CAT Coalition – Infrastructure-Industry Working Group

September 30, 2021 Meeting Summary

Action Items:

- Jeremy will send meeting invites for the upcoming November 18 meeting.

Notes:

Opening

- Tracy herself and Ed as co-chairs of this working group.
- The role of this group is to: 1) support pre-competitive industry research that will advance infrastructure development and maintenance; 2) Connect IOOs with industry; 3) Support the natural evolution of infrastructure to accelerate CAVs; and 4) Clarify terms, definitions and target audiences.
- Tracy provided a brief recap of the previous working group meeting, which featured discussions on digital infrastructure by Darran Anderson of TxDOT, Jeff DeCoux of the Autonomy Institute, and Monali Shah of Google. These presentations will soon be available on the CAT Coalition I-I WG webpage: https://transportationops.org/CATCoalition/infrastructure_industry_WG.
- Jeremy noted that the second round AV scan questions are still open for four different groups to respond:
  1. Private-sector AV providers - https://www.surveymonkey.com/r/HXPN57F
  2. Public-sector: AV Shuttle deployers - https://www.surveymonkey.com/r/AV_Shuttles
  3. Public-sector: Personal Delivery Device (PDD) deployers - https://www.surveymonkey.com/r/AV_PDD
  4. Public-sector: Other AV deployers - https://www.surveymonkey.com/r/AV_Deployment

Digital Twinning Discussion

Chattanooga Perspective

Presenters were Mina Sartipi (University of Tennessee – Chattanooga) and Kevin Comstock (City of Chattanooga). Mina described the Martin Luther King (MLK) Smart Corridor in Chattanooga that was selected as a representative corridor for the city and urban area for this effort. Mina showed a sample intersection in the corridor. She noted that some intersections have LiDAR, others have radar, there are cameras and air quality sensors, Wi-Fi and DSRC roadside units, and the intersections are connected by fiber. A data warehouse was developed that processes over 10 million event messages per day and 500 million data points per day. Before the testbed went live, there was a significant amount of testing and privacy considerations incorporated, such that video is not stored, for example.

Kevin said the testbed will be expanded along the intersecting US 27 corridor (going live Oct. 1, 2021). BlueTooth and MAC address sensing capabilities will be included in the expansion. This corridor helps move the corridors forward to support connected and automated vehicles and vehicle-following applications. The MLK Smart Corridor use cases included visualization to re-create paths of objects like passenger vehicles, buses, and pedestrians. This helps increase understanding of how vulnerable road users (VRUs) use the street. This was of interest to the city to understand the dynamics and interactions in a real working environment to support consideration of geometric changes, enhancing sidewalks, and deployment of new technologies. Seeing the uses of the roadway network gives a granular look at things in greater detail.

Mina shared a screenshot of the dashboard, which tracks the volume of pedestrians, trucks, and cars; the percentage of vehicles arriving in green or red phases; and a variety of other measures. There was a significant amount of work conducted to finesse object tracking and re-identification (e.g., how do you take 60 images of a single truck from a single camera and merge it into a single identified object, and also track that object through the corridor while protecting privacy and not using license plate information?). A single vehicle can thus be represented by the algorithms as a single object as it passes through the corridor.

Chattanooga is currently 9 months into a project to understand how to streamline the corridor to reduce emissions. Computer vision algorithms are being used to build a more accurate model that uses the object classifications.

Mina showed a video that uses the computer vision to identify potential conflicts and near misses between traffic and pedestrians. Kevin noted that the camera resolution and information gathered through the algorithms limits the ability to determine distances between the objects. To address this, LiDAR sensors were added to some intersections to see vehicle movements more clearly. Different colors are assigned to pedestrians, bicyclists, and vehicles to get better ideas and data for counting pedestrians and understanding what variables are impacting operations. This analysis can determine applicable changes that may be made at the intersection.

Kevin also shared how LiDAR is being considered for use in wrong-way detection, which is a major issue in Tennessee. LiDAR can be used to detect a vehicle that is moving in the wrong direction. The equipment is deployed at an off-ramp to detect wrong-way vehicles and also monitoring queues to ensure traffic is not backing up onto the highway. This application will be live in the near future.

