Utah Connected Webinar Series: Webinar #1 Questions & Answers

The Utah Connected program has established a statewide transportation system equipped with real-time situational awareness. Funded by a United States Department of Transportation ATCMTD grant, the program is bringing full-time situational awareness to Utah's transportation system. The objective of the first webinar was to provide attendees with a broad overview of the program and key takeaways from its successful deployments. Some of the key takeaways included:

- Connected and automated vehicle technologies will make roads safer, reduce congestion, and help the environment by lowering the emissions.
- Looking for innovative solutions helps keep us moving into the future.
- Deployments can bring great short-term results, but they take time. Agencies should get started now to prep for the connected vehicles to come.
- Fiber optics lines can be used for more than just communication; they can sense impact events such as crashes, rockfalls, and avalanches.
- Effectiveness of today's automated driving systems often depends on visibility of our lane markings.

Q1: By using connected vehicle technology, is it possible to quantify the amount of emissions reduction? If yes, how much? What metric is used to measure the emissions reduction?

A1: We are attempting to measure emissions reductions. Our team is using the EPA's Motor Vehicle Emissions Simulator (MOVES) model with inputs from connected fleet vehicles (transit buses, snow plows, and emergency vehicles). Using BSM data we can assess vehicle movements at intersections, including stops, idle times, acceleration, etc. These parameters are used as inputs to MOVES to assess emissions from those vehicles. Matching that data with signal priority requests, we hope to assess the emissions impact from keeping these vehicles moving through intersections. Our research isn't finished (it is part of a subsequent ATCMTD grant), so stay tuned.

Q2: Can you give some insight of under the hood technology used for CV?

A2: Our current deployments use dual-mode roadside units (RSUs) that can broadcast in DSRC or C-V2X mode. Because of the FCC rulings in recent years, we have turned off the DSRC broadcasts and are using only C-V2X communication. We have three different brands of hardware installed. At signalized intersections, we communicate to the RSU through fiber with a power-over-ethernet (PoE) fiber switch. This enables data to be sent back to our cloud, and from the cloud to the RSU (for TIM messges). The RSU communicates to the signal controller (to send signal priority requests) through a Signal Control Module which is a Linux computer mounted to a card with fits in the detector slot of the cabinet. The SCM also creates the SPaT data using the TSCBM message provided by the signal controller. We use C-V2X on-board units (OBUs) in fleet vehicles (buses, snowplows, and emergency vehicles). The OBUs pull data from the vehicle through the CAN bus to populate a portion of the BSM. An on-board processor (OBP), a small Linux computer, is often used to connect to other systems on the vehicle to determine if the vehicle qualifies to request priority or preemption (the bus is behind schedule or the snow plow is actually plowing, etc.) Does that answer your question? If not, reach out to us for more information.

Q3: Can you share the list of data you are pulling from the BSM and what you are doing with that data?

A3: Each BSM transmitted by our equipped vehicles has over 100 data fields but only some are populated for a given BSM record with "actual data". For the BSMs transmitted by a given vehicle, the number of data elements populated with "actual data" depends on the extent to which we can successfully integrate with and interpret the data extracted from the vehicle. This level of integration is specific to the make/model/year of the vehicle. For some MMYs, we are unable to populate the entire BSM core data frame with "actual data" but for others we can get more obscure data such as the windshield wiper rate, for example. For many vehicles, we are getting transmission state, vehicle speed, accelerator pedal position, brake pedal position, and ambient air temperature. For a slightly smaller set of vehicles, we are also getting wiper rate, hazard signal on, headlights on, turn signals on, and auxiliary brake status. On a very small set of vehicles, we are getting latitudinal and longitudual acceleration, steering wheel angle, yaw rate, anti-lock brake status, and a few other things. We are using BSMs to quantify changes in vehicle telematics and driver behavior when V2I applications are encountered, such as curve speed warnings, spot weather impact warnings, transit signal priority, and emergency preemption. One of our goals is to identify hotspots of unusual vehicle behaviors (hard braking, rapid changes in lateral acceleration, deployed airbag, etc.) where improved infrastructure or faster response times can enhance safety. Which data elements are you planning to get and how are you going about getting them?

Q4: How did UDOT determine that these deployments were the right ones to conduct?

A4: As we prepared to deploy connected vehicle technology, we evaluated a variety of use cases which could be deployed at a small scale, provide immediate benefit, and be scalable to larger deployments. This effort pointed to transit signal priority as a good and beneficial "first case" use case. Once we selected that use case, we picked a corridor where the transit line was often challenged to stay on schedule because of traffic variations. The corridor also needed to have moderate traffic and be conveniently located to our office. Once that deployment was successful, we expanded to other corridors. In later deployments, we decided to select safety applications that could be demonstrated in a few pilot vehicles. Expansion of these applications is dependent upon equipping fleet vehicles, so the penetration of these applications is limited.

Q5: For DOTs that have never conducted a CV deployment before, how do they get started?

A5: The best place to start deploying V2X technology is on a corridor that has traffic signals, since the intersections already have power, poles and cabinets. Select a location consisting of a manageable number of intersections, say 20 to 30. Start by upgrading the signal controller and related equipment - up-to-date controllers and firmware are needed to generate SPaT messages. If the corridor doesn't have backhaul (fiber or something similar), install that capability. These upgrades - signal equipment and backhaul - will benefit the corridor operations and timing and bring benefit for the expenditure even before V2X is installed. Agencies can do this work now, before they start purchasing, testing and installing V2X.

Q6: What is the limit (in miles) on the fiber acoustic sensors?

A6: One Interrogator Unit, usually mounted in a fiber hub building, can monitor up to 25 miles of fiber with a spatial resolution of 150-feet and update rate of 1 second. Much more information will be provided in Webinar #5.

Q7: Can you provide some orientation on anonymity of collected data, privacy implications (if any), etc.?

A7: The J2735 standards shared in the seven messages Blaine interpreted in webinar #1 have built-in anonymity, so when the vehicle sends a basic safety message, that message has no indication of what the vehicle is. It gives a vehicle length, but it doesn't give the make, model, color, VIN number, owner plate, etc. When we send a signal request message to seek priority or preemption at an intersection, our state policy requires that we know who's asking for that priority.

Q8: What kind of vehicles have OBUs installed? Government vehicles only or are there also commercial/consumer vehicles with OBUs for testing?

A8: They are all government vehicles. We started with snowplows and UTA buses then expanded to fleet vehicles that UDOT employees drive such as sedans and Ford F-150 pickups. From there, we expanded to the Orem where the same kinds of fleet, publicly owned vehicles were equipped plus their snowplows and emergency response vehicles.

Q9: For your new RSU deployments, are you filing those under your established FCC call sign or under an experimental license?

A9: Our early DSRC deployments were installed under our established FCC call sign / license. We have been deploying C-V2X RSUs under an experimental license held by Panasonic, one of our deployment partners. UDOT was one of the parties to the FCC Joint Waiver in April 2023, so we are moving forward with new C-V2X deployments under our FCC call sign as per that Waiver.