Connected and Autonomous Vehicles Working Group White Paper

Overview

We are in a period of transition, as autonomous and connected vehicles begin coming to market. On the SAE International's automation level scale of 0 (no vehicle automation) to 5 (fully autonomous vehicle)[1], Level 4 / 5 automation is coming in the near future, but full market penetration for a wide group of consumers might still be 20 or more years out. Many believe that the technology costs will drop over the next decade, and adoption rates will accelerate quickly[2] [3] [4]. Many of the potential societal benefits of Connected and Autonomous Vehicles (CAV) will not come to full fruition until these technologies achieve a significant market penetration. To help position the Omaha / Council Bluffs region as a leader in CAV technologies, the working group has identified these five initiative areas:

- Safety: The potential traffic safety benefits of CAV are high for motorists, pedestrians, and bicyclists. The National Highway Traffic Safety Administration claims up to 94 percent of crashes are attributable to the type of human error that technology can reduce through automation. Early CAV technology exists now now on many new automobiles to improve safety and reduce crashes. There are opportunities to identify partners for implementing safety warning systems on vehicles, and implementing other passive technologies to benefit all modal users.
- Infrastructure: CAV technologies will require infrastructure investments in addition to traditional roadway related infrastructure. Agencies in the region need to incorporate the required technology and communications to take advantage of the opportunities that CAV offer.
- Urban Planning: Start planning now for how we can make the technology fit our neighborhoods and places – make policies for CAVs that fit within urban context and our desires for neighborhoods. An approach advocated by the National Association of City Transportation Officials (NACTO), referred to as "Autonomous Urbanism", provides guiding principles including: safety as priority, wider mobility, rebalancing street rights-of-way, and increasing vehicle occupancy rates.
- Broader Accessibility: Accessibility is transportation connecting people with goods, services, activities, and opportunities. Access can be measured in terms of jobs, shopping options, and medical / social services. For an inclusive community, that access needs to focus on all modes of travel; particularly on non-automobile connections for transit-dependent populations. There are currently demonstration projects of connected and autonomous transit vehicles being deployed across the US. In the Omaha-Council Bluffs area, these autonomous transit deployments

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[1] http://www.sae.org/misc/pdfs/automated_driving.pdf

[2] https://www.vtpi.org/avip.pdf

[3] https://www.caee.utexas.edu/prof/kockelman/public_html/TRB16CAVTechAdoption.pdf

[4] http://docs.trb.org/prp/16-2284.pdf

should focus on supporting neighborhood-scale circulation, and improving access to existing and planned high-frequency Metro transit routes.

- **Integrate Smart City Concepts:** Smart Cities are those that integrate technologies, communications, and data to improve the quality of services and the public quality of life. Smart Cities often integrate infrastructure with social services and systems via communications technology and a range of data and applications.

Omaha-Council Bluffs Regional Initiative Opportunities

The previous sections have outlined the understanding of issues, challenges, and opportunities associated with CAV for the Omaha-Council Bluffs region. This section identifies some potential local initiatives that can help prepare for the challenges and leverage the potential benefits of the technology, presented by the five initiative areas above.

Safety Initiative

High-functioning CAV are anticipated to rollout over the next several decades based on the stated objectives of automakers and the technology industry. Agencies and researchers focused on transportation safety share a vision that later generations of this technology will drastically improve vehicle safety compared to today's human operated vehicles. Where greater uncertainty exists is in the level of crash reduction anticipated during the transition period where human-operated vehicles mix on the roadway with lower level CAVs. This uncertainty is largely related to disparate views on adoption of CAV technology and not the effectiveness of CAV safety applications, which haven been proven to provide safety benefits in test track / laboratory settings. The Omaha-Council Bluffs CAV Working Group promotes a vision of incremental safety improvement in the next 5 to 10 years through promoting rapid adoption of CAV safety features with demonstrated safety benefits and that are already available on the market. The CAV safety initiative promoted is:

1) Initiate the use of CAV technologies by identifying and promoting technology locally to improve traffic safety for vehicles, bicyclists, and pedestrians.

