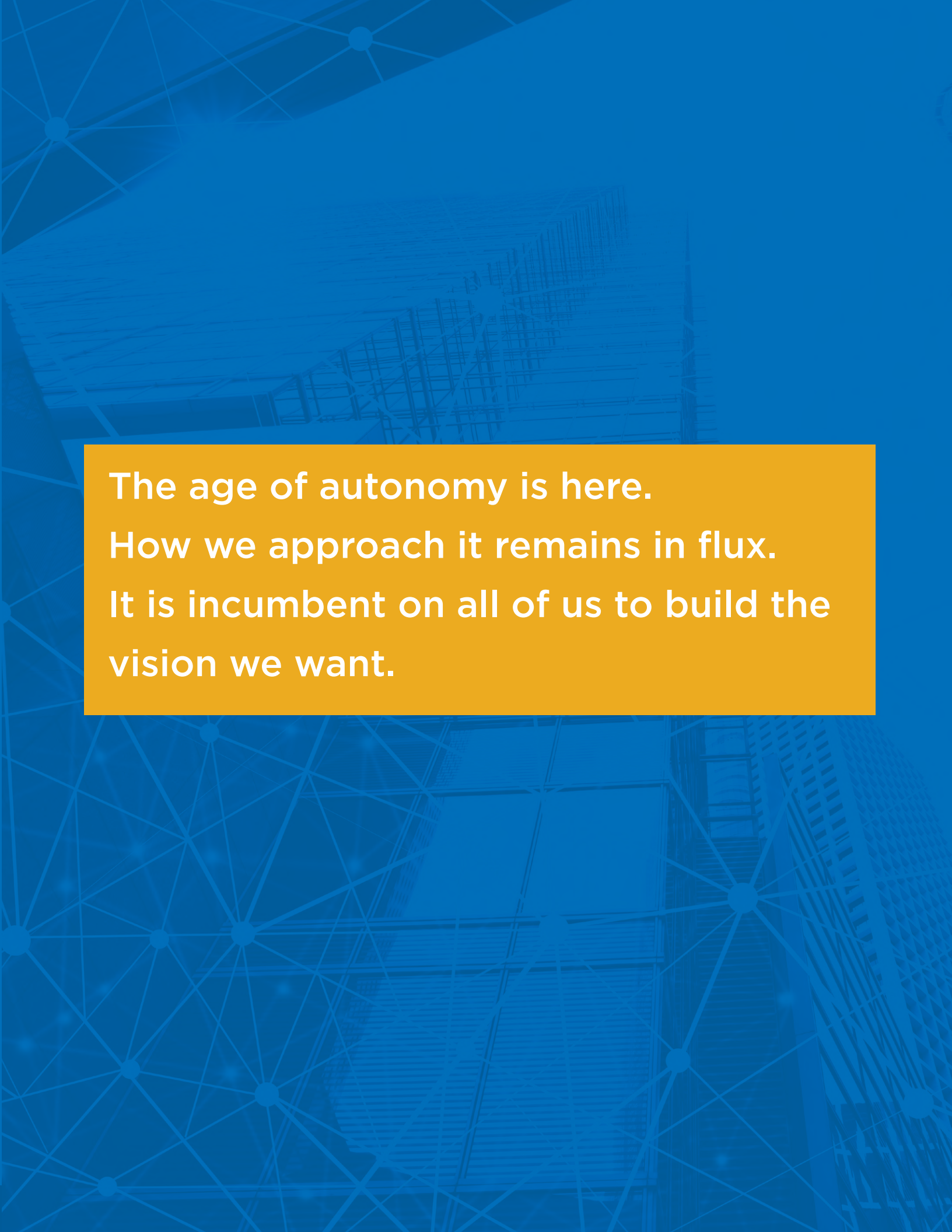
At the same time, cities are experiencing broad cultural shifts in how people get

Autonomous Vehicle Pilots Across America



around. Fewer young people obtain driver's licenses, ride-hailing is ubiquitous in cities, and use of public transit and bike sharing has increased. In the near future, self-driving technology will not only migrate to our cars but will also impact urban transportation methods like busses and subway systems. Cities have a unique opportunity to reshape urban transportation with the ultimate goal of making it more people-centered, flexible and responsive.

The age of autonomy is here. How we approach it and what we collectively decide to do remains in flux. It is incumbent on all of us to build the vision we want. So sit back, put your feet up and let the car do the work. But before you do, read through this guide and learn how cities can work to drive the autonomous future.



The age of autonomy is here.
How we approach it remains in flux.
It is incumbent on all of us to build the
vision we want.

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AV AND GOVERNANCE

The interplay between state and local governments is critical in the implementation of these pilot programs.



While cities are the key players in these pilots, both state and federal governments play a significant role in the development and deployment of autonomous vehicles on city streets. The federal government has traditionally developed nationwide safety standards for vehicles, and a number of different regulations and laws currently under deliberation could greatly impact the future speed and safety of autonomous vehicle rollouts.

On the federal side, The National Highway Transportation Safety Administration (NHTSA) and the U.S. Department of Transportation (U.S. DOT) led the bulk of the federal response to emerging AV technology between 2013 and 2017. The agencies' approach embraces a permissive environment marked by regulatory restraint and heavy trust in AV developers. There is a clear intent to facilitate AV testing and full deployment throughout the country, as well as an expressed desire to include as many actors in this process as possible, meaning that AV testing privileges are not limited to traditional automobile manufacturers but rather

are open to a wide group of public and private organizations. With Congress finally joining the dialogue in 2017, substantial legislation may be on the horizon. Two bills currently moving through the legislative process would significantly restrict states' (and therefore municipalities') abilities to regulate AV presence on public streets.

