US Ignite Smart Transportation

BACKGROUND

There are a multitude of challenges facing communities as they work to create smarter transportation systems. Capacity constraints are driving up traffic congestion. New types of vehicles are impacting public safety. Access to mobility is an equity issue. Financial limitations are putting pressure on infrastructure investments. Transportation affects air quality and the environment. The list goes on.

Unsurprisingly, interest in smart transportation is creating a substantial market for new technology and service solutions. One forecast by Markets and Markets suggests the market size will hit $149 billion by 2023, while another by Grand View Research argues the number will reach $285 billion by 2024.

Regardless of private sector enthusiasm, however, governments need a better understanding of how new solutions translate to their specific community needs before the smart transportation movement can deliver on its potential. That means getting educated on new technologies and policy issues while learning from field tests about what happens when transportation theory meets real-world conditions.

On November 28, 2018, US Ignite hosted a Smart Transportation workshop in the city of Columbus, Ohio with Smart Columbus and other municipal, university, industry, and non-profit partners. The workshop highlighted smart transportation initiatives focused on connected, autonomous, shared, and electric mobility. It offered municipal leaders a chance to share information they've learned through testing and the early development of next-generation transportation technologies and policies.

This playbook examines smart transportation through the experiences of local governments in: Columbus and the state of Ohio; the state of Wyoming; Boston, Massachusetts; Lincoln, Nebraska; and Ann Arbor, Michigan. It includes a review of connected and autonomous vehicle deployments as well as creative innovations taking place to ensure new transportation solutions are safe and sustainable.

There are case studies from each city and state with practical recommendations and resources for communities looking to pursue their own strategies for smart transportation development.

CONNECTED TRANSPORTATION

As connected transportation – the concept of enabling two-way communication between vehicles and local infrastructure – gains attention, researchers and local authorities are investigating what problems it can solve, what technologies are the most effective, and how to apply investments for strong civic outcomes.

On the first issue of how connected transportation can address challenges, numerous pilot projects are now underway to determine where connectivity can make a meaningful difference. These projects include:

- Testing public safety systems and services
- Enhancing traffic mitigation
- Researching vehicle operations
- Supporting new in-vehicle information and entertainment functionality

USE CASE – PUBLIC SAFETY

As a safety issue, connecting transportation corridors can make it easier to alert drivers to adverse road conditions, and to monitor for vehicles in distress. The causes behind road hazards may vary, but the benefits from a responsive roadway communications system are near-universal.

In Wyoming, one major transportation safety concern is multi-vehicle truck crashes. On some stretches of highway, these occur frequently when blowing snow limits a driver's visibility. Once a truck crashes or overturns, often several more approach at full speed without the ability to brake before creating a vehicle pile-up.

Having been selected for the USDOT Connected Vehicle Pilot Deployment Program, the Wyoming Department of Transportation (WYDOT) is now instrumenting an area of dangerous roadway so that when a crash takes place, it is rapidly reported back to the transportation management center (TMC). The deployment includes both roadside communication units and in-vehicle devices installed on snow plows, in highway patrol cars, and with private-sector vehicle fleets. Eventually, the state is aiming for drivers to be able to press a button when they see a crash, and have the information transmitted from vehicle to vehicle, and to the roadside units communicating with the TMC. The TMC will then be able to send out a wider alert notifying drivers to stay clear of the area.