2) Make Omaha-Council Bluffs a leader in adoption of in-vehicle technology to promote safe vehicles. To accomplish that safety initiative, the following areas were explored:

After Market Passive Warning Systems

A 2017 report shows the average age of a U.S. vehicle is now 11.6 years old. That vehicle age suggests that the quality of vehicles manufactured has improved over time to allow for more extensive use, but that also means adoption of new vehicles with automation features will lag significantly behind the features' initial deployments. One solution to that issue is aftermarket warning systems. The following are a few aftermarket features currently available and recommended by an expert from Consumer Reports[5]:

- **Forward Collision Warning / Lane Departure Warning**: A Dash Camera from a major telematics company can monitor potential hazards within 100-150' and will issue audible warning of an impending collision. The system can be purchased for roughly $150. Additionally, a more sophisticated camera and software system can add the provided benefit of lane departure warning and extend the range of

[5] http://abcnews.go.com/amp/Technology/wireStory/car-tricks-adding-safety-tech-older-car-47029863

collision detection by several hundred feet, but may cost roughly $1,000 for system components and installation. IIHS estimates that nearly 1.2 million crashes, 66,000 injury crashes, and nearly 900 fatal crashes in the U.S. could be prevented annually through current Forward Collision Warning technology.[6] IIHS additionally estimates 179,000 crashes, 37,000 injury crashes, and 7,500 fatal crashes could be prevented annually through current Lane Departure Warning technology.[2]

- Blind Spot Detection: These systems use flashing icons connected to sensors on the side of the vehicle to indicate to drivers when making a lane change or other lateral movement may result in a collision with a vehicles / fixed object within 10 feet laterally of the vehicle. Existing system components may cost less than $250. IIHS estimates 395,000 crashes, 20,000 injury crashes, and nearly 400 fatal crashes could be prevented annually through current blind spot detection (called side view assist) technologies.
- Backup cameras: U.S. safety regulators will require all vehicles manufactured after May 2018 to include a backup camera.[7] The technology is aimed at over 200 annual fatalities and 15,000 annual injuries that occur during back-up crashes.[3] Yet, vehicles up to the 2018 model year may still lack this technology, but it can be added to existing vehicles for under $150 and can be purchased for chain automotive part stores.
- Emergency assistance: This connectivity technology does not engage to alert the driver during possible pre-crash events, but will keep vehicle occupants safer through two features. First, mobile phone alerts triggered by covered vehicle mechanical problems. Second, placing an automatic call to emergency services if the vehicle has been in a crash. One recommended system costs $50 to setup and activate and roughly $10 per month subscription fee. A popular brand of original manufacturer emergency assistance claims to respond to more than 100,000 emergency calls every month.[8]

With support from local agencies focused on transportation safety, older metro area vehicles could be retrofitted with all of these technology features for an upfront cost of roughly $600.

New Car Level 1 / Level 2 Autonomous Vehicles Adoption

The complement to promoting after market vehicle technologies is to promote current lower level CAV features, several of which already are standard on some makes and models and others of which are becoming easier to find on new cars each year. Promoting this type of technology takes an awareness of which vehicles include the technology and how much benefit a vehicle owner may receive from paying a slight premium to obtain the safety features.

- Automated Emergency Braking (AEB) is the vehicle assisted application of brakes in a situation where the driver's rate of deceleration is not sufficient to prevent a crash. AEB targets rear end crashes with multiple vehicles and crashes with a fixed object. The system makes use of radar, cameras or lasers to detect a leading object then

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[6] http://www.iihs.org/iihs/sr/statusreport/article/45/5/2

[7] http://www.latimes.com/business/autos/la-fi-hy-autos-nhtsa-backup-camera-20140331-story.html