In the absence of finalized federal requirements specific to AV testing, state polices (or lack thereof) play a significant role in cities' pursuit of AV piloting. Between 2011 and 2017, 22 states passed 46 bills related to AV usage while five governors signed executive orders encouraging their development. Most of the legislative action expressly permitted AV pilots. These laws proved unnecessary as the states had no existing laws prohibiting such programs, but the legislatures wanted to encourage the pilots. In many cases the legislation and executive orders directed state entities to develop a procedure for approving pilots, and often concurrently established committees to study the issue. In 2018 a boon in state action on AV policy is underway, with 28 states introducing,

Autonomous Vehicle Pilots Across America

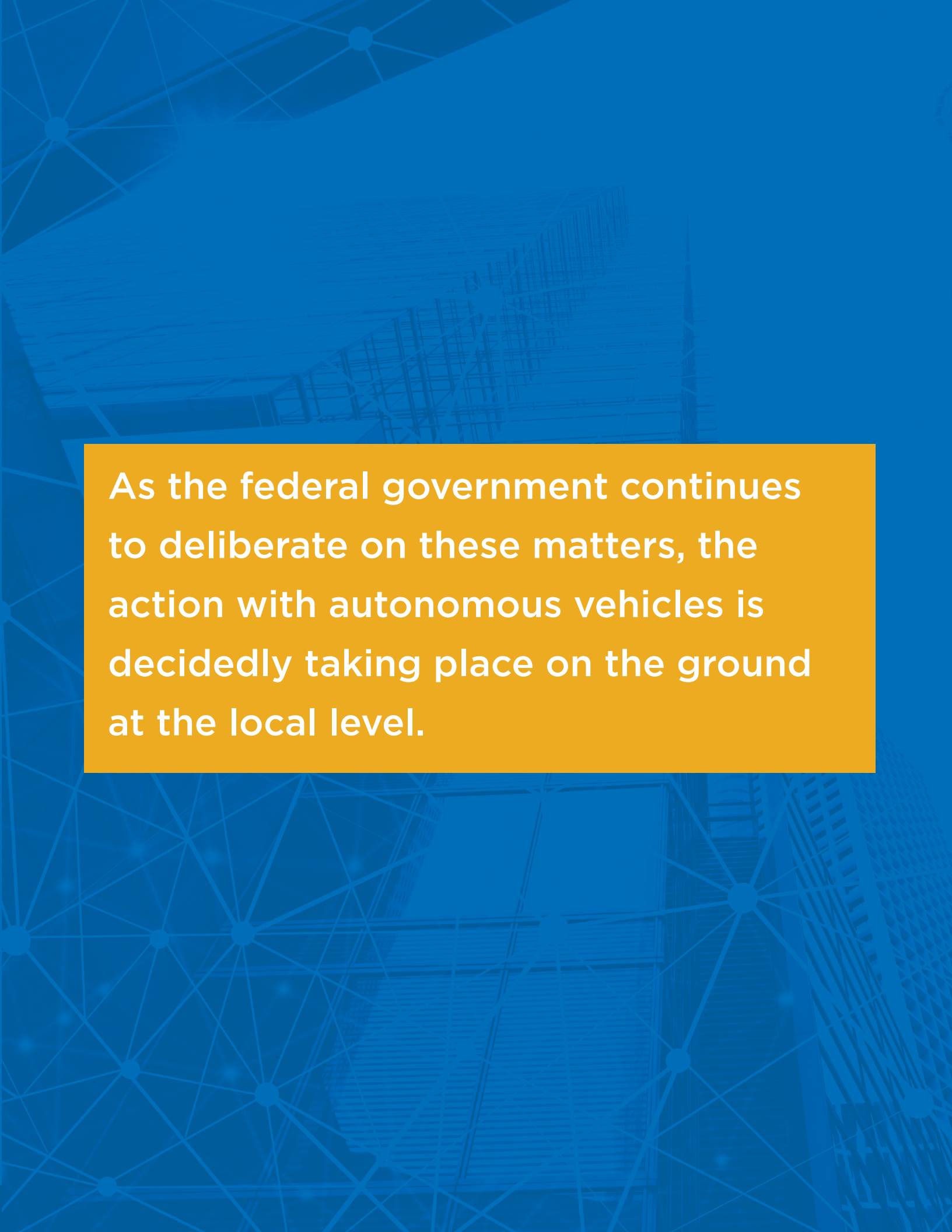
debating and/or passing 98 bills in this arena.¹

State preemption has emerged as a prominent theme for state legislation, particularly in 2018. Georgia, Illinois, Texas, Tennessee and Nevada have laws that directly forbid local governments from prohibiting AV piloting, while Indiana is currently debating such legislation. Others take a more subtle approach. California's latest laws indicate that the entity conducting the testing must only notify the relevant local government in writing; similarly, Maine's policy addresses municipalities, but only in so much as to mention that they may develop an agreement with the state for specific AV pilots.

Perhaps just as important as the ink-on-paper actions are the symbolic ones. As previously noted, the laws and executive orders permitting AV piloting did not change the legal status of AV pilots, which were already permissible. They did, however, play an important symbolic role in indicating a supportive atmosphere that would not attempt to challenge or block AV-related efforts. The most dramatic example of a state leader's impact on AVs comes out of Arizona. Governor Doug Ducey was already known to favor innovation and technology-friendly regulations — he fired a state regulator for attempting to block Uber and Lyft operations in the state — when he signed an AV executive order in 2015.² He then moved even more aggressively and invited Uber leadership to visit the Phoenix area to consider using the state as a proving ground. Consequently, Tempe, Mesa, Gilbert and Chandler found

themselves the hosts of two of the most high-profile AV pilots in the country.

As the federal government continues to deliberate on these matters, the action with autonomous vehicles is decidedly taking place on the ground at the local level. The interplay between state and local governments is critical in the implementation of these pilot programs. In the case of autonomous vehicle pilots, this relationship between city and state is paramount, and ultimately affects the varied approaches that cities have taken. The current state of AV pilot programs is rapidly accelerating and best practices are starting to surface.



As the federal government continues to deliberate on these matters, the action with autonomous vehicles is decidedly taking place on the ground at the local level.

