DEPARTMENT OF TRANSPORTATION

Governor's Advisory Council on Connected and Automated Vehicles
Transportation Infrastructure

Meeting Notes

Meeting Date: September 10, 2018

Jay Hietpas, Director of CAV-X, opened the meeting. Susan Mainzer and Charlene Eigen-Vasquez were present to facilitate the meeting. Participants introduced themselves and their affiliations. Mark Krebsbach from Dakota County was recognized as a co-chair.

Jay presented subcommittee goal: to formulate and recommend to the Advisory Council changes to Minnesota statutes, rules and policies related to transportation infrastructure.

Information from these meetings will be on the Mn DOT website:
http://www.dot.state.mn.us/automated/publicmeetings.html

Timeline: October 30 is the date liaisons will present to the Advisory Council. Another meeting of this subcommittee is scheduled for Oct. 12, if necessary.

Executive Order says the Advisory Council will report to the legislature and governor, this subcommittee provides information to the Advisory Council.

There are seven other subcommittees. All are welcome to join any subcommittee. (More info available on website (http://www.dot.state.mn.us/automated/publicmeetings.html)

Other ways to participate: surveys, subcommittee meeting evaluation, comment cards, state fair, ask us to present to your group.

CAV Goals:

- Brand MN as a place to test and deploy CAV
- Public engagement
- Educate public
- Develop actionable recommendations
- Recommend mobility strategies

Jay presented "CAV 101"

- Automated vehicles take control of some or all aspects of driving
    - All modes of transportation (automobile, truck, shared)
    - We are focused only on surface transportation
    - Some rely on infrastructure, some don't
    - Some rely on government resources, some don't
- "Levels of vehicles" described (0 – 5). As numbers go higher, there is more automation. We are currently at partial/conditional automation, levels 2 and 3. There are no level 5 vehicles, full automation yet today. There are level four (high automation) today.
- Connected vehicles
    - Vehicles "talk" to infrastructure
    - Vehicle "talk" to each other
- Advisory council also wants us to talk about electric vehicles
- Shared mobility also has infrastructure impacts (e.g., shared curb space)
- Truck platooning (vehicle to vehicle communications)
    - If a lead truck accelerates, it signals truck(s) behind to
    - Some other states are allowing trucks to drive much closer together, testing platooning
- Infrastructure
    - Roads and bridges
    - Rural MN is an important piece for the governor and Advisory Council
    - Urban environments – what do we need to do to prepare for CAV?
    - Underground utilities
    - Work zones (road construction)
- Data is also infrastructure (some manufacturers want data from us, real time information on work zones)

Susan Mainzer introduced small group input discussions. Cover the questions from liaisons and anything else. Keep notes, which will be transcribed below. Report out recommendations: What do you want the liaisons to recommend to the Advisory Council?

EACH GROUP'S POST-BREAKOUT REPORT, DESCRIBING TOP 3 PRIORITIES

Infrastructure, Group 1

- Short term
    - Collaboration with industry. At levels 1-3, make baseline supporting data/information available to manufactures about lane closures or construction, for example, so that the connected vehicles can respond. This should include information sharing with railway systems and traffic signal systems.
    - Inform public about what is available in the infrastructure … e.g., that a charging station is available, signage for special lanes
    - Collaborate with manufacturers – needs to be a detailed study to understand what will work and what will not work. The study should consider different weather environments (ice, snow …)
- Long term
    - Central database/ information sharing regarding traffic flow, traffic signals, and road conditions. An example was to start with sharing information on signals or road conditions.
    - Where does info live, how will it be retrieved? How can someone query this information?
    - There will be information going back and forth like air traffic control. Reliability, security will be important. For example: When a pilot is going to fly, he is able to get a bunch of information on weather, flight patterns, and is constantly getting updates while in flight. This model may occur in vehicles in the future, where data is more easily accessible to cars/drivers as compared to today.
    - How will CAV exist with current vehicles (non CAV)

Infrastructure, Group 2

- Establish standards for city/county/state to be future ready.
- What will entry-level readiness at each level be?
- Deploy equipment and standards for testing CAVs, partner with MN industry to get in the game and assure goals/standards are met.
- Work zones are a little future, however start working on it now. Support AV development b/c it is going to be a challenge. We have a short and intense work season. Work zones must be part of the plan.
- Do work on incentivizing electric vehicle chargers. Suggest creating charging zones at rest stops. Maybe start with I-94. Are there other incentives on a state level that would incentivize private industry to create charging zones?