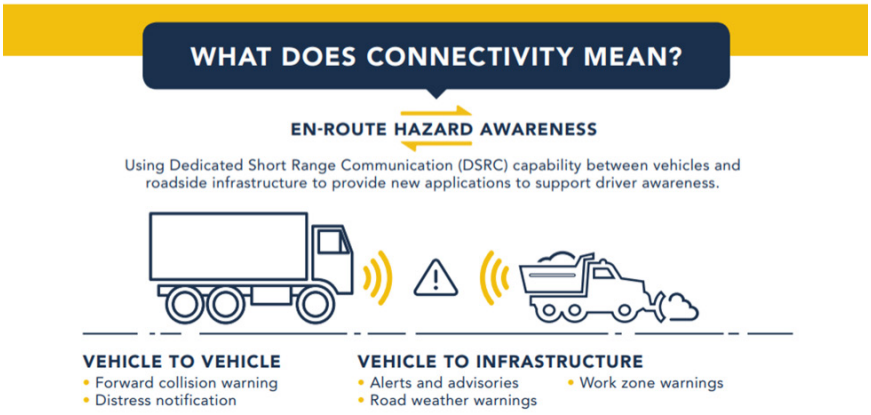


Illustration of a Wyoming DOT (WYDOT) connected vehicle pilot project

Within the Ohio Department of Transportation (ODOT), the organization DriveOhio acts as an interagency authority for connected and autonomous vehicle initiatives in the state. One of DriveOhio's projects is connecting a section of I-90 roadway with a system to mitigate the risks of lake-effect snow conditions. The deployment includes short-range digital communication units spread across 60 miles of the interstate, with sensor data used to inform local public safety efforts. Not only can transportation officials stay up to date on weather impacts and be alert for hazardous driving conditions, but they can also use the data to adjust speed limits through new variable speed limit signs to reduce the risk of road fatalities.

USE CASE – TRAFFIC MITIGATION

The combination of connected transportation corridors and the ability to dynamically adjust traffic signaling has delivered promising results across the country. In Seattle, an initiative called Split Cycle Offset Optimization Technique (SCOOT), used dynamic signaling to decrease the average time needed to travel the notorious Mercer Corridor from 32 minutes to 17 minutes. Details on the deployment are available in the US Ignite Smart City, Big Data playbook.

Many other communities are also looking at smarter transportation systems to reduce traffic congestion and move vehicles more efficiently from place to place.

Ann Arbor, Michigan is hosting one of the largest connected vehicle deployments to date as part of a $50 million project that is equipping 2,200 vehicles in the city with on-board devices. As in other tests around the country, these on-board radios feed data to roadside units, which then communicate back to the traffic management center and inform decisions around traffic signaling.

The traffic patterns in Ann Arbor mean that commuting times are particularly difficult, as are gameday weekends when vehicle volumes can double. Beyond adjusting the timing of stoplights, project leaders in the city are also looking at how to move to one-way traffic flows as needed, and collaborate with the local transit agency and downtown development authority to optimize public transportation and parking options.

In the Columbus, Ohio area, there are currently three connected vehicle pilots underway, with a total of 179 instrumented intersections. In addition, local authorities are aiming to connect 4,200 vehicles in the region by 2020, using a combination of buses in the Central Ohio Transit Authority (COTA) fleet, private business vehicles, and cars and trucks owned by citizen volunteers. Like other cities, Columbus will test communications between vehicles and connected infrastructure as a means for decreasing traffic congestion. Columbus will also kick off demo days to get citizens involved in the project, with officials planning to share information on how they collect and use data. By engaging directly with citizens, the city hopes to improve data collection and derive greater insight into how to mitigate traffic congestion throughout the region.

USE CASE – OPERATIONS RESEARCH

The future of autonomous vehicles is another promising technology that can leverage connected vehicles and infrastructure to deliver value to communities. As part of a large portfolio of projects, DriveOhio is in the process of building a transportation research center within its US 33 smart mobility corridor. Funded by the state government, The Ohio State University, and other agencies, the center is being designed as a large test facility for both autonomous and connected vehicles. Rich Granger, managing director of workforce development for DriveOhio, says that although the center hasn't opened yet, early testing slots have already booked up. Data from those tests will be used to refine further pilot project parameters before vehicles leave the safe testing environment to continue trials on Interstate 33.

A woman examines local traffic data at the Smart Columbus Experience Center in Ohio

Cities are also looking to collaborate with industry partners to make the most of their connected technology investments and technology assets. Honda, for example, is a key partner in Ohio's US 33 smart mobility corridor. In Ann Arbor, local officials have also offered access to their Dedicated Short Range Communications (DSRC) radio infrastructure to Waymo for self-driving vehicle tests. Interestingly, Waymo has declined the DSRC offer. The subsidiary of Alphabet (parent company to Google) has instead decided to rely on detailed city mapping along with in-vehicle technology for its autonomous vehicle trials.