Autonomous Vehicle Pilots Across America

THE STATE OF AV PILOT PROGRAMS

As of this writing, there are several municipalities hosting AV pilot projects within their borders, whether as part of city-led initiatives or private sector programs. There are also several state and federal pilot projects on the nation's highways. Thus far, single occupancy vehicles (traditional cars) are the prevailing mechanism for autonomous technology experimentation, although a number of cities and universities are testing shuttles as a potential expansion

of, or replacement for, existing public transportation options. Several cities also have an AV pilot presence in the form of small sidewalk delivery robots, and states, along with the federal government, are testing autonomous freight and/or highway technologies. Those projects contribute to our understanding of this technology and impact their surrounding municipalities, but are beyond the scope of this guide.



Why Pilot Autonomous Vehicles?

By and large, cities want to pilot AVs. City staff members report deriving a significant educational value from the programs, including information on the specific nature of the technology, its abilities and particularities, and how the city's own typology impacts pilot performance. Pilot cities get to be in the front seat to better understand how AV reacts to its physical space, from braking for tree leaves blowing in the wind to anticipating the challenges of changing elevations and density.³ City governments also report learning more about the public's willingness to accept an AV presence and, in turn, utilizing the AVs to educate the public. In some cases, unveiling pilot plans has the added bonus of putting a city on the map as a technology and business friendly location, ripe for innovation investment.



REALIZING AN AV PILOT PROGRAM

Cities have an opportunity to craft a localized approach to AV piloting that addresses specific municipal goals.



Among cities and towns with AV pilots currently on the street, the mechanisms for initiating and managing these programs demonstrate a wide gradient of government involvement. Pilots have popped up in city neighborhoods throughout the country, and continue to thrive and expand despite varying degrees of local government participation. This phenomenon reflects a permissive federal regulatory environment that has allowed both cities and pilot entities the flexibility to develop relationships at will. Cities should view this gap in legislation as an opportunity to craft a localized approach to AV piloting that addresses specific municipal goals.

In some instances, such as in Arlington, Texas, the city council took full control of conceptualizing, funding and implementing the pilot, directly leasing two EasyMile shuttles.⁴ The next iteration of pilot programs driven wholly by the local governments will take place in new communities planning for AV usage, such as Union Point, Mass., and Babcock Ranch, Fla.

On the other end of the participation spectrum, the Phoenix area municipalities of Chandler,⁵ Tempe and Mesa, as well as the city of Pittsburgh,⁶ took less of a formalized partnership approach. These locations have no formal written agreements with the companies running pilots within their borders and the companies do not contribute to city funds or management efforts. Most cities' approaches fall somewhere in the middle and demonstrate the ability of city governments to play precipitating and coordinating roles in furthering innovative ideas. Las Vegas demonstrates one such hybrid approach. Launching a yearlong shuttle pilot in November 2017, the city claims to have put the country's first autonomous city shuttle on a public road.⁷ While the city initiated and funded the effort, the government turned the project over to a private company, Keolis, to have full design, implementation and managerial responsibilities.

Municipal leadership

Executive Orders and City Council Resolutions

Among cities that chose a more active engagement style with respect to AV manufacturers, several initiated the arrival of AV pilots by directly spearheading legislation around the issue. Prior to manufacturers establishing a presence on the ground, cities such as Boston and Austin introduced executive orders or city council resolutions. These initiatives did not amend existing regulations nor make new ones, but rather expressed the cities' interest in hosting pilots and directed city officials to actively engage the private sector in this matter. The initiatives were seen as a signal to the private sector that testing would be welcomed, as well as a signal to the public and city departments that this endeavor was a priority.

Executive and legislative action also often precipitated the creation of new committees or advisory groups dedicated to examining that city's options in the realm of emerging transportation technology. Los Angeles has been one exception to this pattern, however. The mayor created the Coalition for Transportation Technology in 2015,⁸ but the city council did not pass its first resolution regarding AVs until 2017.⁹

While the friendly intent communicated through an executive order or resolution is important in attracting AV developers, it is not always a direct path to AV

pilot initiation. Beverly Hills passed a resolution in April 2016 but has yet to see an AV presence on its streets.¹⁰

Requests for Proposals

Cities that did not have an organic AV presence are finding that public RFIs and RFPs can be an effective way to initiate dialogue with the private sector. This step seems a necessary one for some cities to attract developers and initiate movement. Washington, D.C., for example, added a section to its municipal code in 2013 allowing AVs on the streets,¹¹ but the city remained without a pilot until releasing an RFI in 2018.¹² San Jose's engagement with AV pilots is notable for its shift in municipal engagement. The city previously provided a welcoming, if detached, atmosphere that permitted AV piloting to flourish. These programs, however, were run by private sector entities and centered around developing private passenger vehicles. After several years of AVs regularly traversing the streets, the city government now seeks to develop public-private partnerships in this realm to forward city goals. The city released an RFI for how AV piloting could specifically address and resolve public transportation problems.¹³

City as Facilitator

Outside of testing within privately owned facilities, AV pilots do not exist in a vacuum. Further, the software-driven quality of AV development opens the industry to pilot entities outside



of traditional auto manufacturers. Unconventional actors such as tech companies and universities are able to enter the AV market. An overwhelming majority of cities bringing AVs to their streets extended their invitations to diverse actors in the public and private sectors when developing partnerships to realize this goal, capitalizing on their geographic luck.

Many cities brought together this consortium of participants by hosting AV conferences and demonstrations prior to making formal agreements with piloting institutions. Austin partnered with TxDOT and Texas Technology Network to host the first Texas Mobility Summit in 2016¹⁴ and founded the Texas Innovation Alliance.¹⁵ Tampa hosted the state's first AV Summit in 2013, although its creation was a state-led FDOT initiative.¹⁶

Nearly all municipalities with AV pilots rely on partnerships with existing local institutions. In these cases, the city government plays a coordinating role. Examples of private sector partnerships include: AECOM's Tampa area office which provides in-kind consulting to that municipality; Panasonic's Denver office which spearheads the pilot there; and GM, Ford and Intel which run testing programs near their offices in the Phoenix suburbs of Chandler and Tempe.