[8] http://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2015/jul/0729_onstar.html

actuators within the vehicle apply the brakes if the driver does not take action quickly enough. NHTSA reports that in 2012, one-third of all police-reported crashes involved a rear-end collision as the first harmful event in the crash[9]. As such, NHTSA, in collaboration with the Insurance Institute for Highway Safety (IIHS), reached an agreement with automakers representing 99% of U.S. sales to make AEB a standard feature in all new to market vehicles by September 1st 2022. The IIHS estimates the commitment will prevent 28,000 crashes and 12,000 injuries nationwide over a three year period starting in reporting year 2022.[10] Yet, AEB has been an optional feature in some vehicles dating back to 2006.[11] As such, one current opportunity to promote technology-enhanced safety is through better awareness of vehicles currently providing AEB as an option. NHTSA has recognized that need to acknowledge vehicle automation in vehicle safety ratings and for 2018 model year vehicles, AEB and other advanced technologies will be rated under its 5-Star Safety Ratings[12]. AEB as currently developed must be installed by the initial vehicle manufacturer; thus, cannot be used as an aftermarket treatment.[13]

- Forward Collision Warning, Lane Departure Warning, and Backup Assist are vehicle technologies that can be part of the originally manufactured vehicle in addition to their availability as after-market technologies. All three systems would similar levels of safety benefit as both original equipment and after-market, but vehicle owners interested in acquiring a new or newer model year used vehicle can find makes and models with this technology. NHTSA added all three systems to its 5-Star Safety Ratings for 2011 model year and later vehicles. Of the three technologies, only Backup Assist is mandated to be standard in each vehicle manufactured (May 2018 and beyond), so there is some responsibility on the vehicle owner to assess the safety benefit versus cost in selecting a vehicle to lease or purchase.

Vehicle safety focused agencies could work to promote these features in recent vehicles through strategic communications activities, incentive programs, and other combinations of policy, communications, and investment.

Safety-Focused Technology and Communications Infrastructure

CAV technology can gain even greater safety benefits through the connectivity of vehicles and infrastructure trading basic safety messages. Here are a few areas where agencies could develop safety-focused infrastructure to communication with CAVs. Information gathered from these vehicle and infrastructure interactions could be leveraged to provide safety warnings to non-CAV in certain situations. Concise explanations of each vehicle to infrastructure technology are provided from the U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office.[14]

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[9] https://www.nhtsa.gov/equipment/driver-assistance-technologies

[10] http://www.iihs.org/iihs/news/desktopnews/u-s-dot-and-iihs-announce-historic-commitment-of-20-automakers-to-make-automatic-emergency-braking-standard-on-new-vehicles

[11] https://www.nhtsa.gov/equipment/driver-assistance-technologies

[12] http://www.iihs.org/iihs/news/desktopnews/u-s-dot-and-iihs-announce-historic-commitment-of-20-automakers-to-make-automatic-emergency-braking-standard-on-new-vehicles

[13] http://howsafeisyourcar.com.au/aeb/

[14] https://www.its.dot.gov/infographs/index.htm

- Intersection Movement Assist: Warns drivers if it is not safe to enter an intersection – for example, if another vehicle is running a red light or making a sudden turn.
- Do Not Pass Warning: Warns drivers that it is not safe to pass a slower moving vehicle if the passing zone is occupied by another vehicle.
- Red Light Violation Warning: Issues warning to the driver if he is about to run a red light.
- Stop Sign Gap Assistance: Alerts the driver when it is unsafe to enter a STOP-sign controlled intersection.
- Work Zone Warning: Alerts the driver to use caution when traveling through a work zone.
- Curve Speed Warning: Alerts the driver if current speed is too fast for an approaching curve.
- Pedestrian in Signalized Crosswalk: Warns drivers when a pedestrian is crossing the street as the driver is making a right or left turn.
- Connected Vehicle Safety for Rail: Warns drivers if there is a train approaching and if there is a potential risk of collision, as well as provides drivers with information on the estimated amount of time until the train clears the intersection.

These safety applications and others require that agencies invest in infrastructure that performs combined function of detecting hazards and communicating those hazards. In cases like Curve Speed Warning, the detection may be a simple as sharing a communication channel with an approaching CAV and sending a message to the CAV that it is approaching a curve and should consider a lower speed. Other warnings, like Intersection Movement Assist could require a balance between communicating threats detected by CAV and using the intersection own radar / video detection combined with threat processing software to equip the Intersection Movement Assist benefits for locations with limited CAV users. The appropriate level of infrastructure investment that agencies should engage in to support CAV is an active discussion. As the situation stands currently, most connected infrastructure deployments are considered as pilot studies or test beds, but full deployment case studies are likely to come online within the next few years and should help establish the business case for investing in CAV-supportive infrastructure.