Mina showed a computer visualization of the digital twin. She noted there are challenges in both simulation and digital twinning. Two digital twins are being developed: one reflects actual real-time conditions and the second is a test digital twin where different scenarios can be applied. Because it has been calibrated, the test digital twin should have higher accuracy than other simulations. One project is looking at traffic controllers, another is looking at higher-risk VRUs like the elderly and those with disabilities. As an example, this latter study might see how long it takes these high-risk VRUs to cross the road versus the amount of time they were given, and whether it would be possible to observe or detect the VRUs to adjust the timing.

Kevin shared that Chattanooga is part of the G20 Smart Cities Alliance, which also includes San Jose, CA as the only two US cities. This group examines a variety of policy and deployment issues related to technology. This group is looking at how to best use data, maintain privacy, and other data issues.

Questions & Answers

Are there preferences for technology that is deployed at the intersection? Chattanooga has developed preferences for different technologies. Kevin believes LiDAR provides a more accurate view of the intersection. Thinking beyond pedestrians and vehicles, combining LiDAR with signal phase and timing (SPaT) information could provide many opportunities for information sharing. Because of the accuracy of the distance and range of LiDAR technologies, Kevin believes it will become a more prevalent in the transportation industry.

How much redundancy do you recommend in intersections? Kevin noted there are two high-resolution LiDARs at the intersection, both with a very high rate of monitoring. The speed does not make this level of redundancy necessary. A stationary unit is able to project out to the intersection, and with one on all four corners there are no moving parts, which benefits the maintenance perspective. When use one or two LiDAR units, then a large truck can shadow the view of pedestrians, so the use of four sensors can help identify all users present.

Are there data storage or processing challenges? LiDAR is extensive in the volume of data collected, so a lot of data crunching is taking place with edge computing. Microprocessing at the edge is likely to become a bigger thing for transportation. The transportation ITS network with sensors and technologies are basically microcomputers at the edge currently, but as this system is challenged to do more, more edge computing capacity will be needed. CAVs will require huge data transfers and bandwidth needed to accomplish that will be taxed significantly.

Can you talk more about the sophistication and definition of digital twins? Every agency works with tons of data every single day, and there are many opportunities to use this data in new and different ways to provide good intelligence. Kevin works in a maintenance group that manages the traffic signal system, and can get into a lot more details about the types of information that the data can provide. Mina noted that digital twin can be defined differently, but it comes down to what kind of digital twin can be built based on what exists already. There are some things that cannot be measured. It can be challenging for the technology to detect queue length and not identify multiple vehicles as a single object, for example. Data is given to the digital twin to build that environment and continue the calibration. Once in a while staff go to the testbed to collect data, e.g., speed data, to help further calibrate the digital twin. There are a lot of things that can be done with LIDAR, which can be redundant with camera capabilities, but there are costs and other considerations when it comes to the technology being used.

What LiDAR technology was used? Chattanooga works on these projects in a technology agnostic way to not favor any one vendor, so there is no proprietary driver or limitations by being tied to a single vendor.

What are the constraints and feasibility of deploying these technologies? The city has very limited rights of way, and it can be challenging to accommodate capacity expansions. However, the technologies being deployed can be used anywhere. In theory, any LiDAR sensors deployed at any intersection can be moved to any other location. This is feasible as part of the discovery process to get information about the use at that location, but compared with the costs of video detection, it is not that different. It may be feasible to scale the use of LiDAR technology more broadly. The old technologies cannot be relied on all the time as they used to be, so new technologies are being examined to see what makes sense for each location.

Being vendor agnostic, what format do you require to contribute data? These issues are currently being worked through, so there are no standards yet. As these technologies are being developed and deployed, Chattanooga is researching these technologies as tools moving forward. Ultimately, the goal would be to create a data library that is universal across the country or world in this space to facilitate interoperability across jurisdictions. Chattanooga Is working with multiple LiDAR and camera companies; there are always some adjustments needed at the beginning of a deployment.