On the public sector side, Southwest Research Institute in San Antonio provides technology and engineers for the city, and most cities have a local university connected to their pilots providing a range of resources including physical space, technical resources and funding. These partnerships are

numerous: UT Center for Transportation Research in Austin, ASU in the Phoenix area, UMichigan in Ann Arbor, Clemson University with Greenville and so on.

Critical, too, are city partnerships with the federal government, particularly in securing sources of funding. U.S. DOT has awarded \$350 million for advanced transportation technologies — including \$40 million to Columbus as the Smart City Challenge winner — and numerous cities continue to benefit from Federal Highway Administration Advanced Transportation and Congestion Management Technologies Deployment grants. Cities that work with their local universities have additional ways to benefit from federal funds, as those institutions can win research grants for work on this subject matter.

Engaging the public

Cities have also actively engaged their citizens and called for public input throughout the process of planning for and then deploying AV pilots on their respective streets. Austin and Tampa both put substantial effort into community engagement and education. Austin hosted several public demos as well as opportunities for public engagement at the Texas Mobility Summit in 2016 and 2017 and the South by Southwest conference in 2017. Meanwhile, Tampa hosted similar demonstrations and conferences in addition to a community brainstorming session, and Boston held an “AV petting zoo” to familiarize its citizens with the technology.



An overwhelming majority of cities bringing AVs to their streets extended their invitations to diverse actors in the public and private sectors.

ZOOX

THE PRIVATE SECTOR PERSPECTIVE

Zoox, a California-based startup founded in 2014, is developing a fleet of fully autonomous vehicles for ride-sharing service in cities. Like many companies working in the realm of AVs, mapping is key. The software consistently learns and improves as the AVs spend time on the road and update in real time, albeit with human engineers double checking the computer's interpretation of its environment. These maps can then be fed into simulations that train vehicles on specific locations or challenges before even putting them on a public road. Developers and cities sometimes have divergent views of what should be included on the map. For example, some city officials want to have real-time updates on their streets, such as pothole locations, which are not necessarily mapping priorities for AI developers.

Zoox sees its vehicles as solving four critical urban challenges: sustainability, mobility, accessibility and safety. The company is developing 100 percent electric vehicles that are purpose-built for city use. For example, the doors slide open for easier curbside entry and exit. They are also bidirectional to facilitate navigation in

dense areas.

Ridesharing is a critical component of the Zoox vision, in which its vehicles can accommodate four passengers and are constantly occupied, shuttling riders throughout the city at the touch of an app button. This vision contrasts sharply with vehicles that sit idle for significant portions of the day, as many privately owned cars currently do.

Speaking to safety, the Zoox vehicles strive to usher in an era of better road sharing between cars, cyclists and pedestrians. Not only is the AI expected to perform more safely than human drivers, but the

We're developing a vehicle that's purpose-built for city environments.

BERT KAUFMAN | HEAD OF CORPORATE AND REGULATORY AFFAIRS | ZOOX

robots are also designed to use novel ways to communicate with other road users. The AVs also employ proactive safety measures, compared to the reactive features of today's standard cars. AVs are programmed to avoid hitting anything and



Credit: Zoox

to not veer off a road.

To enable AV testing and deployment, Zoox recommends strong city leadership from the executive or the city council level. City leaders should clearly and effectively communicate the city's vision for future transportation options. City leaders should also use their platforms to bring law enforcement and emergency response officials to the table from the beginning. Zoox recommends designating an AV point person in a mayor's office to coordinate city stakeholders. This role should work with developers on how to responsibly bring AVs to that city, and will also conduct train the trainer events to educate responders.

While some cities are concerned about investing in smart infrastructure

in preparation for widespread AV deployment, Zoox doesn't expect all cities to do so. The company is instead focusing on developing an AV that can operate in all locations, irrespective of the connectivity of those streets, as well as under all weather conditions. Zoox also recommends that cities proactively think about strategies for deploying EV charging infrastructure.

When a vehicle encounters a particularly challenging space, it has the ability to communicate with a remote operator who can provide instruction. This communications feature is expected to remain present in vehicles once a commercial rollout occurs for safety and product experience.



CITY EXAMPLES



ARLINGTON, TEXAS

There's no better way to understand AV technology than to actually be testing it yourself.



ALICIA WINKELBLECH
ASSISTANT DIRECTOR, STRATEGIC PLANNING



POPULATION 390,000

CITY SIZE 100mi²

DENSITY 3,900/mi²

PILOT TYPE 12-passenger shuttle

PILOT GEOGRAPHY Fixed route, not on public roads

With enhanced regional mobility and a focus on technology serving as the two prongs of the city council's strategic vision, piloting AV technology was a natural step for the city of Arlington, Texas. The city council had three goals for the pilot. First, councilmembers wanted to understand AV technology. Seeing that the presence of AVs in the country was growing, the members of Arlington's city council wanted to see the technology operate on their own streets to better understand how to plan for its full deployment. Secondly, the council sought to familiarize the public with AVs and increase understanding and

acceptance. The third goal of the pilot was to highlight Arlington nationally as an innovative testing ground for research and deployment.

The city had a specific vision of improving mobility for spectators flocking to events in the entertainment district, and selected as its partner France-based EasyMile due to its ability to provide an autonomous shuttle with wheelchair accessibility. Arlington set about leasing two low-speed shuttles, running them on an existing path to carry passengers between parking lots and sporting and concert venues. The city added pickup and drop off areas, made a few physical