Infrastructure, Group 3

- Partnership. Complexity of the right of way as a publicly owned space. Charging stations, curb space management, drop boxes for AV delivery vehicles, smart signs.
- Resources: very near-term need is the need for research funds for the public section to test technologies in the real world.
- How to charge the user in the end when some of the funding goes away?
- Pilots: near term need is to ID pilot projects in key areas of learning and need. E.g., testing autonomy in cold weather, rural areas and urban build out conditions.
- System and data: near term needs to build out fiber optics to enable this new world. Put conduits in roads. Who is responsible for mapping and data stewardship? (IA funded or is private industry) Decide MN approach.
- Other states have coalition models
- Multiple levels of government need to be involved … private/public is complex. Work through who is responsible for what.

Legislation and Policy, Group 1

- Need for standardization of protocols with this technology. Classic role for government (for example, the FCC). Needs to be a public/private partnership, ongoing coordination and stewardship, think this will be at the federal level.
- Who and how to pay for capital and operating? Allow MN to be innovative (research and education takes money)
- Beyond the gas tax, funding from other sources
- Focus on engagement and education, find funding for this
- Data Questions. Who owns it? Who has access to it? Liability questions? Data protocols and standards.

Legislation and Policy, Group 2

- What is MN trying to do in the realm of CAV? Get clear on goals before developing policy. Do we want to be the leader?
- Strike balance in funding stream … public and private mix
- Plug the policy gaps to allow testing and investment in MN while protecting the public interest, safety, and liability. Don't be so proscriptive that companies don't want to come here.

Legislation and Policy, Group 4

- Have a state funded area(s) to test, emphasize winter and rural driving challenges. Partner with industry.
- Funding – CAV will accelerate the trend toward electric vehicles. How to fill the gas tax gap? Partner at federal level to fix the funding problems.
- Partner with freight rail partners, e.g., crossing challenges.
- In the beginning, consider designated routes for AVs (like college campuses)

Infrastructure and Legislation and Policy, Skype Group

- From a policy perspective, some of the areas of interest include: Procurement / Partnerships; Policy related to Commercial Vehicle Operations (truck platoon following distance, vehicle safety and inspection; international border crossing documentation and clearance, etc.); Testing versus Deployment
- Infrastructure
    - From both investment and policy angles - and as a starting point - articulate the greatest outstanding transportation needs and determine how CAV could potentially address them.
    - When looking at transportation needs and subsequent investments, try to do so without jurisdictional boundaries so gaps in new infrastructure can be minimized as it is implemented. Met Council Transportation Advisory Board is a good example of a multi-jurisdictional body like this.
    - At a minimum, the Alliance would like the MN CAV policy to include Levels 3-5, Requirement of a $5M bond for insurance purposes, testing AND deployment, Prohibition on local/municipal action against automated vehicles, and definitions based on SAE (Society of Automotive Engineers). [SAE developed the 5 AV levels.]
    - To clarify, the "definitions based on SAE (not verbatim) is separate from the local/municipal prohibition suggestion.
    - Regarding infrastructure investment, clarify priorities among and within unique modal needs for general vehicle travel, commercial vehicles, transit, and non-motorized (e.g. biking, walking). We won't be able to build everything at once so having some structure around modal (and regional) priorities could help.
    - From an infrastructure perspective: Development of Use Cases for CAV is critical for defining infrastructure needs to support automated driving systems; Definition of Operational Design Domains (don't forget about operations); Foundational Elements (markings and striping, communications infrastructure, data management platforms to support storage, aggregation, analytics, decision support); Infrastructure needs for MaaS (Mobility as a Service), including curb

management, mobility hubs, common payment platforms, etc.; Electrification Opportunities including charging station infrastructure, grid modernization, wireless induction capabilities; Positive Train Control and Communications Based Train Control technology supporting automated train solutions; Barrier Control systems for mixed traffic environments (example: use of AV shuttles in shared lanes with peds, bikes, scooters, etc.); Managed Lanes for AVs and Platooning.