Urban Planning Initiative

CAVs offer the opportunity for more efficient and safe travel. However, with this efficiency comes the potential for longer trips, more trips, higher travel speeds, unequal access to mobility, and other travel changes that, if left unchecked, could lead to negative impacts to our neighborhoods and environment.

The CAV working group placed a priority on ensuring that CAV technology fits within our community fabric and supports our community's vision for livability. With the view that transportation is a means of providing access between people and places, our urban future with CAVs needs to including maintaining the integrity of our neighborhoods and places. This vision also supports the "Nodes and Corridors" Working group's vision of creating a region made up of a network of dense nodes and corridors that are walkable. This vision can be supported and enhanced through a variety of transportation modes and options including the use of CAV technologies to provide a wider range of public accessibility options.

A particularly relevant guiding document is NACTO's "Autonomous Urbanism" vision outlined in *Blueprint for Autonomous Urbanism*. This document provides six guiding principles:

- Safety is the Top Priority
- Provide Mobility for the Whole City
- Rebalance the Right-of-Way
- Manage Streets in Real Time
- Move More with Fewer Vehicles
- Public Benefit Guides Private Action

Key initiatives outlined in the NACTO document that support the Omaha-Council Bluffs vision of integrating CAVs into a people-focused, not vehicle-focused environment are summarized in the sub-sections below.

Safety is the Top Priority

Traffic speeds should be established that reflect the desired character of the neighborhood. The NACTO document calls this "20 is Plenty", referring to 20 miles-per-hour as the speed limits for creating neighborhoods that are safe and conducive to pedestrian, cycling, and transit activity.

Another action would be collecting better data to support safety decisions. The document suggests that big data can be collected and analyzed to determine locations of safety hazards in the city.

The safety focus area finally suggests that cities and regions set operating principles that prioritize people, referring to establishing operations and design criteria that reinforce human-scale, not just vehicular safety and convenience.

Provide Mobility for the Whole City

Key elements of this principle include creating cross-department and cross-agency working groups for the region. This approach allows an integration of CAVs into a range of government functions, and could be expanded off of the current Heartland 2050 autonomous vehicles working group.

This approach also identifies streets that prioritize active modes of transportation like biking, walking, and transit.

Rebalance the Right-of-Way

This approach would minimize the need for more vehicular travel lanes. This principle also dedicates travel lanes to transit and active modes, potentially finding opportunities for making curbside "flexzones" that adapt to various uses during the course of a day. For instance, transit lanes in the peak periods could be used for deliveries, street vendors, and sidewalk dining during off-peak periods. This approach will create new opportunities for revenues lost from the decline of parking revenue and the loss of gasoline taxes as the vehicle fleet transitions to electrification. [15]

[15] https://www.economist.com/news/international/21725765-ride-sharing-and-electric-cars-take-governments-are-seeking-new-ways-make

Manage Streets in Real Time

The growth of big data offers opportunities for real-time street management through data exchange from third party vendors. The NACTO document also discusses the flexzone curbside concept above with pricing to allow delivery and pick-up, and provides access for all modes of travel.

Move More with Fewer Vehicles

This principle identifies that CAVs and the shift to mobility-as-a-service will mean fewer dedicated parking stalls required. Flexible parking structures and spaces are encouraged as this transition occurs. This conversion of publicly-owned parking structures to retrofitted residential and commercial uses will lead to increased urban density and amenities, and offer an opportunity to monetize existing public-owned parking structures.

The conversion to CAVs is also expected to involve a shift from combustion engines to electrified vehicles, and ongoing programs like MAPA's initiative to encourage electric vehicle charging stations would support this future transformation.

Finally, initiatives like MAPA's "Close the Gap" recognize that CAVs can support high-quality transit services, and facilitate the urban future that many residents desire.