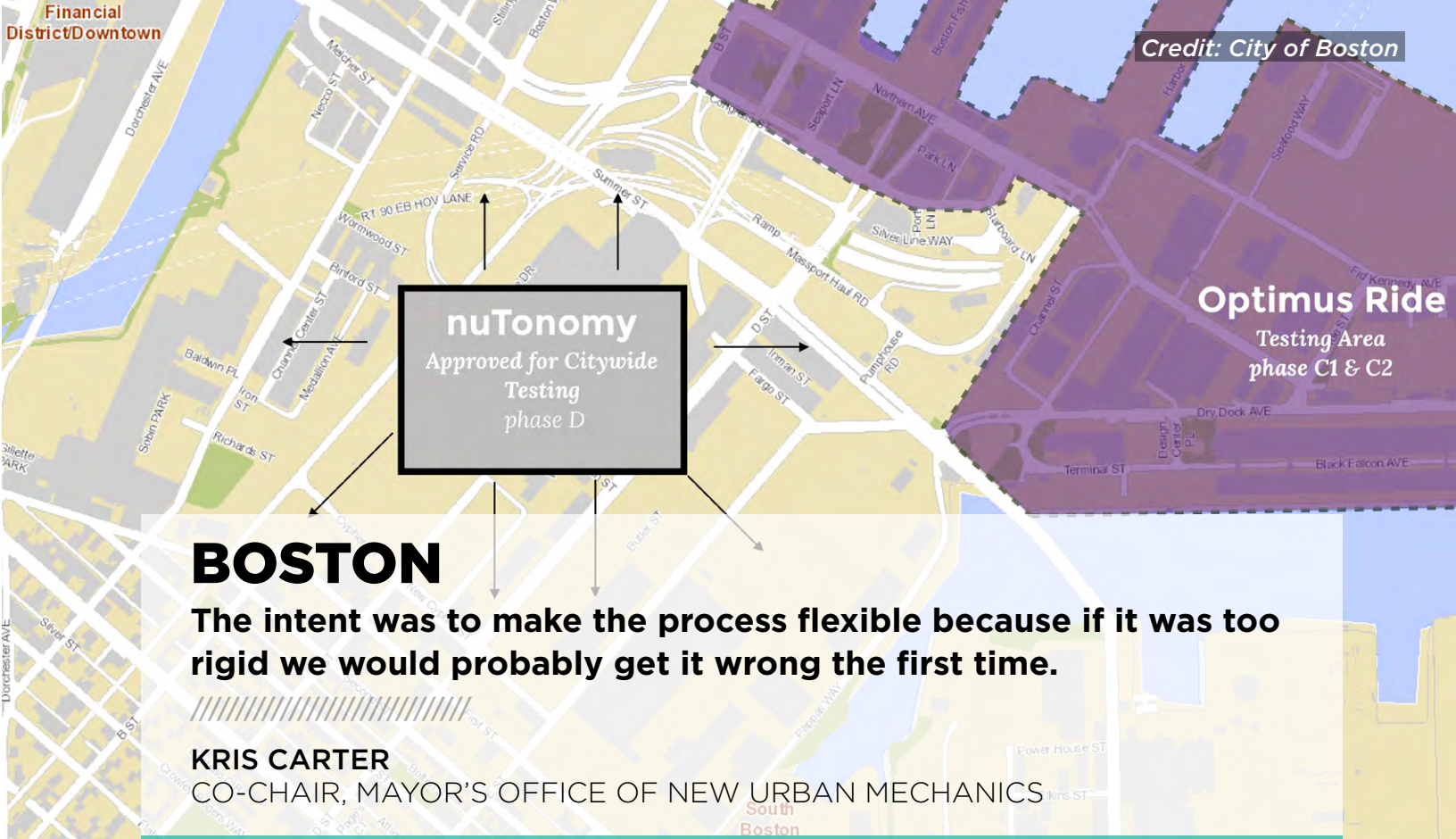
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adjustments to the path, and partnered with the Conventions and Visitors Bureau to provide on-board information ambassadors who could operate the shuttles manually if necessary.

With a route closed to other traffic and an operator onboard to answer questions and assist the public, the shuttle pilot provided a safe introduction to AV operations. Passengers were asked to complete surveys at the conclusion of their ride, and they overwhelmingly reported a positive experience that they would repeat or recommend to others. Since August 26, 2017, the shuttle has given over 1,500 rides.

Feeding off the success of the shuttle pilot, the city plans a forthcoming second phase of on-street testing. While the technology used for mixed traffic pilots is more complex and the experience different, the success of this initial phase makes city officials optimistic that the public will embrace the next phase. With funds from a federal congestion mitigation air quality grant, Arlington has issued a competitive RFP to bring autonomous passenger vehicles to the streets in a geofenced part of the city. They expect on-street AV service to

debut in Arlington this coming fall. Arlington's hope for the long-term development of its AV programming is to add transportation options for residents and visitors. Historically, Arlington residents have voted three times against utilizing sales tax to fund public transportation. However, a Council-appointed Transportation Advisory Committee developed recommendations in 2017 for the use of innovative technology-based solutions to fill the existing transportation gaps. Building off those recommendations, the city launched the Via rideshare service in December 2017. The city envisions the rideshare service, which continues to do extremely well, as an autonomous option in the future.



BOSTON

The intent was to make the process flexible because if it was too rigid we would probably get it wrong the first time.

KRIS CARTER

CO-CHAIR, MAYOR'S OFFICE OF NEW URBAN MECHANICS

POPULATION 685,000

CITY SIZE 48mi²

DENSITY 13,841/mi²

PILOT TYPE Single occupancy vehicle; App-based rideshare

PILOT GEOGRAPHY Fixed route initially, with recent approval to expand throughout the city; isolated road initially, graduating to public roads

Boston's experience with AV piloting demonstrates a case of local and state action dovetailing to enable innovation. The city began intentional efforts to bring an AV pilot to its streets in 2015 with an application to USDOT's Smart City Challenge. As part of that process, city staff began mulling over what their future AV policy would look like and agreed upon a desire to learn alongside the companies conducting research and development in this space. Boston did not win the challenge, but grew its application into a new submission and, in September 2016,

was recognized by the World Economic Forum as a focus city for future mobility. The city consequently received in-kind support from both the Forum and The Boston Consulting Group.¹⁷

This announcement set in motion a quick rollout of the city's first pilot. Shortly after the Forum announcement in the fall of 2016, Mayor Marty Walsh signed an executive order directing the Transportation Department to create guidelines for AV testing.¹⁸ On the heels of that announcement came a corresponding

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executive order from Governor Charlie Baker, creating an AV working group and requiring all AV pilot entities to develop an MOU with both MassDOT and the municipality where testing would occur.¹⁹ The city and state offices worked in tandem, co-releasing the orders to provide the city with clear authority to move forward.

