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TECHNICAL MEMORANDUM

TxDOT IAC – Technical Support to the CAV Task Force

DATE: February 9, 2022

TO: Zeke Reyna, TxDOT
Strategic Research Analyst, CAV

COPY TO: TTI_Reports@tti.tamu.edu
Tim Hein, Research Development Office, TTI
Ed Seymour, Executive Associate Agency Director, TTI
Robert Brydia, Senior Research Scientist, TTI

FROM: Beverly Kuhn Research Supervisor
Senior Research Engineer Texas A&M Transportation Institute

RE: Safety, Liability, and Responsibility Subcommittee
February 2, 2022 Meeting Notes

Attendees:

Andrea Chavez	Grace & McEwan Consulting, LLC
Andrew Smart	Santec
Anne O'Ryan	AAA Texas
Beverly Kuhn	Texas A&M Transportation Institute
Beverly Storey	Texas A&M Transportation Institute
Colton Fedell	Argo AI
Daniel Goff	Kodiak
Darran Anderson	Texas Department of Transportation
Donald Davidson	Volkswagen Group of America
Jeff DeCoux	ATRIUS Industries, Inc
Krishna Satti	Michael Baker International
Kristie Chin	Texas Innovation Alliance
Leighton Yates	Alliance for Automotive Innovation
Maniel Vineberg	Maniel Vineberg
Michael Moore	Michael Moore
Mollie Hindraker	Center for Transportation Research at UT Austin
Monika Darwish	Kodiak

Robert Brydia	Texas A&M Transportation Institute
Tony Reinhart	Ford
Zeke Renya	Texas Department of Transportation

I. Opening Comments– Zeke Reyna, TxDOT

- Welcome and thank you for attending this first meeting of the Safety subcommittee. We appreciate everyone taking the time to attend and participate
- Review of members and attendee list in lieu of roll call.
- Unfortunately, neither of our chairpersons could attend at this time, however we will move forward and keep them in the loop as far as developing work.

II. Mural Board Discussion – TTI Team

- Focus
  - Goal: Identify the breadth of infrastructure components (digital and physical) that need to ultimately be addressed for AV operations and determine current status and guidance.
  - Audience: CAV Industry – Public and price sector
  - Deliverable: White Paper
  - Goal for Today: Review status / Input on content and/or missing items. Recruit interview volunteers.
- Background
  - Infrastructure enablers and practices as they relate to automated vehicles
    - Current infrastructure is designed for human drivers.
    - Existing standards are based on the idea that human performance has limitations.
    - At lower vehicle automation levels (SAE Levels 1 and 2), vehicles are expected to use existing road infrastructure and follow design practices.
    - Enabling AVs to travel along public roads may require independent lanes, different infrastructure upgrades or adjustments under different future scenarios, and potentially new materials or methods.
    - Vehicle to infrastructure technology and digital infrastructure associated with enabling vehicle-based communications will play an important role in the future and will require some government investments.
    - Debate remains about the industry's reliance on government-supported and supplied traveler information, but much research has described a renewed emphasis on the digital infrastructure requirements of emerging technologies.
    - Long-term impacts of AVs and shared mobility on the physical infrastructure remain unknown.
      - The performance of pavements, bridges, and other physical assets following a transition to highly automated travel is largely unstudied and highly uncertain.
      - Changes in vehicle following distances, lane positioning, acceleration, and other practices can alter the expected performance of built infrastructure.
      - Changes to freight movements, including platooning, could also impact pavement and structural conditions.