Public Benefit Guides Private Action

This principle recognizes that public engagement and acceptance are critical to adoption. Public-private partnerships can facilitate adoption. [16]

The key takeaway from an Urban Planning perspective is that the various agencies and departments in the region should work together to make CAV technology fit within the community we want to live in. Where possible, the benefits of CAVs should be broadened to include access for all members of the community. The technology should conform to our sense of place, should be safe for all users including pedestrians and bicyclists, and should support our wider community goals for enhanced accessibility and improved regional transit connections.

Broader Accessibility Benefits through Autonomous Microtransit

Accessibility focuses not on how fast you can move vehicles, but on connecting people with goods, services, and activities. This concept ties directly to the discussion of smart cities included later in this paper. One of the major barriers to wider use of transit is connecting residents trip ends (for instance, where they live or where they work) with high-frequency transit lines. This issue is often called the "first mile / last mile" problem, and is a particular barrier in metro areas like ours with only moderate levels of land development density. CAV transit services offer the opportunity to provide more efficient, cost-effective access to a broader cross-section of our community, measured in terms of:

- More jobs available within a reasonable transit commute.
- Expanded grocery or other shopping options within an affordable, easy, and fast trip of all neighborhoods.
- Medical / social services available to a wider segment of the community.

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[16] theatlantic.com/business/archive/2016/10/public-transportation-uber-chariot/505658/

Several communities have made progress in deploying CAV transit / micro-transit. These include:

- **Columbus, OH**: currently deploying small 6-passenger micro-transit vehicles in the downtown and nearby neighborhood[17].
- **Contra Costa, CA**: a CAV microtransit program is running in this suburban Bay Area community, attempting to tackle the "first mile / last mile" problem. The program is being tested at a large business park with 30,000 employees, and is tied to its designation as one of 10 national proving grounds.[18]
- **Las Vegas, NV**: after some limited testing in 2016, more extensive runs of driverless shuttles have begun in downtown Las Vegas with mixed traffic.[19]
- **Tampa, FL**: after an earlier testing program, in January 2018 the local transit agency will begin operating a full-time 14-passenger autonomous bus service along 0.6 miles in downtown Tampa.[20]
- **Arlington, TX**: started in June 2017, the program used 12-person driverless shuttles to connect an entertainment district and sports venues.[21]
- **Washington, D.C.**: a pilot program was testing driverless transit buses in 2016.[22]

Many other cities are studying deployments of microtransit, including Lincoln[23].

Access is not only measured in terms of the improved vehicular travel that CAVs will offer, but how access to other modes of travel will be improved, particularly connections for transit-dependent populations. The Omaha-Council Bluffs region has undertaken the "Close the Gap" initiative for improved transit connections across the region, particularly focusing on improvements in access to jobs and education, and improved non-automobile mode share. A potential CAV deployment pilot project in the Omaha-Council Bluffs area could be to use autonomous transit deployments that focus on supporting neighborhood-scale circulation to transit stops on high-frequency transit lines. The goal is that this CAV transit deployment could be targeted at improving access to existing and planned high-frequency Metro transit routes.

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[17] http://radio.wosu.org/post/city-council-allow-microtransit-vehicles-columbus#stream/0

[18] http://www.govtech.com/fs/driverless-shuttle-program-kicks-off-in-california-to-tackle-first-milelast-mile-mobility-obstacle.html

[19] http://www.businessinsider.com/las-vegas-strip-driverless-shuttle-bus-launches-2017-11

[20] http://www.tampabay.com/news/Tampa-will-get-a-look-at-its-driverless-downtown-shuttle-launching-in-January_162485747

[21] http://www.govtech.com/fs/arlington-texas-experiments-with-driverless-shuttles.html

[22] http://washington.cbslocal.com/2016/06/18/driverless-bus-to-begin-frequenting-d-c-streets/

[23] https://www.apnews.com/038968cf97284b54b1c9af100085460a

Infrastructure Initiative

Technology background

A connected vehicle has the capability for exchanging data via wireless communications between vehicles (vehicle-to-vehicle or V2V communications), to infrastructure (vehicle-to-infrastructure or V2I communications), and to mobile devices. Pedestrians, bicyclists, or motorcyclists can carry mobile devices and communicate with vehicles. As noted in the Federal Highway Administration's *Connected Vehicle Impacts on Transportation Planning – Primer* the type of information communicated through these means may include:

- Presence, speed, location, and direction of travel.
- Road and traffic conditions.
- On-board vehicle data, such as emissions, braking, and windshield wiper activation.