The city provided an open application period and selected two startups with local affiliations at the Massachusetts Institute of Technology, nuTonomy and Optimus Ride. The leadership teams of both companies had worked with city government on other issues, and had existing professional relationships with city staff members. These preexisting relationships helped provide the trust and efficient communication necessary for a smooth entry of AVs to city roads.

Boston brought MassDOT, the Registry of Motor Vehicles, the port authority, state police and state government representatives together to coordinate a way forward with respect to AV piloting. The group agreed to a graduated test plan that slowly increases the level of complexity in order to mitigate safety concerns. When selecting a test site, the city looked for a neighborhood without residential units in order to decrease the amount of traffic, pedestrians, and bicycle activity. They

also chose an area with no traffic signals and no complex intersections. The Marine Park — an industrial site — was selected for the first phase of the pilot, with the seaport area as the location of the second phase.

The testing plan that Boston requires of its AV providers is flexible and designed to avoid renegotiations. The city holds the expectation that the AV provider will raise issues with the city as they arise and ask for permission to change the terms of the pilot. For example, Optimus Ride received permission to run their vehicles in fog and rain for learning purposes. Boston's approach also requires quarterly public reports — in which the companies submit their updates — and qualitative data sharing.

In January 2017, nuTonomy set its first self-driving cars onto the roads of a city park,²⁰ expanding to the Seaport District and Fort Point neighborhoods by April.²¹ Members of the general public were not directly included in the pilot until late 2017 when Lyft worked with nuTonomy to offer rideshare services in driverless cars throughout the Seaport District.²² That same year, Optimus Ride received similar approval to introduce its vehicles to the same downtown park. Given the success thus far, nuTonomy is working to map the entire city in anticipation of reaching the next phase of the pilot and allowing the AVs city-wide movement.



PORTLAND, ORE.

Technology is values neutral; cities are not.

PETER HURLEY
SENIOR TRANSPORTATION POLICY PLANNER

POPULATION 650,000

CITY SIZE 145mi²

DENSITY 4,375/mi²

PILOT TYPE City-run permitting process for various types of services
PILOT GEOGRAPHY TBD

Portland's impetus for bringing an AV pilot to its streets was a desire to understand how AVs would impact the city and, more importantly, how the city would prepare for their arrival with a corresponding AV policy that articulated the city's values and goals. City officials defined their role as promoters of city values, charged with ensuring that any forthcoming transportation or technology program aligned with the following core issues: safety, equity, pollution reduction and congestion reduction.

In the summer of 2017, the city opened an RFI focused on how AVs could benefit Portland's existing public transit system,

receiving 19 responses from interested AV developers. City officials are in the process of evaluating each application and working with the private sector to select specific projects to pursue. The city notes that the technology improves so quickly that some of the projects they were considering a year ago no longer seem as appealing or useful. Further, with the private sector eager to move this technology from development to deployment, the city is hoping to provide permits for self-funding entities rather than to pay for a pilot from government funds.

One of Portland's most significant

Autonomous Vehicle Pilots Across America

lessons learned during this preparatory process is that the focus of transportation technology should be on providing a service to people, not on providing specific vehicles. City officials describe this shift in their interest as stemming from their belief in improving access to opportunity and avoiding the congestion they fear privately owned AVs would bring.

Thus far, Portland's negotiations with the private sector have been fruitful, with many companies understanding the importance of emphasizing the city's stated values. Portland's vision for the pilot — expected to reach the streets in 2019 — is for the city to enable private sector actors to provide a range of mobility services and solutions through a permitting process. The details are still under discussion, but the city plans to develop ways to incentivize ride sharing and deployment in particular locations in order to achieve what city officials refer to as their “triple bottom line” of equity, economy and environment.



PITTSBURGH, PA.

AV technology is not any good to us unless we can use it to address some gaps that we have right now.



KARINA RICKS

DIRECTOR, DEPARTMENT OF MOBILITY AND INFRASTRUCTURE

POPULATION 305,700

CITY SIZE 55mi²

DENSITY 5,460/mi²

PILOT TYPE Single occupancy vehicle; App-based rideshare

PILOT GEOGRAPHY City-wide

Pittsburgh’s entry into the world of AV piloting began with a handshake agreement in 2016 between the mayor and Uber. The latter already had a presence in the city due to a research and development partnership with Carnegie Mellon University and wanted to move its testing of AVs from a closed site to city streets. The city did not develop an MOU or other written agreement with Uber, and has no plans to do so with any of the four other companies that have since launched AVs on city streets. Part of the city’s reasoning here is that written agreements require months of negotiations and prevent the city

from fostering a nimble and adaptive environment necessary to embracing technological innovation.

Pittsburgh officials see the city’s role as one of a purveyor of technology and — now that they have achieved proof of concept due to several years of AV presence on city streets — believe that further testing can help the city pursue its larger objectives of preserving human life and creating great communities. The city is currently focused on actively guiding the use of AV technology by establishing working groups that will recommend policies necessary for both piloting and full

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deployment. The city sought to bring as many stakeholders to the table as possible, including seniors, families, cyclists, employers and workforce access advocates. These participants are helping to guide the city's discussion across multiple departments and agencies, and to create a unified vision of what the public wants AVs to provide for the city.

The city points to its multi-year experience with Uber as a helpful step in familiarizing the public with this technology. Six months after Uber's AVs arrived on city streets, Pittsburgh conducted a public opinion survey. Most respondents reported that the AVs performed better than human drivers, and people who self-identified as cyclists or pedestrians overwhelmingly indicated positive attitudes about sharing the road with AVs. Those who identified themselves as frequent drivers responded negatively towards AVs, although only with the complaint that they move too slowly. In the years since, AVs have become "old news" in Pittsburgh, and the city does not anticipate public pushback or related challenges for future pilots.

With an RFP due to open this year, Pittsburgh envisions the next chapter of its AV piloting experience to specifically center on improved public transportation. The city is open to use cases involving any medium, from micro transit to medium-sized shuttles to city buses, so long as the outcome serves city priorities, addresses first mile/last mile gaps and provides equitable access to vulnerable populations.