- Regarding infrastructure investment, clarify priorities among and within unique modal needs for general vehicle travel, commercial vehicles, transit, and non-motorized (e.g. biking, walking). We won't be able to build everything at once so having some structure around modal (and regional) priorities could help.
- There is support for thinking through the operational (and maintenance) implications of any new infrastructure. This includes the workforce expertise needed to operate and maintain.
- Consider if/how CAV policy and investments could continue to be managed separately - just in the beginning - from the traditional transportation planning and investment processes. Suggesting that this could establish a more cohesive foundation and support learning/information sharing that would guide an eventual shift back to the more traditional processes.
- Priorities from Skype Conversation
    - A recommendation to develop commercial vehicle operations policy for testing (such as platooning). This is different than deployment.
    - Understand needs and funding without jurisdictional boundaries, avoid gaps in new infrastructure.
    - For levels 3 - 5, require a bond for insurance purposes for testing and deployment.
    - For investment clarify unique modal and regional needs and develop funding priorities.
    - Standardized terms are important. Use SAE definitions.
    - Development of Use Cases for CAV is critical for defining infrastructure needs to support automated driving systems; Definition of Operational Design Domains (don't forget about operations); Foundational Elements (markings and striping, communications infrastructure, data management platforms to support storage, aggregation, analytics, decision support); Infrastructure needs for MaaS (Mobility as a Service), including curb management, mobility hubs, common payment platforms, etc.; Electrification Opportunities including charging station infrastructure, grid modernization, wireless induction capabilities; Positive Train Control and Communications Based Train Control

technology supporting automated train solutions; Barrier Control systems for mixed traffic environments; Managed Lanes for AVs and Platooning.
    - Manage CAV policy and investment separately from traditional.
    - Focus on low hanging fruit such as striping, signage, signal consistency and modernization. Investment in electrification to build-out charging infrastructure to ease range-anxiety; develop marketing to help further educate the public; and prioritize grid modernization.
    - Look at how data analytics will support planning and operations. Ten: Partner with private sector to provide information - reduces risk.
    - Partner with private sector to provide information - reduces risk.
    - Public engagement

Facilitators' Note: A few participants mentioned their 3 top choices as priorities, but most people did not engage. A true agreement regarding the priority of these recommendations did not occur except that public engagement was essential.

THEMES / POTENTIAL RECOMMENDATIONS FROM THIS SUBCOMMITTEE

- We recommend that MN pursues partnering frameworks, public/private partnerships
    - For sharing data
        - Work zones, construction
        - Traffic signals
        - Rail road crossings
    - For right of way to publicly owned spaces (e.g., curb, smart signs)
    - Partnering for CAV testing
        - To test technology (needs funding)
        - For research into what works (e.g., weather, conditions)
    - To clarify who is responsible for what

- We recommend that MN plan for CAV funding needs
    - For how users pay beyond the gas tax
    - Avoid gaps in new infrastructure
    - Funding for public education and outreach
    - Clarify unique modal and regional needs and develop funding priorities

- We believe that public education and engagement are important policy considerations
    - Safety
    - Information about what is available (e.g., charging stations, special lanes)
    - "Marketing" CAV in MN
    - Develop workforce program for CAV technical skills

- We recommend MN support CAV testing – allow testing and investment while protecting the public, safety and liability
    - State funded pilot areas for testing
    - Establish standards
        - Entry level readiness
        - For testing and deployment of CAV
        - Pilot projects
        - Work zones
    - Allow for platooning testing
        - Commercial vehicle policy for platoons, truck automation, logistics, border crossings

- We recommend MN have an overall data management framework

- We recommend that MN address short term system needs
    - Incentivize electric vehicles
    - Fiber optics/conduits in roads
    - Mapping – decide who is responsible (public/private)

- We recommend that MN establish infrastructure foundation
    - Focus on "low hanging" fruit … signage, signal consistency, modernization, charging stations
    - Standardization protocols with this technology (consensus agreement from 9/10 meeting)

ADDITIONAL MEETING NOTES FROM THE SMALL GROUPS

Additional comments from the Skype Group

- Operations Perspective - Look at how data analytics will support planning and operations. Improved decision support for operations through integration of AI at TMCs (Traffic Management Centers); staffing impacts from automation of current functions within the operations environment; ultimate impact on traffic signal control, traveler information infrastructure (DMS (Dynamic Message Signs) and 511, for example); Look at infrastructure and operational functions that can be reduced or for which responsibility (and risk) can be transferred to the private sector (traveler information services, payment processing, cloud services, edge computing capabilities, etc.)