USE CASE – IN-VEHICLE INFORMATION AND ENTERTAINMENT

When the industry talks about connected transportation, it's often in the context of enabling vehicles to communicate with local infrastructure and transportation authorities. However, providing WiFi connectivity throughout the transportation system – particularly in public transit vehicles – is another important element of the whole. As more consumers expect ubiquitous WiFi connectivity, the ability to offer it as part of public transportation is critical to getting people to consider public transit as an alternative to driving alone in a car.

Among the many projects COTA has undertaken in Ohio, one important one has been to build free public WiFi into its buses, bus stops, and main transit center. COTA, however, didn't stop at just making WiFi available. It partnered closely with Cisco to make WiFi connectivity seamless across vehicles and COTA sites by creating a cross-platform system that operates across three different networks: a cellular network provided by T-Mobile, leased fiber lines, and COTA's own fiber backbone that connects its main facilities. Once a user logs in to the system, that user stays logged in and can move across networks without losing connectivity.

A COTA bus outfitted with next-generation WiFI systems

According to Aaron Hibbard, systems architect at COTA, the WiFi system can support up to 65,000 concurrent connections, and users currently consume roughly 1.2 terabytes of cellular data transmitted via WiFi per day. COTA covers the cost through its operating budget and through a 0.5% sales tax.

Use Case Takeaways

- Early tests suggest that greater connectivity and faster communication of vehicle distress, roadway congestion, and weather impacts can be used to: speed up emergency response; adjust signaling to distribute traffic more effectively; change traffic flow patterns to make road conditions safer.
- There is high demand for testing environments (including testing on actual community streets) that will allow both private companies and public entities to discover how new connectivity systems affect complex transportation systems.
- The technology for in-vehicle connectivity is growing more sophisticated. User experience will play a role in the options citizens choose for their own transportation.

CONNECTED TRANSPORTATION – TECHNOLOGY

Whatever the use cases, connected transportation applications only work when the necessary communications infrastructure exists. Fiber is ideal for backhauling large volumes of data, but installing and maintaining fiber lines raises a number of financial, technical, and regulatory challenges.

And the challenges differ from locality to locality.

In Ann Arbor, the city needed to upgrade the fiber used to support its traffic management center as part of a project to create a connected vehicle testbed environment. The options for doing so were limited by the city's franchise agreement with Comcast. Through its existing agreement, Ann Arbor either needed to lease new assets from the cable company or build its own network.

Ann Arbor chose to build its own network, constructing a 35-mile ring of fiber with an additional bisecting line of fiber running down the middle. Today, the city only uses about 10% of the network's available bandwidth, but given the excess capacity, officials know they won't have to dig up the city's roads again to lay new fiber for the foreseeable future.

In Lincoln, Nebraska, the fiber obstacles were different. The city couldn't build its own network because of a prohibition on municipal broadband. However, officials did come up with a creative solution. The city has put conduit in the ground that private companies can use to house their own fiber for broadband services. Lincoln makes it easier for commercial providers to get their infrastructure deployed with the existing conduit, while also generating revenue through leasing agreements.

Lincoln has successfully invested to bring several competitive fiber services to the region

Sometimes fiber isn't an option at all. In Wyoming, there isn't an economic case for building fiber along rural highways, so roadside communication units rely on microwave radio backhaul. But there are limitations. In a project to instrument 400 vehicles with their own devices to communicate with those roadside units, the state expects to generate 54 terabytes of data per year... just in text-based messages. Anything beyond text could easily tax network capacity.

Beyond network backhaul, the big technology debate surrounding smart transportation is how to wirelessly connect vehicles and infrastructure for data exchange. For years the standard has been dedicated short-range communications (DSRC), but DSRC systems aren't necessarily all compatible with each other. That's one area where researchers in Wyoming have been working with counterparts in Tampa, Florida and New York City. The partners participated in a Department of Transportation interop event in 2018 to ensure their connected vehicle applications work across different equipment systems.

