Utah Connected Webinar Series: Webinar #3 Questions & Answers

UDOT has deployed connected vehicle technology in multiple ways on our roadways. The objective of this webinar was to highlight the deployment process and lessons learned from deploying V2X systems along roadways and in vehicles. Speakers discussed planning, installation, and testing of the roadside and on-board systems and the approach to system maintenance. In addition, speakers discussed the generation of intersection MAP messages on the devices and how they protect the transmission of data over the V2X system. Some of the key takeaways included:

- Start developing CV technology now, starting small and scaling up over time. Involve relevant stakeholders in the process.
- Roadside and vehicle software such as RSUs, SCMs, and OBUs are essential for detecting and tracking buses, snowplows, and emergency vehicles.
- CV technology can increase basic safety, traveler information, and Connected Intersection Preferential Treatment.
- Utilize the USDOT MAP messaging tool and connected vehicle pool phone setting MAP guidance document when developing MAP messages.

Q1: Scott said that the antennas of the RSUs are ensured to not interfere with existing radios. Can you describe how you did that investigation?

A1: We've put these devices out in the field at limited sets of intersections and vehicles, opening risks to interferences. Fortunately to date, we haven't really seen any issues with that, and it's a little bit of a trial-and-error approach. Antennas have the radiator attached, and we look at the Smith charts to see what their radiating pattern is and ttheir interferences between different spectrums. You need to make sure that you have a ground plane on that antenna because you're not getting it from the vehicle, especially buses since they have a fiberglass lid.

Q2: Have any automakers indicated they have plans to offer CV technology in their vehicles that is compatible with Utah's system?

A2: Several years ago, Ford announced that they would put CV2X equipment in all of their vehicles in North America. They haven't yet done that, and the deadline they set when they made the announcement has been passed. However, over the last several years, we've had a lot of regulatory uncertainty with the Federal Communication Commission, which has caused the automakers and a lot of others to hold back temporarily. We believe that Ford will move ahead with that commitment at some point in the future. There are other automakers who are working in this space actively but haven't made any formal commitments. They aren't building specifically to the Utah deployment per se, but they're building their systems to meet a set of national standards as are we. We're hoping that all of us around the country will build to these standards, and the automobiles and the rest of us will all be able to wirelessly communicate in the V2X environment. We do have an active project going on with several of the automakers where we are testing some of our intersections and making sure that we meet the standards that are expected, and the automakers are involved so that they can give us feedback about those and help us meet the requirements.

Q3: Are the RSP and OBP necessary? Is this equipment already integrated into the RSU and the OBU?

A3: The roadside processor came about because of some of the institutional Utah DOT requirements not wanting to put additional processing demands on the signal controller. The SPaT message needs to be generated and, at the time, there was no way to do that on the RSU. There was also no way to generate SRMs on OBUs. UDOT's consultant, Narwhal, developed the capability to do those functions using an on-board processor (OBP) on the vehicle and a signal command module (SCM) at the roadside. Similarly, we are not aware of any OBUs that can do RTCM correction so an OBP is still required to perform that function. With current hardware capabilities, we could install software on the RSU or the OBU to create SPaT or SRMs on the device, but we are using multiple brands of hardware, and rather than customizing the software for each platform, having it on the OBP and the SCM allows us to have the software be consistent across platforms.

Q4: Is UDOT using NTrip streaming to support DGNSS?

A4: At some locations UDOT is using subscription based NTRIP streaming with virtual mount point from the Utah Geospacial Resource Center (https://gis.utah.gov/). At other locations UDOT is using the Signal Command Module (SCM) with an RTK GNSS module installed as a standalone RTK base station.

Q5: Does a testing and validation facility need to have FCC waiver to install CV2X RSU?

A5: Currently, an FCC waiver is required when registering CV2X locations. In the past, the FCC granted experimental licenses for deploying CV2X RSUs. These experimental licenses have now expired and the FCC will no longer grant experimental licenses. When UDOT was deploying DSRC RSUs to test locations, the test location was required to be registered with the FCC. Registration is required to insure that RSU wireless messages that are being broadcast by the RSU do not interfere with other FCC licensed devices that are located near the RSU's location. All UDOT CV2X RSU locations will be/are registered with the FCC. UDOT has received a wavier from the FCC to deploy CV2X RSUs. Regarding your question "If a testing and validation facility needs an FCC wavier to install a CV2X RSU", it would be best to contact the FCC to get their official answer.

Q6: The BSM definition contains part I and part II. The BSM messages in UTAH deployment, how is it configured on-board, Part I only or including Part II as well?

A6: The data which is populated in the Basic Safety Message (BSM) depends on the make, model and year of the vehicles, and the ability of our installers to decode the data coming from each of the vehicle's Controller Area Network (CAN) bus. Currently, only a portion of the BSM Part I message is populated for Utah vehicles, with some vehicles havnig only a few data fields populated and other vehicles having more. For light vehicles, the data is extracted from the On-Board Diagnostics Port (OBD-II) and on heavy vehicles, the J1939 port.