The ability to link vehicles with infrastructure enables coordination and cooperation that can reduce congestion and system reliability, and improve traffic safety. The ways in which these vehicles communicate includes Dedicated Short-Range Communications (DSRC), cellular / LTE, and Wi-Fi:

- Currently, DSRC offers the most reliable technology for vehicle-to-vehicle (V2V) communication. DSRC operates over the 75 megahertz (MHz) of spectrum in the 5.9 gigahertz (GHz) band, allocated for transportation safety purposes by the Federal Communications Commission (FCC) in 1999. This dedicated network provides a low-latency, short- to medium-range wireless communications medium that permits very fast and reliable data transmissions critical for safety applications.
- Cellular technology uses mobile networks provided by private mobile carriers. Cellular communications currently do not consistently provide the low latency required for critical safety applications, but this medium can carry longer-range communications for transfer of data that support some mobility and environmental applications, along with supporting data disseminated/collected by transportation agencies, such as traffic and pavement data.
- Wi-Fi communications are typically short range and are not as reliable as DSRC for communications with moving vehicles. Wi-Fi can carry large data transfers in areas where vehicles may be stationary for extended periods of time.[24]

Current Infrastructure Context

The region is currently working towards adopting some of the technology upgrades required. The City of Omaha is a good example of where the region is moving from an infrastructure perspective, and is discussed in this section. The City of Omaha is in the early stages of deployment of signal system improvements that were outlined in a master plan in 2013. These improvements include: traffic signal controllers, detection, cabinets, flashing yellow arrow implementation, CCTV and video management systems (VMS), traffic management facilities, advanced traffic management software (ATMS) systems, communications infrastructure, adaptive signal control technology (ASCT) and more.

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[24] U.S. Department of Transportation, Office of the Assistant Secretary for Research and Technology, Intelligent Transportation System Joint Program Office, Connected Vehicle Impacts on Transportation Planning – Primer

- **Traffic Operations Center**: The City of Omaha has deployed a small traffic operations center (TOC) in the existing Traffic Maintenance Facility. This will allow City staff to proactively manage and monitor the signal system and traffic operations, particularly for special events or emergency situations.
- **Citywide Communications Network**: The City has deployed a large portion of a backbone citywide fiber optic communications system. This system leverages an existing agreement with a private communications provider, and connects the Civic Center and Traffic Maintenance Facility with thirteen additional communications hubs across the City. Future signal system projects will integrate with this backbone network and eventually provide the bandwidth required to communicate with the City's 1,000 traffic signals.
- **Traffic Signal Controller Local Software (CLS) and Advance Traffic Management System (ATMS) Software**: The City has procured new software that will enable new safety and operational features, particularly the flashing yellow arrow. The new system also allows for continuous and real-time management and monitoring of the system via signal status, alarms, and high-resolution data collection.
- **Adaptive Signal Control Technology (ASCT)**: Omaha is finalizing the design on several ASCT corridors, which through advanced detection and additional software, will allow the traffic signal controls to continuously monitor and automatically adjust timing based on fluctuations in traffic, whether due to special events, incidents, work zones, or weather.
- **Communications / micro-cell upgrades:** Many agencies in the region are working with private communications providers to accommodate private investment in small cell technology. For instance, to date the City of Omaha has entered into agreements with Verizon, Mobilitie, and ExteNet that allows these entities to install small cell equipment. The equipment is generally being installed on existing street light poles. The City continues to explore methods by which the general public can leverage this private technology investment for not only the transportation system, but for the City and region as a whole.