- Increased investment in traveler assistance services, including mounted variable messaging, 511 systems, and traffic management, may be unnecessary or redundant over time.
- Many investments in data collection and real-time monitoring have been delayed or greatly reduced
  - A similar decreased reliance on ITS and traveler assistance services could be a foreseeable outcome emerging from new vehicle and platform designs.
- Among the areas where research has shown the largest impacts are:
  - setting regulatory policy,
  - encouraging pilot developments,
  - identifying work zones, and
  - data frameworks.
  - Pilots need to be put into context of TRL.
- Substantial evidence of the need for additional research bridging the gap between public and private sector motivations
  - roles for further development of emerging technologies.
- Different end uses and vehicle types would require varying infrastructure enablers.
  - Low speed shuttles can likely operate without sign recognition, with or without dedicated lanes, and with minimal infrastructure modifications.
  - High speed, intercity travel has different requirements, as would complicated urban environments.
  - Truck platoons and automated commercial vehicles could have even different needs for lane widths, pavement selection, and advanced traveler information.
  - Automated trucks will require hubs close to interstates
- Different rural and urban needs/designs
- Comments on Background Section
  - Potential increasing aerial component in the future
  - Since timeline is unknown, risk is inherent in trying to establish certain infrastructure needs that may not satisfy the vehicle types at the moment.
  - Have to recognize that this is a continuing to develop system and will have to evolve in the future
  - what are the implementation timelines for the various segments of the transportation community?
  - part of looking at the future is looking at an opportunity; freeways and highways are systems and oriented toward human drivers; as we look at this committee, we might want to consider the roadway and the AV as a single system
  - we largely focus on the ground on this; do we want to include an arial aspect of this as well? could be more arial things going on in the future (deliveries, etc.); increasing arial component in the future; the start begins on the ground
  - what is the best way for the subcommittee members to provide the most helpful input?

- Digital Infrastructure
  - Multiple potential communication formats:
    - Satellite, Wi-Fi, 4GLTE, 5G, DSRC, C-V2X, dual-mode DSRC/C-V2X
  - Multiple different architectures and placement paradigms for devices and computing power
    - Edge, fog, cloud, dust, etc.
  - Minimum needs include:
    - Hardware and Software integrity
    - Data security
    - Security Credential Management System
    - Universal coverage
    - Wide interoperability
    - Storage considerations:
      - 20-100 Terabytes of data per day per vehicle depending on Level
  - Comments on Digital Infrastructure
    - NTSB activity related to connectivity (Feb 8th meeting?)
    - support TMS in terms of planning and ops; overall planning of the infrastructure
    - SCMS - an autonomous ID / aka sim cards
      - APNT - Assured Position Navigating and Timing (terrestrial)
        - also about drones (unmanned systems) that could take advantage of this
      - include LIDAR, RADAR, and other high-fidelity sensor systems
      - Look at zero trust systems to examine security needs.
      - Not all data may need to be stored in perpetuity
- Digital Twinning
  - A digital version of a physical object or process based
  - Two-way data exchange between digital and physical entities in real-time
  - Designed to help improve decision-making
  - A transportation digital twin can be conceptualized as traffic data being collected from different physical systems, such as sensors, connected vehicles (CV), traffic signals, and traffic monitoring cameras in real time to create a cyber-copy of the systems.
  - Comments on Digital Twinning
    - Planning and real-time operations
    - US Voices program
    - autonomy institute website. Austin DT - first in the universe
    - DT allows all the lead engineering forms to effectively share and architect the future of this common infrastructure
- Physical Infrastructure
  - Physical Infrastructure
    - Roadway Types
    - Roadway surfaces
    - Roadway Edges
    - Roadway Geometry
    - Operational Constraints

        - Speed Limit
        - Traffic conditions
        - Comments on Physical Infrastructure
            - highlight the charging infrastructure
            - truckports - on the side of highways or beside highways
            - physical infrastructure to support upgrades and modifications in an easier manner
            - Hydrogen and other alternative fuels infrastructure
    - Operational Constraints
        - Speed Limit
        - Traffic conditions
        - Comments on Operational Constraints
            - Lists feels very similar to components to an ODD
            - operators that monitor their vehicles remotely
    - Objects
        - Signage
        - Roadway Users
        - Non-roadway User Obstacles/Objects
        - Toll booths
        - Water-filled potholes
        - Overhanging vegetation
        - Downed power lines
        - Falling objects
        - Delivery robots
        - Comments on Objects
            - ASOC - Autonomous System Operations Center
            - provision as part of the infrastructure for rescue, vehicle removal, or emergency response for passengers (not necessarily realied to a crash)
    - Connectivity
        - Vehicles
        - Traffic Density Info
        - Remote Fleet Management System
        - Infrastructure Sensors and Comms
        - Out-dated mapping details
        - Fibers, Towers, etc.
    - Environmental Conditions
        - Weather
        - Weather-induced Roadway Conditions
        - Particulate Water
        - Illumination
        - Time of day
        - Glare
        - Ice/Snow
        - Comments on Environmental Conditions
            - Not really a physical infrastructure component - could be stand-alone