Along with the compatibility issue, however, is the fact that DSRC may ultimately face an extinction point if the spectrum allocated for DSRC networks is reassigned for other uses. This is something the Federal Communications Commission is considering, and if it happens, DSRC equipment may have to be replaced. (See statements provided by FCC Commissioners Jessica Rosenworcel and Mike O'Rielly.)

Security is another challenging component of technology development in the connected transportation space. The researchers in Wyoming found this out when they built an entire connected roadway system and then tried to add in security after the fact. Many components of the system broke down.

The system now has security baked in, starting with the people operating the equipment, who are trained and vetted through background checks. Both roadside and on-board vehicle devices include hardware security modules, and virtual private networks are used to protect data in transit, according to Vince Garcia, geographic information & intelligent transportation systems program manager with WYDOT. The traffic management center also uses database encryption, and all stored data is secured behind firewalls.

Technology Takeaways

- Fiber is critical for complex connected transportation deployments, but governments must consider how best to pay for the investment where fiber doesn't exist, and what leeway they have to make decisions on fiber deployments based on city and state regulations. Rural areas may need to consider alternatives to fiber like microwave radio backhaul, even while understanding the limitations.
- DSRC technology has been a mainstay in the connected vehicle space, but there are possible system interoperability challenges, and there are concerns about how spectrum reallocation may impact DSRC's use in the future.
- Security cannot be an afterthought in connected vehicle systems. Trying to bolt security on after the fact adds significant time and effort to deployment.

CONNECTED TRANSPORTATION – FUNDING AND WORKFORCE DEVELOPMENT

Economics are a big part of the connected transportation story. Raymond Hess, transportation manager for the city of Ann Arbor, believes that the city's investment in fiber was a sound decision because no matter how challenges around spectrum allocation and equipment compatibility shake out, fiber will always be valuable for backhauling large amounts of data. That said, Ann Arbor is still faced with recruiting customers for its dark fiber while the city uses only a small fraction of the overall capacity. Being able to generate revenue is a critical part of the investment equation, and finding partners in the commercial sector won't necessarily be easy.

Hess also acknowledges that while Ann Arbor secured significant federal funding to create its connected vehicle test environment, the competition for federal grants is now heating up, potentially making it difficult for other cities to undertake large connected transportation projects.

In Ohio, there are two major factors that created an economic foundation for smart transportation development. One is an executive order that Governor John Kasich signed in January 2018, with a goal of eliminating vehicle crashes. The order established a new agency called DriveOhio, which combined the efforts and resources of several existing government agencies toward the purpose of improving transportation safety and reliability.

The second is a concerted effort in the state to join public, private, and non-profit entities together for research and testing around smart mobility. DriveOhio itself acts as a point of contact across these different sectors and works to nurture resource sharing between the government and private industry.

At a more local level, Columbus also credits its ability to partner with and secure funding commitments from private-sector companies as a major reason it won $50 million from the U.S. Department of Transportation and Paul G. Allen Philanthropies in 2016 through the Smart City Challenge. Columbus was able to show that it could match federal government funding with another $90 million in private investments from a variety of local companies. That money from the private sector is fundamental to the city's and state's ability to move smart transportation efforts forward. (See more details in the US Ignite Smart City Funding Strategies playbook.)

There is one other piece of the economic puzzle around smart mobility, and that's workforce development. Part of Governor Kasich's executive order in 2018 included a focus on training workers in new jobs related to the smart mobility industry. As a result, DriveOhio has teamed up with education partners to train automotive tech students in installing new radios in connected vehicle fleets. The organization will also bring in students to its transportation research center when that facility opens.

Workforce training is a major point of emphasis in Ohio's smart mobility efforts

As DriveOhio explains it in informational materials: "Workforce considerations are a key mission for DriveOhio as it attracts companies and jobs in the smart mobility industry, prepares workers for emerging jobs, trains and transitions potentially disrupted employees into new jobs and ensures equitable access to education and jobs through the state's mobility initiatives."