SAN JOSE, CALIF.

We want shared autonomous electric vehicles that integrate with public transit and are equitably deployed. Having that clear framework is important because, in the absence of that, the city won't be able to understand what it needs to get out of the public private partnership.



SHIREEN SANTOSHAM
CHIEF INNOVATION OFFICER, SAN JOSE

POPULATION 945,900
CITY SIZE 180.5mi²
DENSITY 5,776/mi²

PILOT TYPE TBD
PILOT GEOGRAPHY Specific corridors designated by the City

San Jose's proximity to the headquarters of multiple major tech companies meant that the city's engagement with AV development was inevitable. After observing AVs using their streets for private testing, city officials decided to take an active role in shaping how this technology should become part of daily life. Chief Innovation Officer Shireen Santosham spearheaded the effort by organizing a stakeholders' round table hosted by the mayor and attended by over 30 private sector AV developers as well as leadership from the Department of Transportation and regional transit agencies. This event

opened a productive dialogue in which the companies asked for curbside drop-off space and electric vehicle charging stations, and the city in turn requested a data sharing agreement and transit options for specific neighborhoods and 'use cases.'

Based off these initial conversations, San Jose opened a formal RFI in June 2017, receiving 31 written responses. The AV developers who responded demonstrated a clear interest in developing a long-term, mutually beneficial relationship with the city. San Jose officials found that the private sector looks to them not

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only for access to city infrastructure and city data, but also as a leader in public conversations around trust.

With vehicles expected to roll out in early 2019, the city is currently working with a handful of companies on critical specifics such as law enforcement interaction plans and data sharing. The city has learned that having early conversations with companies can lead to the latter building into the algorithms data points that the city finds useful. The city's initial costs, beyond staff time, have been minimal. City officials are, however, beginning to think about the future cost of making connected infrastructure upgrades throughout San Jose.

The next step for city officials will be to engage with San Jose's citizens directly. The current plan is for a fixed-route pilot with established pick up and drop off points, and the city wants to give the public an opportunity to help choose those locations and inform other aspects of the design to increase trust in using this new technology. Though exact locations are not yet public, the 'use cases' laid out in the RFI included building autonomous connections between the airport and train station, linking the downtown area and neighborhoods with a significant number of jobs, and serving vulnerable populations like formerly homeless veterans by connecting them to public transit. An additional goal of the forthcoming public engagement sessions is to learn how different segments of the population want to utilize this technology, be it for recreation, commuting, assistance for aging populations and so on.

Despite the excitement surrounding AV development, the city remains realistic that a complete turnover of vehicles may still be many years away. Another learning point for city officials centers on the wide variety of private sector developers and the importance of carefully selecting those with whom the city can maintain a positive relationship for many years to come. Thus far, San Jose officials have found their selected developers will help the city to promote its goals of a safe and sustainable AV presence that removes transit redlining for the next generation of public transportation.



CHANDLER, ARIZ.

What can we do to facilitate the development of this technology because we believe in its long-term benefits?



MATTHEW BURDICK

COMMUNICATIONS AND PUBLIC AFFAIRS DIRECTOR

POPULATION 236,000

CITY SIZE 65mi²

DENSITY 3,810/mi²

PILOT TYPE Single occupancy vehicle; App-based rideshare

PILOT GEOGRAPHY City-wide

The Phoenix suburb of Chandler presents a unique case study, both for the length of time that the city has had an AV presence, as well as for the widespread geographic range of the pilot, with AVs having a city-wide presence since 2016. Arizona's Governor Ducey signed an executive order in 2015 that facilitated a start to AV testing throughout the state, and the city of Chandler quickly agreed to follow that lead. From the city's perspective, this industry presents significant long-term benefits for the public and the local government wants to aid in its research, development and ultimate deployment. Chandler officials point to the willingness of the city's political leadership to welcome AV testing as a significant precipitating factor in Waymo's initial arrival in 2015.

With an existing technology and automotive ecosystem, Chandler was a natural location to host some of the country's first AV testing on public roads. Intel serves as the city's largest private sector employer, having been located there for the past 40 years and currently employing 11,000 people. Other companies in this sector have a presence in Chandler including Rogers Corporation and NXP Semiconductors, companies that provide sensors and chips for connected vehicles, and Garmin, which provides GPS. On the automotive side, the General Motors IT Innovation Center is located in Chandler as well, and Toyota, Volkswagen and Nissan have historically had research and development facilities in the area. In addition, Local Motors is producing an

Autonomous Vehicle Pilots Across America

autonomous shuttle bus, called the Olli, in a micro-factory adjacent to Chandler. Moving forward, the city is eager to support the ever expanding AV activities by encouraging companies that provide components to come to Chandler.


Given the robust presence of the technology sector, Chandler's residents are open to embracing innovation and additional actors in this space, warmly welcoming Waymo in 2015 when the company brought the first AV demonstration to the city. Several thousand people showed up for a weekend demonstration to ask questions and see the software and hardware up close. Waymo continued to actively participate in community events, bringing vehicles to the mayor's state of the city address. This transparency and willingness to share their work with the public helped to establish public trust in the company and an inclination in favor of moving forward with the pilot.

In addition to the overall familiarity with tech companies, the diligent and slow progression of AV introduction helped maintain a positive public perception. For example, Waymo put its vehicles on the street with typical drivers as operators for a number of months during the mapping phase. This course of action helped familiarize the public with seeing the vehicles on the street and was followed by a slow integration of vehicles running autonomously. Now that AVs have coexisted with Chandler's residents for over two years, they are a commonplace sight throughout the city's neighborhoods.

City officials see their role as that of facilitator while the state serves that of regulator. Therefore, Chandler does not

have formal agreements with any AV developers. The city instead focuses on enabling collaborations that promote AV development. For example, the city invited the engineers to test emergency response vehicles on a closed track alongside city employees, in order for the city's own responders to become familiar with how their operations in a fully autonomous world might occur. The city also brought its police and fire department representatives to visit company headquarters in the Bay Area to advise on their needs and concerns regarding AV interaction.

