UDOT Keeping Utah Moving

TRANSPORTATION TECHNOLOGY

Utah Connected Webinar Series: Webinar #2 Questions & Answers

UDOT has built an entire ecosystem that ingests and analyzes “Big Data” from multiple sources in real time. This analytics platform is the “cloud-based heart” of our connected vehicle system. UDOT's comprehensive approach to effectively manage data that affects all users and modes of Utah’s transportation network is enabling UDOT to generate new insights and produce actionable information in real time. The objective of this webinar was to detail the ideation process used in the development of this data ecosystem and outline how other peer DOTs can replicate this process to create a fully connected system. Some of the key takeaways included:

- UDOT, in partnership with Panasonic, has developed a connected vehicle platform that optimizes mobility. The platform allows UDOT to monitor the health of the connected vehicle system and provide situational awareness to users.
- Connected vehicle technology will help to save lives and improve safety on Utah roadways for all users. Multi-disciplinary deployment teams will enhance success!
- Zero Fatalities can be achieved with the help of connected vehicle technologies.
- Critical experience is gained through “real world” deployments. Actionable data can meaningfully inform decision making.

Q1: Does the VBS or in-vehicle C-V2X systems have a Cirrus component, or how do Cirrus RSUs collect the data from the vehicles?

A1: Information from the vehicle is broadcast by the OBU and is received by the Roadside Unit (RSU). Messages also are sent in the other direction. So, there must be a CV2X OBU in the vehicle and a CV2X RSU on the roadside. Cirrus is a cloud-based platform that collects, analyzes and stores the data, using these OBUs and RSUs. Data in the RSU is moved over UDOT's fiber network to the Cirrus platform. Some messages, like TIM messages, are generated by Cirrus, then sent to the RSU over our fiber and broadcast to the vehicles.

Q2: What type of faults do the Cirrus system reports for RSUs?

A2: In general what we do is we ping the device and then we pull information across something called SNMP, which is a networking protocol language. That tells us a really rich set of information about what's happening with the device, and we get that data essentially in real time. We get things like, “Is the device alive (as in awake and connected)?” We also get really detailed information about 2 different kinds of data sets: One is, “How is the device performing physically? Is the CPU overloaded? Does it have memory? Is it hot?” Also, “What kind of settings are present in the device, and are those the right settings? What IP addresses is it set up on? Is it forwarding BSM messages properly in the right direction? Which broadcast channels is it using for the CV2X communication, etc.” And so kind of across the spectrum, really what we're looking for is a step process. Is the device connected and alive? Is it properly configured, and then is it actually doing the thing that it was put in the field to do? Depending on the device capabilities or our platform's hardware agnostic, we try to work with any of the different RSU and other manufacturers that are out there, and they're the ones that really determine the specific hardware capabilities or features of their device. We were able to connect to those capabilities that they have implemented and pull whatever information they've designed into their system or into their hardware. Our platform doesn't really care which hardware endpoint, but the hardware endpoint does determine the specific capabilities of that device that we can monitor against.

Q3: How would vehicle autonomy affect Cirrus functions?

A3: We do a couple of things: One, we rotate the ID of the vehicle to maintain anonymity. The OBU is a temporary ID, and that rotates but not on a fixed pattern. Instead, it's intended to obscure the traceability of that vehicle across the ecosystem, so we could never do things like origin destination tracking against such a traditional OBU. The other thing is that the BSM message content specifically does not include the vehicle VIN, driver characteristics, ownership, etc. so that we don't have that information on the platform, and we don't have to worry about violating user's privacy in that way. However, BSM does give us interesting information about the experience that each vehicle is having with that privacy intact, so we get location information and other data about the vehicle movements, including the vehicle's condition, windshield wipers, engine temperature, whatever those things might be. It gives us the operating condition information that we need while preserving driver privacy and driver security. This question also uses the word "autonomy". If the vehicle were to be driving autonomously, this same information would be provided to Cirrus, anonymously, giving us deep insights into the driving environment and vehicle movements.

Q4: Is the Cirrus application able to connect to Traffic Management Center systems?

A4: We have done research with our traffic operators about what kind of data they would like to have and how the data should be presented, but we have not yet connected Cirrus with our Traffic Management Center system. We are currently replacing our Traffic Management Center software. When that implementation is complete, we will identify ways to share data between Cirrus and that new management software.

Q5: Can you capture vehicles traveling the wrong direction on a roadway through the BSM data set?

A5: Wrong-way driving is a serious problem that a lot of DOTs are challenged with and trying to figure solutions for. We've had a few problems with getting our GPS data to be consistently accurate, but once we work through those and get really good lane-level accuracy on the GPS, it could be used to determine whether there's a vehicle going the wrong way on those lanes because the BSM data is being produced every tenth of a second. We are able to see the travel path of the vehicle! There are a few challenges, however: How do we respond to this data? We could, for instance, trigger some kind of evasive action, a flashing light or something; that's what a lot of wrong-way driver warning systems do. We could put up a sign or notify the police about a vehicle moving the wrong direction, but what we can't do is tell them what that vehicle looks like. Because of the anonymity of the BSM, We have no information on make, model, color, plate, etc., so we've got that challenge. In addtion, every vehicle would need to have an OBU on board - we won't get data from vehicles that aren't equipped with an OBU. This is an example of a great safety use case we will be able to tap once the OEMs equip essentially all of their vehicles. We're looking forward to many benefits to this system once the OEMs are fully equipping their vehicles, including wrong-way driving, adaptive ramp metering, and others.