- Policy and investment considerations also need to be made for the sharing economy/mobility on demand. CAV, electrification and sharing/on demand all seem to be converging at the same time. Need to find ways to both isolate and combine the impacts of each.
- For both policy and investment - keep engaging the public. Jay's comment about differences between the national AAA survey vs. State Fair survey results on acceptance shows how recent Minnesota engagement is likely helping the public understand - and eventually support - the direction Minnesota takes with CAV.
- Where Connected, Automated, and Shared mobility are concerned, de-emphasize traditional infrastructure – the road and existing traffic control – while keeping that all maintained is good, it's not sufficient; are investment increases even viable? or would make a meaningful difference? and when snow obscures it, it's instantly less relevant, AV industry isn't counting on it, and chasing legislations for infrastructure may not be fruitful; one consideration for hard infrastructure is designing/rebuilding more flexibly now so cross sections can be modified later (e.g., narrower or dedicated interstate lanes, or repurposed curb lanes for shared mobility)
- Prioritize, now and in the future, communications infrastructure (e.g., fiber), electric infrastructure (e.g., grid, especially since CAVs will increasingly be electric, too), and workforce "infrastructure" – getting the key positions created to keep MnDOT abreast of the wild developments
- Suggestion for priorities: 1) Establish partnering framework for CAV deployment and operations; 2) Establish data management framework for analytics and decision support; 3) Provide infrastructure foundation for CAV, including striping/markings, communications network infrastructure solutions, grid modernization; 4) Develop workforce program for CAV technical skills; and 5) Focus on Commercial Vehicle policy framework for platooning, truck automation, logistics and border crossings.

Group 1 – Notes regarding priorities

- Regarding work zones, must standardize, need better GPS locations
- Need to improve communication to create better awareness. This includes public information and hardware
- Need to collaborate with industry. This includes rail grade crossing and signals.
- Need to figure out how to intermix with other vehicles.
- Short term
- Need signage for CAV, to include:
    - EVs
    - Charging stations
    - Connected corridors

- Need to communicate electric corridor locations
- This is a technology change – need to communicate CAV options
- Consider dedicated lane(s) for AVs
- What are parking requirements

Notes that were emailed from small groups

Short Term focus areas

1. Information on reliability of autonomy supporting infrastructure

-We primarily discussed the need to share information in real-time with vehicles so as to enable/disable low level autonomy functions onboard. For example a vehicle with lane keeping feature will struggle to perform in a work zone where lane markings do not exist. Instead of the driver being frustrated by this fact, it may be better if MnDOT is able to make available a real-time query able database that provides information such as – "I94 between mile marker 182 and 186 no lane lines are present" – the vehicle can then use its GPS information and disable the land keeping ability between these mile segments. While this was only a possible solution – the main theme of the discussion "was what can be done to better support existing automation capabilities on today's vehicles. – Especially in work zones, snow covered roads etc".

-Some participants expressed that they would feel frustrated that a capability that they paid for did not function at all times.

-How can we ensure the quality / reporting of issues of lane markings and other signage in both rural and urban areas?

-How can autonomous vehicles be kept safe at railway crossings?

2. Promotion of MN initiatives in CAV areas

-MnDOT should promote awareness amongst the public about infrastructure that is already available in support of CAV vehicles. For example the fact that EVs can travel from Minneapolis to Duluth with recharge facilities available on the way is not well known to the public. Perhaps adding "EV charge" sign to existing gas station / exit info signage would be beneficial.

-Making people aware of available infrastructure – might incline them more to get an EV vehicle. Perhaps EV manufacturers will be willing to pay to promote this.

3. Collaboration to study future infrastructure needs

-Though we discussed a few possible infrastructure issues, a detailed study needs to be done with industry, MnDOT, university partnership that assesses the effect different infrastructure investments will have on enabling autonomous and connected vehicles. Perhaps we can start with established automation features available at present in the short term.

Long Term focus area

1. Two way information sharing – Infrastructure and hardware. Covering both information dissemination and information gathering

-Everyone agrees that information interchange between vehicles and a central/decentralized information and also between vehicles will be vital to reap all the promised benefits of CAVs. MnDOT should focus on the communication links to vehicles. Some of the key questions to be answered are

- What field of information will be made available (signal conditions, road condition, power outage, HD maps etc). Perhaps we can start with a small list of obvious services with future provisions to add more.
- What is the means of communication to and from vehicles (both hardware and software)
- If the service centralized / decentralized. How do we build redundancy and security into the system?
- What levels of latency is acceptable
- How to vet incoming information from vehicles (Eg : road conditions, delays) – before broadcasting to others
- Liability issues associated with the information shared
- Is this central database going to be available to anyone to query or is it going to be subscription based ? Perhaps it is made available for free to recognized entities. Does MnDOT want to / how can it monetize this service – because it is going to be expensive to maintain and run?