To continue enabling AV testing and easing the city's transition to larger numbers of AVs on the streets, Chandler officials have modified their zoning development code. The amended code reduces parking requirements by up to 40 percent and encourages passenger loading zones as drop off and pick up locations for autonomous vehicles and ridesharing. The city hopes that AVs will increase shared ridership leading to a decrease in parking needs.



Transparency and willingness to share work with the public helped to establish public trust.



**STRATEGIES FOR
CITY LEADERSHIP**

Conclusion

AV pilots show no signs of slowing down in municipalities across the U.S. San Antonio announced its own request for submissions in July 2018.²³ Meanwhile, San Ramon and Frisco recently made waves in 2018 with autonomous shuttles hitting the streets in March²⁴ and July, respectively.²⁵

One thing is certain: with current federal regulations, uniquely permissive, non-traditional actors will continue to be able to participate in AV development and testing. A forthcoming pilot in Greenville, S.C., stands out as one that demonstrates the successes that are possible through collaboration between public and private entities. Greenville's city council coordinated funding sources for the project, winning a \$4 million grant from the Federal Highway Administration, securing \$2 million from the nonprofit Global Autonomous Vehicle Partnership and bringing in \$1 million from the developer of the residential community to which the pilot will expand. The city further received donated technology from Robotic Research, and in-kind support for management of the initial phase by Clemson University's International Center for Automotive Research.²⁶

Similarly, the state/local relationship for this policy area continues to develop. In July 2018, the state of Massachusetts

announced a partnership with 15 cities to host AV testing alongside to-be-named developers.²⁷ Building off Boston's recent successes, the state signed an additional MOU with 14 local governments for both urban and highway testing.²⁸ The announcement, just the latest in a string of new AV pilot programs, focuses on improved mobility options and demonstrates how constructive partnerships and well-defined values enable local governments to create a city for all.

Recommendations

1 Determine the city's goals and reasons for pursuing an AV pilot project. Is the city trying to reduce congestion, remedy a lack of public transportation, or improve its image as a forward-thinking innovation hub? Defining clear goals will not only help a city to design its pilot but will also establish realistic expectations of developers. Portland and Pittsburgh found that listening to public stakeholders and examining city values surrounding mobility and equity helped to focus their RFP process away from a purely technological endeavor to one that was citizen-focused. Additionally, these goals can be applied to future developments in mobility technology and guide a city's adoption of scooters, dockless bike share programs, sidewalk delivery robots and so on.

2 Build a consortium. Thus far, NHTSA and U.S. DOT guidelines maintain access to the AV market for a wide variety of entities, allowing not just traditional auto manufacturers to introduce and test AV technology, but other types of companies and academic institutions as well. Cities should take advantage of their unique geographies by partnering with think tanks, advocacy groups, technology companies, consulting firms, developers and research universities that already have a

physical presence nearby. For example, San Antonio currently partners with local organization Southwest Research Institute on exploring AV options, Tampa receives in-kind consulting from the local AECOM office and Panasonic's Denver office is working to bring that city's first autonomous shuttle to the road.

3 Engage the private sector. Along with the first point, cities should look far and wide in gathering partners to absorb the financial burden, whether that be through donated technology, in-kind consulting or full-scale management of an entire project. Further, developers have demonstrated an interest in funding pilot projects that would increase public transit access to new neighborhoods.

4 Look to join or create a regional alliance. The greater the testing area that municipalities can offer to piloting entities, often the more robust the argument. For example, Texas hosts a wealth of AV pilots, covering both urban spaces and highways, within its metropolitan triangle between San Antonio, Austin, Dallas and Houston. Regional alliances also help in attracting state and federal funding. Further, coordination between cities provides a streamlined experience for the private sector.

5 Scale appropriately.

Determine what type of AV testing and usage is most appropriate and realistic for the city's goals and investment plans. From shuttles on a set route to autonomous rideshare apps, cities have an opportunity to guide the selection of which vehicle will bring this technology to their streets.

Financial: Some cities — such as Boston and Pittsburgh — pay virtually nothing for the pilots outside of an investment of staff time. Others, such as Arlington, cover the entire cost or a portion thereof. Chandler even profits from leasing facilities to Waymo.

Temporal: The existing pilots run for anywhere between one year (Arlington's Phase I) and an indefinite period (Chandler, Tempe, Pittsburgh). Other cities arranged a structured phasing-in of the pilots (Greenville and Boston).

Geographic: In the largely 'hands-off' cities, major companies such as Uber and Waymo deploy their fleet throughout multiple neighborhoods. Other cities prefer to specify innovation zones for single-occupancy vehicle pilots or fixed-route shuttles. (The Texas Innovation Alliance refers to this range as "closed," "controlled" and "open" testing sites.)

Technical: Cities may have the option to specify the degree of vehicle autonomy although, for the most part, this is regulated at the state level if it is regulated at all. All pilots have thus far begun with an engineer sitting in the

driver's seat and most are still in this phase. Waymo's vehicles in Arizona and California recently moved from an empty driver's seat with the operator observing from the back seat, to an empty vehicle with a remote safety operator. For shuttle programs, some have human backup operators onboard while some in development plan to be fully autonomous.

6 **Work with the state.** This step is particularly important to prevent reactionary restrictions by states that would halt all AV activity. Cities should attempt to avoid a regulatory arms race with their state legislatures by working with their state DOT as well as neighboring municipalities to form organizations that combine multiple levels of government, like the Texas Innovation Alliance.

7 **Pursue a phased plan.** While phasing is not a required step (officials in Chandler, for example, are pleased with their city's experience with the Uber pilot), cities have found that a gradual introduction of AVs helps to ease public concerns and sets the conditions for an overall positive implementation. In particular, those in Arlington and Boston deliberately constructed pilot phasing in order to provide ample time for AV education and familiarization for both city staff and the public. An added benefit of this approach has been a close and positive relationship between those city officials and their selected AV developers.

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