Takeaways

- State sponsorship is a valuable way to increase economic support for smart mobility issues, but regardless of state government involvement, cities should pool resources where possible and seek partners in the private sector.
- The connected transportation sector offers workforce development opportunities that should be factored in to any new initiatives.

AUTONOMOUS VEHICLES

Autonomous vehicle research and testing has largely taken place in the private sector, but increasingly governments are beginning to recognize the complexity of autonomous vehicles as a subset of the connected transportation movement, and to study the technology for insight into potential regulatory and economic impacts.

AUTONOMOUS SHUTTLES

From a municipal perspective, one of the more interesting use cases for autonomous vehicles (AV) is autonomous shuttles that circulate riders in popular downtown areas. By providing an alternative to driving along key routes, these shuttles have the potential to reduce congestion, air pollution, and the need for parking. Most if not all still require an operator aboard to assist passengers, but the goal is to make them run more efficiently than those without autonomous technology, and eventually to remove the need for a human operator at all.

The fact that local governments are participating in real-world AV testing is important because it helps them understand the capabilities and limitations of the current technology. For example, when the city of Columbus began planning for autonomous shuttle testing, officials had several ideas about the route their shuttle would use. They quickly discovered technical challenges, however, and had to adapt to the need for lower speeds of operation and a route with predominantly right turns. Left turns are possible, but only when there's a dedicated green arrow preventing oncoming traffic flow.

Columbus selected Michigan-based May Mobility to operate the city's AV shuttle route in a high-traffic downtown location. Three all-electric vehicles service the 1.5-mile route, with shuttles arriving at each of four stops approximately every 10 minutes every day of the week from 6am to 10pm. The vehicle, which has a maximum speed of 25 MPH, has a four-seat "campfire" configuration in the rear of the vehicle as well as a 49-inch digital display that provides system and route information. A human operator rides aboard each vehicle with access to driving controls at all times. May Mobility employs its fleet attendants.

The shuttles operate autonomously, using a suite of sensors that deliver a 360-degree view around the vehicle. The sensors and intelligent software help the vehicle understand where it is; in which direction to steer; and when to slow down, accelerate, or stop for something in its path. Mapping allows the vehicle to know every inch of its route and navigate through various traffic conditions. The vehicle operator provides riders with information about the route and technology and can take control of the vehicle at any time.

Officials in Lincoln, Nebraska have also conducted AV shuttle tests, and have experienced their own set of technology-related surprises. Leaders in the Nebraska city selected a $200,000 shuttle from Navya for their pilot program, forgoing more expensive models running upwards of half a million dollars. However, their test vehicle didn't operate flawlessly from the start. The manufacturer advertised 8-10 hours of usage on a single charge, but 5 hours proved more realistic. In the first ride with local politicians, rain also leaked into the vehicle, suggesting some improvements would be necessary.

Initial problems with autonomous shuttles are not uncommon. An autonomous shuttle in Las Vegas was infamously involved in a crash on its first day of service back in 2017. In that case, however, there were no injuries reported and experts determined the cause was human error, and that the driver in the other on-site vehicle was at fault.

Autonomous shuttle running in Columbus, Ohio

Takeaways

- Public-sector involvement in the testing of autonomous vehicles is important for informing policy decisions.
- Current AV technology is limited, which means its ability to impact mobility patterns today is also limited.

RADAR, LIDAR, AND WHAT ABOUT 5G?

There are multiple technologies that autonomous vehicles can use to gather data from the world around them in order to operate effectively. Two common ones are radar, which uses radio waves to detect and measure object characteristics, and lidar, which uses pulsing laser light to do the same. In Lincoln, there is a government mandate that AVs use both technologies to create the most comprehensive picture of surrounding objects and activity.