Opportunities for Improved Infrastructure / Accelerated Adoption

There is no dedicated source of funding to support deployment of the technologies. For instance, with the City of Omaha's program has currently secured funding to construct improvements at the first 175 signals. This funding is largely federal funding like the Surface Transportation Block Grant program (STBG) and Highway Safety Improvement Program (HSIP) funds. Funding for the remaining 825-plus signals in the Omaha system has not yet been identified. The City is working to identify alternative sources of funding such as the Congestion Mitigation and Air Quality (CMAQ) program. However, no funds have been committed for the expansion of Omaha's program.

This demonstrates the challenge that communities have encountered in paying for infrastructure upgrades. New funding sources, potentially local sources and public-private partnerships similar to the implementation of micro-cell technology, may be required to implement the technologies required to support CAV adoption.

Successful Models for CAV Deployment in Other Communities

One strategy for achieving this safety initiative is to model off the successful practices of other communities. In the U.S., there are currently limited examples of communities that promote CAV adoption. The three highest profile CAV pilots are sponsored by USDOT and are the New York City DOT Pilot, Tampa-Hillsborough Expressway Authority Pilot, and Wyoming DOT Pilot. The pilots are currently still in the design phase and thus do not provide tangible results at this time to promote CAV deployments. The USDOT has also promoted 10 automated proving grounds to develop a community of practice for CAV. The 10 automated proving grounds designees are:

1. City of Pittsburgh and the Thomas D. Larson Pennsylvania Transportation Institute
2. Texas AV Proving Grounds Partnership
3. U.S. Army Aberdeen Test Center
4. American Center for Mobility (ACM) at Willow Run
5. Contra Costa Transportation Authority (CCTA) & GoMentum Station
6. San Diego Association of Governments
7. Iowa City Area Development Group
8. University of Wisconsin-Madison
9. Central Florida Automated Vehicle Partners
10. North Carolina Turnpike Authority

These proving grounds have begun activity in 2017, but there is limited information documented on the progress of their on-going activities. An additional type of deployment that could be modeled from is based on European pilots. ConnectedAutomatedDriving.EU is a web site that tracks pilot projects in Europe.[25]

As more information is shared on the outcomes of these pilots, the CAV Working Group will distill the findings that were most successful in CAV adoption to support a model of CAV use in the Omaha-Council Bluffs metro area.

Integration of Smart City Concepts

The concept of Smart Cities is essentially leveraging technology to improve the urban experience for its residents. The concept requires tying the systems and infrastructure associated with the City (buildings, bridges, roads, water, energy, sewer) with the social systems we rely on (governance, employment, public safety, health, education, and urban context). There is technology required to deliver the smart city services and connections between infrastructure and services. The benefits of smart cities are essentially doing more with less: an October 2012 article from McKinsey & Company estimates that smart cities can achieve a:

- 50% reduction over a decade in energy consumption

[25] https://connectedautomateddriving.eu/research/

- 20% decrease in traffic[26]
- 80% improvement in water usage
- 20% reduction in crime rates[27]

Summary of Regional Goals / Close the Gap Workshop Input

In Fall 2017, the Heartland 2050 Summit took our subcommittees through a process developed by a leading Smart City to successful evaluation of new technologies and how they can be adopted for use with CAVs. Columbus, OH created the blueprint our groups followed. The Columbus Smart City proposal resulted in securing the $40 million US Department of Transportation Smart City Challenge grant, which was leveraged into $500 million in total Smart City funding. While smart cities and planning are typically believed to be focused heavily on the latest technology, Columbus's success came from a focus on the community's pressing societal issues. The workshop used Columbus' approach to look at issues in the Omaha-Council Bluffs area through the following steps:

- **Identifying a problem**: in Columbus it was reducing child mortality
- **Find Key Organizations**: choose stakeholders capable of implementing changes
- **Find Decision Makers**: selecting leaders that can rally support on this issue
- **Identify Barriers**: listing the obstacles that have prevented previous solutions
- **Look at Transportation Solutions**: discuss existing or pending technologies that can help solve this problem.
- **Evaluating Community Readiness**: looking at all these factors, how ready is the community for change and how likely to succeed is it?