Q6: What is the saturation percentage of connected vehicles in this data?

A6: We currently have 270 vehicles that belong to UDOT, The Utah Transit Authority, and Orem City with OBUs installed. With current projects, another 45 vehicles will be added, so this is continuing to grow. Although this is a realtively small number of vehicles, our goal is to have our system ready for the vehicles from OEM manufacturers that will have this capability in the next few years.

Q7: What caused the apparent gaps in the data ingestion map shown in Panasonic's slides?

A7: We deployed a system update at that time, so we had coordinated in advance to just push some updates that we're going to discontinue data collection during a small window of time and then turn it back on after the updates were complete.

Q8: Can you notify vehicles when they are entering a construction zone and possible action to take like slow down, etc.?

A8: We can certainly issue a TIM warning or something like that. In that instance,one of the things we've recently talked about doing and haven't initiated yet is just that: taking work zone data from the National Work Zone Data Exchange and converting that into some kind of a message that could be delivered to the vehicle. If you've got good, reliable data on the work zone, you could put it into the car.

Q9: The placement of a curve warning sign is based on posted speed or some an anticipated operating speed of the traffic. Shouldn't the CV application timing of the message be based on the actual speed of the target vehicle for safer deceleration and vehicle control?

A9: We explored this because there are passenger vehicles all the way up to a semi truck that need greater distances to brake and reach those appropriate speeds. As an infrastructure owner, UDOT is building an application that the infrastructure produces independent of what vehicle may be approaching the roadway. They send the curve speed warning alert, and the alert basically says, “This is the curve; this is the advisory speed.” Because we developed how that alert is displayed in the vehicle, we did have to create some logic as to when and what this alert would be displayed. But ultimately, it's the vehicle itself or the manufacturer of the vehicle that will probably be determining how these alerts are managed. With the application that we've built now, because it's an infrastructure produced alert, we can't know exactly what vehicle might be approaching. The alert has to be generic, and the vehicle itself, based on its characteristics, will ultimately be able to take that alert and produce the appropriate notification to the driver.

Q10: Will the driver be exposed to the speed warning alert even if their speed is at or below the curve speed?

A10: That depends. This is intended to be a vehicle side implementation, so the vehicle that we've outfitted in Utah, primarily Utah fleet vehicles, does have some influence on how this is done. The idea that we tried to follow is that we want to do something like what this question is asking, so there's gonna be a different recommendation in the TIM depending on the vehicle speed, whether you're over or under the suggested speed. Ultimately, these things are up to the implementation in the vehicle, so as the auto OEMs or other manufacturers integrate connected vehicle technology into their vehicle, they'll get to make those choices on what's the best user experience for their customers, their drivers.

Q11: Is UDOT reading OBUs in actual consumer vehicles? Or in UDOT fleet vehicles?

A11: Right now there are no Automotive manufacturers who have CV2X OBUs in their vehicles. A few years ago Ford indicated they were going to install CV2X OBUs, but because of some regulatory issues, with the FCC and others, they haven't yet done that. We believe some other automakers are working towards that, but today there are none. So all of the OBUs we have in our system are installed in fleet vehicles that belong to either the Utah Department of Transportation or one of our partners: Utah Transit Authority, and the city of Orem. There are about 270 of those so far. We are working with some other partners for future deployments.

Q12: How did UDOT able to integrate OBU - vehicle integration (CAN-bus)? Also can you explain the penetration into the vehicles? Is it only in UDOT fleet vehicles?

A12: We install an OBU under the dashboard in the vehicle. It connects to the power supply in the vehicle, and then it's got a connector into the CAN-bus through the OBD-II port. The data in the bus is secured through obscurity by the manufacturer and it is up to us to decypher that data. The OBD-II port is a standard diagnostic support on all light vehicles today, and it connects in the vehicle electronic systems there. We then have to go through a process to interpret the data that comes through the OBD to determine what it is. This is different for all vehicles, with changes down to make, model, trim, and model year. The process is a bit different on heavy vehicles like our snowplow dump trucks, large buses, and fire engines. For these vehicles, there’s not an OBD port, but there is a J1939 port that serves a similar purpose. We connect to that.

Q13: Are you using any OBU lite hardware on bicycles or micromobility?