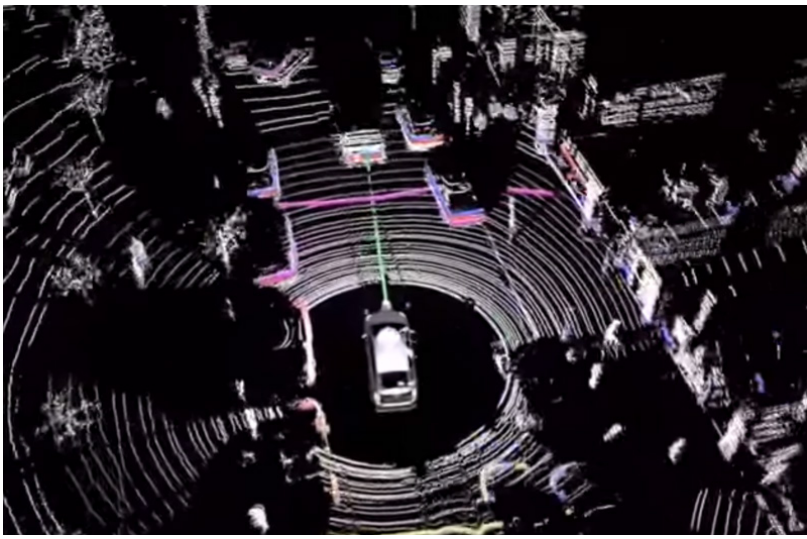
There are advantages and disadvantages to both radar and lidar. Radar depicts the shapes moving around a vehicle, but offers very little detail about other visual characteristics. Lidar offers more visual detail, but depending on angles, can create shadows that distort imagery. To complement both methods of data collection, AVs also use cameras to (literally) fill in the picture.


Radar imagery as presented by David Young, manager of fiber infrastructure with Lincoln, Nebraska

Once data is collected, an AV has to interpret that information and make decisions about driving. This is where part of the debate about new 5G cellular technology comes into play.

Using DSRC for transmitting and receiving vehicle information from roadside communication units is a viable option for some traffic management functions. However, there is an argument that 5G networks – with their extremely low latency rates for signal transmission – will ultimately be necessary for supporting real-time driving decisions in autonomous vehicles that have to communicate and take in significant amounts of information from the surrounding environment.

Today, autonomous vehicles avoid latency challenges by containing all data processing within the vehicles themselves, no communications required. There is a computer built in specifically to analyze real-time data inputs and prompt activity like speeding up, slowing down, or making a turn. In the future, there is the possibility that some computations will take place outside of these vehicles, however, and this use case is often cited as a major reason for adopting 5G technology.



Lidar imagery as presented by Lincoln's David Young

Whether the AV industry evolves toward 5G-based systems remains to be seen. The sector leaders, such as Waymo, are moving forward today even without the newest cellular technology.

Takeaways

- Radar and lidar technology offer different advantages and disadvantages for autonomous vehicles.
- Development in the AV sector is already progressing even before the widespread deployment of 5G cellular networks.

REGULATIONS AND FUNDING

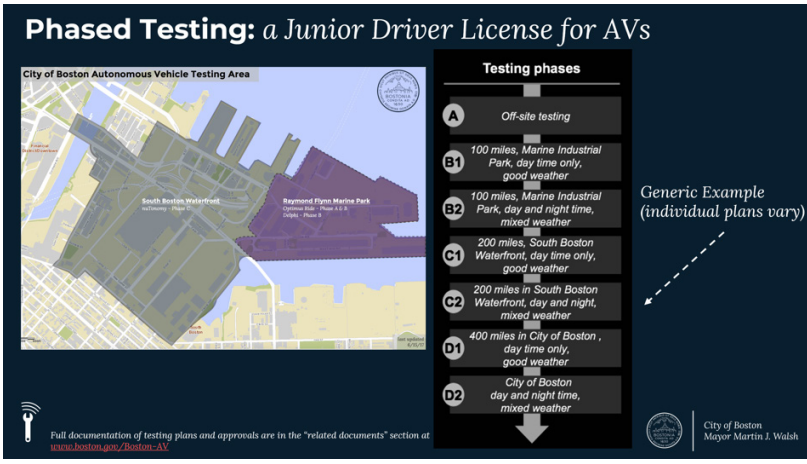
It's so early in the development of autonomous vehicles that issues around how to regulate the industry as well as its economic implications are still up for debate. One recent development does offer some insight: the rapid rise of ride-sharing services. Thanks to Uber and Lyft, communities have learned just how big a shift can occur in a short period of time, and how local governments can fall behind industry trends if they don't act quickly.