        - Construction should potentially be their own grouping - so as not to get lost
        - emergency services for passengers and autonomous vehicles
    - Zones
        - Rural and Urban differences
        - Geo-Fencing
        - Traffic Management Zones\School/Construction Zones
        - Regions/States
        - Interference Zones
        - Misc ODD components
- Identified Research Needs
    - Develop a new "design driver" to the roadways that would allow for additional discussion on the existing standards
    - Standardize machine vision and visibility standards across relevant sources
    - Quantify ROI of making national changes to physical infrastructure elements
    - Assess utility of dedicated lanes during mixed fleet operations
    - Assess the total costs of transportation infrastructure upgrades and modifications plus identify funding strategies to promote proactive planning and investment.
        - Monika likes this one, would allow us to get a bit more concrete
        - Insurance requirements for AV manufacturer and fleet operators
    - Study on truck platooning impact on structural loading
        - Need to understand truck operating distances which are state defined.
    - Assess data frameworks and other digital infrastructure that could enable AVs and shared mobility
    - Create best practices guidance for managing work zone markings, cone/barrel placements, duration, and other elements that can be used to support improved operations for AV and shared mobility providers
    - Quantify and compare varying impacts of AVs on pavements, bridges, and culverts, including those from the increased traffic speeds of AVs.
    - Develop best practice guidance and standard for infrastructure in rural applications, including changes to lane markings, uncontrolled intersections, and high speed two lane rural highways.
- Interview Questions
    - Digital Infrastructure
        - Do you need to map and/or test a route explicitly before deploying? If so, how will you accomplish this?
        - How important is digital twin technology for you?
        - What is your plan for data sharing?
        - What are your plans for data processing, i.e., Cloud, Edge, etc.?
        - Do you have plans for data sharing (send and/or receive)?
    - Physical Infrastructure
        - What are your initial ODD thoughts and what is your longer-range intent?
        - How important are lane marking paint/width and other physical infrastructure needs to your AV operation? (now and in the future)
        - How would standardization of AV related digital and physical infrastructure benefit your AV development?

        - Do you have intentions on remote operations?
        - Are there any markings on your vehicle to denote it is autonomous (all types of AVs) to increase awareness of other roadway users and law enforcement as well?
        - If you are considering connected operations, do you have intentions on platooning?
        - Are you planning for driving the entire route in AV mode, or are you considering transfer plans/points?
        - Do you have a willingness to be part of state or local projects, such as connected vehicles or work zone data exchange participation?
    - Comments on Interview Questions
        - there is still the pushback that they need to know exactly what they can integrate into their software; what will they get the best bang for the buck and actually optimize the system
        - funding is the most foundational issue in all of this; need to show a clear path to PPP; the shared necessity for the infrastructure for private sector and public use will help accelerate it forward in Texas; real estate and digital twin all save value for everyone
    - Who will participate?
        - interview teams could vary depending on the topic
        - Andrew Smart - can combine inputs from within Stantec for all aspects.
        - Kodiak

III. Next Steps – Bob Brydia, TTI

- As is taking place across all the subcommittes, we will be continuing these interviews, reaching out to different companies to get answers to these questions. Again, we're not asking for anything proprietary.
- We will wrap it all up into a position paper of which you will see an initial draft for review so we can get your input.

IV. Closing Remarks – Zeke Reyna

- Thanks everybody for joining us today. I appreciate you taking the time out of your schedules to be part of this.
- Even though our chairs could not attend at this time, we certainly appreciate everyone working together with us on moving this forward and being so active in the conversations.
- Expect to hear from us in the near future regarding Senate Bill 1308.
- Keep an eye out for an invite to a full task force meeting in the next month or so.