A13: These devices have only very recently become available, and some have very small OBU form factors. We've looked at them briefly. We have a project underway in a later phase with different ATCMTD funding where we're looking very closely at trying to prevent crashes with pedestrians and bikes. That's a very important and troubling trend these days– increased crashes with vulnerable users. We're looking at ways to prevent those crashes. This is a potential tool that could help us do that. Since they're barely becoming available, we haven't done anything with them yet, but they're certainly on our radar screen. There was a similar tool years ago when we were doing DSRC deployment that was essentially an OBU that snapped onto the back of your cell phone, and we bought one of those but never found the right use case. We're anxious to see what's happening in that market, particularly with bicycles. I know the bike manufacturers and some of the automobile manufacturers are very interested in that prospect, and so we'll work with them to move that forward.

Q14: How is support for the Data Community funded? Are there access fees for use of the data and tools?

A14: The Data Community is funded through the support by the Infrastructure Owner Operator associated with the location of the devices which generate the data. In Utah, UDOT supports the operation of the Data Community and access is free for those who UDOT approves access for. We are interested in making this data available to a broad community so that we can all work together to get value out of the data, so at this point, we are using internal UDOT funding to support this data community.There's no fee or cost for you to become part of the member community and use that data. We believe it's the right thing to do to share this data and to get everybody to use it. We are hoping that by doing that, many of you will come up with beneficial use cases and good ideas on how to use the data that we haven't yet thought of. People can go to the website, click on Kjeld and Lauren’s presentation, and scroll to the last slide to access information about how to apply to be a part of the data community.

Q15: How is hard-braking defined, and is that uniform across all vehicles?

A15: The definition of 'hard braking', per the 2020 version of SAE J2735 is that a vehicle has deceleration greater than 0.4g, or about 4 m/s^2. The 2022 version of the specification redefines hard braking for large, heavy-duty vehicles as deceleration greater than 0.2g but leaves light-duty vehicles at 0.4g. UDOT uses the 2020 version for all vehicles. We are considering whether a vehicle needs to experience this deceleration for more than 100 ms (a single BSM message) to classify it has experiencing hard braking but haven't made a final decision.

Q16: Could TIMs be delivered over satellite?

A16: Absolutely! In fact, I think that's one of the ways that the Wyoming DOT delivered TIMS on their connected vehicle pilot project that they did a few years ago. I believe their system is still live. They're covering Interstate 80 across Wyoming, which is a large, very long, challenging corridor across some wide-open areas with a lot of weather challenges. They did deploy some OBUs along the corridor but also employed satellite communications, so it certainly could be done; we just haven't done it that way. Being delivered by satellite, there’s a little bit of a lag or delay. Some TIM alerts might have minimal impacts if this delay exists, but others need and require that near-immediate transmission and reception of the TIM to make sure that the driver is alerted in a timely manner. Verification warning is very time sensitive, and if it takes a few seconds to get up to the satellites and back, sometimes that’s too much time.

Q17: Once a TIM is created in a certain area will it notify other drivers in the same area of the applicable warning?

A17: Yes– the way that TIMs work is that TIM is created and then established out on the network of roadside units that are part of the infrastructure side of the ecosystem. Then, those are continuously broadcasted during the duration that's established for them, so any vehicle that's in the vicinity that has the connected vehicle capability will receive those messages. The TIM isn't unique to one specific driver or vehicle. It's broadcast out to drivers in the vicinity of the hazard within a GEO fenced area, with a specific time limit when the message is applicable. We can control time and space aspects of the message but all equipped vehicles can receive it. The TIM can also specify the directionality of the vehicle that it applies to, and that's particularly relevant to the curve speed warning or vehicles approaching the curve from one direction. Once the message is received, the internal vehicle systems can determine when and where it's appropriate to display that message to drivers or take some action based on the content of that TIMs message.

Q18: What percentage of drivers can receive these TIMs? How are the automakers responding to this infrastructure?

A18: The vehicles that we're equipping in this connected vehicle ecosystem are specific fleet vehicles, selected based on their routes and roles. Currently, we have 270 equipped vehicles that belong to UDOT, The Utah Transit Authority, and Orem City. With current projects, another 45 vehicles will be added, so this is continuing to grow. Although this is a realtively small number of vehicles, our goal is to have our system ready for the vehicles from OEM manufacturers that will have this capability in the next few years. As we continue to develop and prove our use cases we encourage OEMs to take advantage of these systems. With some of our current applications useing our fleet vehicles, we are sending TIM messages. In order for the driver to benefit from that message, the vehicle needs to have a human machine interface, or some kind of a screen. We've experimented with a little heads-up display, with replacing the display panel that's already in the vehicle with an enhanced version, and with a simple tablet mounted to the dash board. We have only a few vehicles with this capability today. The automakers are very interested in the capability for us to provide them information. They are, however, very protective of the inside of the cabins of their vehicles, so what will happen as automakers start to install OBUs in their vehicles and start receiving these messages from us, is unknown. Each individual automaker will decide how to deal with this information. A weather related TIM message, for instance, could be delivered as displayed text, an audible message, or maybe with a haptic response - a vibration in the seat or steering wheel. We are having some conversations with the OEMs and making sure that the messages we send to them are relevant, acdurate, and trustworthy.