In an attempt to get ahead of future disruption, Mayor Martin J. Walsh of Boston signed an executive order in late 2016 putting the local transportation commissioner in charge of autonomous vehicle oversight, and both the local department of transportation and the Mayor's Office of New Urban Mechanics in charge of recommending new AV-specific policies. The coalition is tasked with delivering policy recommendations and ensuring that the private sector isn't alone in setting the city's AV agenda.

Since the 2016 executive order, Boston has learned quite a bit and begun to apply that knowledge. The city now gives out tiered licenses for AV testing, allowing companies to operate in different areas and times depending on their qualifications.

The city has also run models to determine the likely impact of autonomous vehicles on things like traffic and parking. Officials have concluded that both traffic and parking needs will go down with greater AV deployment, although distance traveled per vehicle will go up, and individual travel time will remain roughly the same.

Kris Carter, co-chair of the Boston Mayor's Office of New Urban Mechanics, says the city is now thinking through what its findings mean for continued AV governance. Where appropriate, officials will likely adjust parking prices and road access to guide both industry and citizen behavior. Carter believes it's important to get some initial policies in place quickly. By setting a norm before the industry develops fully, he suggests that Boston will be able to maintain more control over how valuable roadway space is best put to use for citizens.



The city of Boston's tiered AV licensing model

As local governments learn more about the pros and cons of autonomous vehicles, they're also raising new questions about what the technology could and should mean for their own capital investments. Buying an autonomous shuttle isn't cheap, but on the other hand, neither is building a new municipal parking garage to meet the parking needs of a growing number of drivers.

David Young, manager of fiber infrastructure for the city of Lincoln, points out that the city spent $75 million on three new garages in 2015. But if autonomous shuttles ultimately cut down on parking demand, those garages could become far less necessary. And that same $75 million could have purchased a significant number of autonomous shuttles that might have been better for the community as a whole.

Whether citizens would use autonomous shuttles regularly is another question, but from research done in Lincoln, Young says the answer seems to be closely tied to how much consumers would have to pay for shuttle access versus the cost of parking. That means the government could affect usage through policies like providing shuttle passes as incentives, or altering parking prices and requirements depending on how often a person takes a shuttle as an alternative to driving.

Young notes that governments need to consider these factors as a way of avoiding the infrastructure trap – a situation where communities regularly build expensive new physical infrastructure as an automatic response to the growing demands of a changing population.

Takeaways

- The explosion of rideshare services should serve as a warning to local governments about the need for early proactive policy-making as new technologies take hold in the transportation sector.
- Communities may need to offer incentives to drive adoption of some new transportation technologies and services. These incentives should be included in any economic modeling.
- New transportation solutions can help communities avoid the infrastructure trap and should be evaluated not only in terms of the costs required, but also the costs saved (e.g. parking garage construction).

SHARED, SAFE, AND SUSTAINABLE

As the notion of mobility continues to evolve, many cities are coming up with creative solutions to ensure their transportation systems are both safe and sustainable. Some like Columbus are testing micro transit options by giving local businesses incentives to employ manned shuttles with adjustable routes to help workers get to and from the office. Others like Boston are adjusting downtown parking prices dynamically and setting new policies for curb access for ride-sharing services to ease congestion and gently nudge citizens toward less frequent solo driving.