This process was facilitated by breaking the workshop attendees into subgroups, with each subgroup selecting a regional issue. The subgroups then worked through the process together on issues facing the Omaha-Council Bluffs areas like:

- Underemployment
- Food Deserts
- Housing and Transportation Costs for Low Wage Workers
- Student Absenteeism

These issues can be addressed by CAVs if the technology can providing cheaper and more equitable forms of transportation, resulting in broader access for all citizens across the Omaha-Council Bluffs region. Unfortunately, after looking at these issues with the process used in Columbus, the groups' consensus was that the region is not prepared to solve these problems. Specifically, most groups identified the need to find a true leader or champion, key stakeholders, and/or existing barriers as the primary reasons these problems won't be solved with technology alone, even one as transformational as Autonomous Vehicles and the key for the Omaha-Council Bluffs area to implement CAVs is in rallying our existing stakeholders and leaders, not through short term technological implementations.

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[26] Note that while smart cities can work to reduce traffic volumes through improved modal travel information to citizens, the technology associated with connected and autonomous vehicles have the possibility of increasing vehicle miles traveled in our community.

[27] https://www.mckinsey.com/industries/public-sector/our-insights/the-smart-city-solution

Conclusion

Overview

The region should approach adoption of connected and autonomous vehicle technology with the understanding that CAVs and smart city concepts to have the potential to improve safety for all system users, and increase access to jobs and services for all citizens of the region. These technologies have the ability to:

- Significantly reduce the number of vehicular crashes and bicycle and pedestrian crashes compared to today, by removing the human element from decision making and inserting warning and avoidance technologies in vehicles. Safety is also improved by creating urban, activity-focused corridors where vehicular speeds are lowered to improve pedestrian and bicyclist safety.
- Decrease the cost of transportation, through enhanced rideshare / mobility-as-a-service opportunities and decreased operating costs due to electrification. These reduced costs can also be expected for commercial vehicle and public transit fleets.
- Increased access equity, providing broad, effective, and cost-efficient transportation options through new ownership structures and improved access to \ existing and planned high-quality, high-frequency transit lines, supplemented with CAV transit and safer pedestrian environments.

Action / Next Steps

The next step for the region is to work towards formalizing a CAV vision and framework. It is critical to identify partners as we take our next steps. This includes several opportunities:

- A near-term goal should be to establish a Transportation Technology Action Plan that fits within regional goals and achievable steps.
- Developing this Action Plan as an implementable and effective framework requires an integrated approach. The current Heartland 2050 working group could be expanded to represent more agencies and departments. Thus, we propose continuing and expanding the Omaha-Council Bluffs CAV Working Group. The committee could continue being a clearinghouse for market trends and disseminating information. The committee could continue focusing on sub disciplines such as:
    1. Safety Technology Deployment & Testing
    2. Planning Issues / Placemaking Implications of Technology
    3. Private Industry Coordination
- Identifying local foundations and private funding to advance the safety and infrastructure elements of the CAV initiative.
- Promoting the safety initiative to the public, and communicating the benefits the technology offers.
- As a part of the Heartland 2050 structure, identifying partner agencies that can benefit from technology and improved access. This would build on the Heartland 2050 Summit smart city goals of addressing societal issues through transportation technology.
- Engaging with national experts for implementation advice.

- Work to gain additional public agency engagement and commitments. This includes expanded engagement with regional agencies, integrated with MAPA's ongoing efforts, and collaboration with the Nebraska and Iowa Departments of Transportation.
- Implementation will require identifying the funding and policy elements, including:
    - Demonstrating the commitment to private partners to support regional goals
    - Identifying public funding opportunities at the city, county, state, and Federal level.
    - Identify supportive policies and the local and state level to ensure the safety, infrastructure, urban planning, and societal benefits are achievable.
    - Identifying early adoption opportunities, including opportunities for CAV fleet purchases for local agencies, and identifying private sector / after market installation partners for passive warning systems for safety benefits.
    - Coordinate investment decisions at the regional level to achieve the action plan.

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