What conclusions have been drawn using the air quality sensors? Mina said she thought the correlation between air quality and traffic changes would be easier to identify. She noted that air quality gets worse at night, so they explored the reasons why and discovered it had to do with the temperature not increased truck volumes, for example. Low-cost air quality sensors are being explored as a solution to expand the analysis area.

How are deployed technologies evolving in the corridor? Mina said they are working to continuously improve and upgrade the technologies and sensors in the corridor. There are a lot of lessons learned along the way (e.g., LiDAR was not initially planned but privacy restrictions made that a more favorable alternative to cameras). The city identified public safety as a focus area for activities from the corridor. What things can be learned from this corridor and then be expanded across the city? Although four LiDAR units are not going to be deployed at every intersection as part of the expansion, the lessons learned from this corridor provide a more advanced starting point to more strategically deploy technologies and generate benefits elsewhere.

What are some workforce challenges associated with this? Originally, electrical mechanics managing intersections had to be trained to be IT technicians. The team is certified in traffic signal maintenance and are now receiving new training to accommodate the needs in the corridor. Compensation levels are currently being adjusted accordingly to reflect these changes. Access to the university researchers provides a great benefit to staff who can learn from them. As staff see the technologies being deployed and the benefits, they gain a deeper and better understanding of the direction being taken. They have a better understanding of how the system operates and improved workforce development helps them have the capabilities needed to advance into new or different positions around the city. The University also discussed the real world, practical experience they were gaining through the implementation of various components of the project.

What kind of scenarios are being run in the second digital twin? Currently, two different optimizations are being run for two different traffic controllers. Algorithms are being run to understand differences in the percentage arrivals on green or red.

How successful is the wrong-way detection? A wrong-way driver was observed while the equipment was being set up for a different purpose, and that provided a basis for calibrating the equipment to double for wrong-way detection. Mina noted that she did a live demonstration once and while doing so a wrong-way car was identified and then verified by looking out the window. There is a lot of work still to be done for verification and calibration. The technology is ready to go, but the government permissions and approvals to set up the technology for wrong-way detection is a bigger challenge. Leadership is becoming more open to Kevin's ongoing requests, because they are beginning to see the benefits and results that demonstrate why these things are being done.

Where can I find more information? The following website has more information: http://www.utc.edu/cuip. Contact Mina via email for more information: mina-sartipi@utc.edu.

Closing Remarks

Mina noted that the collaboration between the university and city has been a great opportunity for students, as well as for the city and staff there. Kevin acknowledged the government processes in place, but it is important to not be too comfortable in your box. The DOT needs to collaborate with others to make new technologies successful. Lines are being blurred between technology and engineering issues

on the roadway, particularly related to CAVs. There are many use cases and potential benefits available beyond the traditional options. Ed noted that information from this discussion is very useful for vehicles and OEMs.

Partner Updates.

- USDOT. John Corbin noted progress in finalizing the FHWA Roadway Automation ConOps, which may help to enable and catalyze these conversations. This could be a potential topic for the next Infrastructure-Industry Working Group webinar, which could also inform a strategic discussion for how the ConOps moves forward into the next version. A stakeholder group is meeting later this month to discuss this. Additionally, the CAT Coalition is considering an alternative futures discussion in early 2022 to consider how this type of organization continues and evolves moving forward.
- AASHTO. The AASHTO annual meeting will be in person October 26-29 in San Diego. There will be a CAV group meeting on that Wednesday morning to discuss the principles that have been developed.
- ITS America. World Congress is soon taking place in Hamburg, Germany, and ITS America will be in-person in Charlotte in December. There are a number of recent position changes at ITS America that have been announced, including Shailen Bhatt stepping down and being replaced by Lauren Chase as CEO and Kristin White becoming COO. Tracy is moving from policy to programming at ITS America. ITS America released autonomous mobility principles earlier this week, and Tracy will share more about that at the next webinar.

Next WG meetings and Adjourn

The next meeting for this working group is tentatively scheduled for Thursday, November 18, 1:30-3:00 pm ET.

Registered Attendees:

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