Boston has also launched a variety of interactive marketing campaigns around transportation, including one that was designed to find the city's safest driver. Officials partnered with a telematics company to let participants measure their own dangerous driving behaviors including phone distraction, speeding, rapid acceleration, and harsh braking. The city found that participants were excited to prove they were safer drivers than their friends and family members (particularly spouses), and during the test, phone distraction dropped by almost half, while speeding and harsh braking dropped by about a third.

There has also been an intense push in many cities to encourage more electric vehicle (EV) driving as a way of reducing environmental impact. Columbus has made electrification a central part of its Smart Columbus work, both by committing the city to purchasing 200 EVs, and by working with local business partners to install charging infrastructure. At the beginning of the Smart Columbus initiative, EV adoption was .38% in the Columbus area. By 2020, the city hopes to boost EV adoption by 1.8% using several initiatives including a consumer marketing campaign, encouraging employers to offer EV incentives, and training car dealers to sell more EVs.

Columbus is encouraging development of local electric vehicle charging infrastructure

More than anything else, the key to the decisions that communities make about transportation policies will ultimately come down to data. Cities are beginning to examine new data sources and also to figure out how to apply data insights to improve mobility options. This is largely uncharted territory for US communities, but several pilot projects for smart city data management have recently launched, including one in Denver where the city has developed a data management architecture with inputs from video and radar detection systems, weather data sets, air quality sensors, GIS mapping technology, and much more. (More details available in the US Ignite Smart City, Big Data playbook.)

The city of Columbus is also on board with the data management concept, and has used its grant funding from the Smart City Challenge to develop the Smart Columbus Operating System, with development led by consultants from a company called Pillar Technology (recently acquired by Accenture). The city has also recruited 130 industry professionals as volunteers for technical working groups to advise on different aspects of the system including how data can be translated into narrative stories, what data policies the city should implement, and how the technical design of the Smart Columbus Operating System should progress.

From a data stories perspective, Columbus has begun publishing content online that shows how information from the city's open data platform can be used to address real-world problems like high vehicle crash rates. On the policy front, Columbus is working on how to improve data sharing across the public and private sectors by examining rules that would require shared mobility vendors to contribute their data to the Smart Columbus Operating System in exchange for the right to do business in the area. And at a technical level, the city is not only relying on hired IT experts to develop the Smart Columbus Operating System, but also on community members that can participate in development through hackathon events.

Brandi Braun, deputy innovation officer for the city of Columbus, says the Smart Columbus Operating System is being built with open source tools and has the potential to be a model system that other communities can follow. Rich Granger from DriveOhio has already noted that the state is hoping to leverage what Columbus develops for a broader statewide data management system, and given the grant funding resources Columbus has available, many more communities and states may also want to take advantage of the city's development work in the future.

Data will increasingly be an important currency in the connected transportation sector, which means understanding how best to collect and read civic data will be a valuable component in any smart mobility strategy going forward.

Takeaways

- Competition and consumer challenges are powerful tools for driving civic engagement.
- Local businesses can and should play a role in the spread of new electric vehicle charging infrastructure.
- Data management is a major challenge for smart cities. Columbus is seeking to develop a model data management architecture with the Smart Columbus Operating System.

FURTHER RESOURCES

Smart Columbus Playbook
https://smart.columbus.gov/playbook/

Wyoming DOT Connected Vehicle Pilot
https://wydotcvp.wyoroad.info

About the Ann Arbor Connected Vehicle Test Environment
http://www.aacvte.org/get-connected/586-2/

Lincoln Autonomous Shuttle Project
https://lincoln.ne.gov/city/pworks/shuttle/

Drive Ohio Fact Sheet
http://drive.ohio.gov/assets/DriveOhioMediaKit.pdf

Autonomous Vehicles: Boston's Approach
https://www.boston.gov/departments/new-urban-mechanics/autonomous-vehicles-bostons-approach

US DOT Announcement of AV Funding Grants
https://www.transportation.gov/av/grants (deadline March 21, 2019)

US Ignite Smart City, Big Data Playbook
https://www.us-ignite.org/programs/US-Ignite-Forum/us-ignite-forum-playbooks/

US Ignite Smart City, Funding Strategies Playbook
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