2. Collaborative study to identify bottlenecks in CAVs co-existing with present day vehicles and infrastructure

-Here again we need to conduct funded studies to identify corner cases and bottleneck scenarios on the interaction of CAVs with other older vehicles which may not have such capabilities.

-Would it be beneficial to allocate dedicated pathways for CAVs at first

-Independent studies to evaluate autonomy failure modes and security vulnerabilities that may exist in CAVs and how common are they

Group 2 Notes

a. What infrastructure investments should Minnesota make today to support current AV and CV technology?

i I to V/X tech/equipment at signals/roadside in corridors

ii Establish standards for connected vehicle equipment for city, county, and state signals

iii Cyber security

b. What infrastructure investments should Minnesota consider making to support future AV and CV technology?

i Keep flexibility as technology evolves
ii Evaluate next gen signing and striping
iii V to V or signs or other internet broadcast of work zones or lane closures
iv Government invest in facilitating 5G; allow small cells in the R/W
v Consider how paving lines impact how lanes are perceived

c. What infrastructure considerations should Minnesota make to prepare for more Electric Vehicles?

i Incentivize driving cars and installing more chargers.
ii Facilitate those with fleets and other private to electrify and install chargers
iii Incentivize gas stations to transition to having some chargers
iv Install chargers at rest areas.

d. What infrastructure considerations should Minnesota make to prepare for emerging trends in shared mobility?

i Develop single occupant vehicle that is narrow and could facilitate more capacity by driving side by side
ii How pedestrians will interact with autonomous cars, always yield to peds, creates operating issues

Group 3 – Notes

- Road infrastructure funding, where will funds come from?
    - Will there be public and private investment
    - We need to keep pace
- This is a changing environment for Traffic Engineering
- Transition period will be challenging
    - Driver v Driverless vehicle
    - Combination infrastructure (regular vehicles and CAVs)
    - Liability and risk
- Need for additional resources to address new multi-tier infrastructure as tech evolves
- Data: accessibility, privacy, standards, ownership
- Federal and state level legislation
- Differing highway systems, hierarchy of implementation
- Differing environments, urban v rural

- IMPORTANT – Need to maintain an on gong "multi-agency" committee(ies) to provide/coordinate recommendations to lead agency
- Monitor policy, legislature, state
- Lane lines v GIS or other location system
    - Need to have a standard protocol
    - Warmer weather v cold weather climate
- Work zones and other incidents will have significant impacts
    - Possible for research and testing
- Identify areas where legislation (statutes) are barriers to research and testing

Group 4 Notes

- Need to mitigate risks to trains
    - At grade intersections
    - Looking at specific routes, look for intersection overpasses or under passes
- How will infrastructure be paid for?
    - Electrical Vehicle (EV) fee v gas tax
    - $75 surcharge on EVs?
    - Are the utilities the responsible entity?
    - Should it be a surcharge on your bill?
    - Rural MN, how much more money will it cost?
    - Should there be a charge for congestion? Base fee in the Metro?
- Sharing of work zone mapping
    - Make an effort to provide that
    - Provide date regarding length, timing for trains locations
    - Push for train detection technology vehicles
- Regarding transit, fill gaps for people who have no transportation
    - Need more infrastructure advancement than just run on a track
        - Community vehicle sharing
        - For rural, very expensive, challenges for even having access to wireless service
        - May need federal policy v state policy due to large funding
- Regarding investments to support future AV and CV technology?
    - Map out clear conditions for regulation
    - We did not get a lot of input in this area

Infrastructure and research considerations to prepare for more EVs

- Begin pilot programs (and accelerate that) to support in systems/technologies such as sensors for snow

- Don’t keep reinventing the wheel, but find avenues with private industry to keep progressing
- Need not to favor just one technology
- Look at Waymo, Ollie, EasyMile opportunities to keep advancing technologies
- Off track method of train detection
- Rural areas – sight lines technology

Regarding emerging trends in shared mobility

- Engage with businesses to weigh investing into public funds v private partnerships
- Trucking stations for platooning trucks work with private industry to make sure they are heard
- Where does data go?
- We are not comfortable with MnDOT being he keeper as then the data is public information. Need a separate entity.

Next Steps

Liaisons and facilitators will look for themes and gaps in these notes and bring tentative recommendations back to the group for discussion and refinement.