Q7: To your knowledge, are deployments of RSU mentioned today interoperable, via a same OBU, with those in NYC, Tampa, or Wyoming?

A7: Today, our deployments are not interoperable with the deployments in NYC, Tampa, or Wyoming. Those three deployments, funded through the USDOT Conected Vehicle Pilot program, used Dedicated Short Range Communication (DSRC) RSUs and OBUs. That was the standard at the time, and Utah's early deployments also used DSRC. The FCC signaled their intent in 2021 to abandon the DSRC technology and authorize C-V2X technology in its place. Most of UDOT's deployments now utilize C-V2X, including those discussed on the webinar. UDOT is replacing our remaining DSRC RSUs and OBUs with C-V2X. To our knowledge, NYC has not replaced any of their DSRC units and Tampa is moving toward C-V2X (but I don't know the current status of that move). In addition to DSRC, Wyoming uses satelite radio for communication. I don't think they have replaced their DSRC with C-V2X yet. Over time, all V2X systems in the US that use the 5.9GHz spectrum need to migrate to C-V2X. To the extent that those deployments meet the new C-V2X and Connected Intersection standards, they will be interoperable.

Q8: Have you had any issues with the OBU being behind the seat as shown, that is, damage to the unit from repetitive seat impact or such?

A8: The OBU is low-profile and does not interfere with or make contact with the driver's seat. We have not had any instances of damage to OBU's mounted behind the driver's seat.

Q9: Is there a plan for ongoing system monitoring and system maintenance? The devices and integrations seem like they need a more rigorous maintenance plan than do traditional ITS devices.

A9: We are actively monitoring and maintaining the system. Webinar #2 introduced Cirrus by Panasonic, a platform which includes the RSU Manager and Connected Intersection Manager functions. These are used to monitor the health of the V2X system. When problems are identified responses include troubleshooting, rebooting equipment, field assessments, and hardware replacement. We also use the data generated by the system to assess whether messages are being sent and recieved, including identifying when signal priority messages are not being received or acted upon. The challenge with monitoring this system is that different components are managed by different systems and groups of people. While Cirrus monitors all the V2X systems, traffic control systems are monitored by UDOT's signal control system and maintained by UDOT's signal group. So, when priority requests are not being acted upon, we need to evaluate the V2X system and the signal control system. A lesson we are learning is that we need to improve communication and coordination between our V2X team and our signal team; we are planning some cross-training so both groups have a better understanding of the other. Additional rigor in our maintenance plan is required because 1) the V2X system is newer and less developed, and 2) the mixture of the V2X and signal systems requires more aggressive coordination.

Q10: Is the exchange of data between RSU and OBU in real time? How is this achieved?

A10: Yes, communications between RSUs and OBUs are in real-time. An OBU broadcasts BSM messages 10 times per second. An RSU sends MAP messages once per second and SPaT messages 10 times per second. All of this is done with direct wireless broadcasts over the 5.9GHz spectrum, also known as the "ITS Band" or the "Safety Spectrum", specifically at 5905 - 5925 MHz frequencies, or channel 183.

Q11: Do any of the SCM intersections also have rail preemption? I was curios about the SCM software versus the hardwire preemption interactions if you do.

A11: The connected vehicle systems we have developed for priority and preemption at intersections is limited to vehicles on the roadway. We do not use this system for rail preemption. Rail preemption is done with a different system.

Q12: What is the RTCM data source you are using?

A12: There are 2 sources for RTCM data that UDOT is broadcasting: 1) The first source is an NTRIP server network provided by the Utah Geospacial Resource Center (https://gis.utah.gov/). UDOT has a subscription for each site that is using the UGRC NTRIP network. Currently the subscriptions are complimentary but normally cost $600/year/site. 2) The second source is to use the Signal Command Module (SCM) as a standalone base station. SCM's equipped with an RTK GNSS module are capable of acting as an RTK base station. Both survey-in and fixed precise location methods are supported by the SCM. The advantage is that there is no subscription fee or reliance on network connectivity.

Q13: It would seem that there should be a mechanism to convert MAP to NMAP - rather than the reverse.

A13: UDOT is moving away from NMAP file usage. The USDOT ISD Message Creator web application is the preferred method for creating MAP messages. The ISD tool can create a MAP JSON file or a binary MAP message from the data that a user enters into the application's graphical interface. There are cases when the aerial imagery in the ISD tool is out-of-date, then the method of using the ESRI ArcMap software application with up-to-date imagery is used to create an NMAP file. The software in the intersections' Signal Control Module (SCM) has the capability of reading NMAP files, MAP JSON files, or the binary MAP messages created by the ISD tool. If NMAP files or JSON files are uploaded to an intersection's SCM, the the SCM's software will create a binary MAP message. The NMAP and JSON files are text files that must be read and then the information in the files is used to create the binary MAP message. If a binary MAP message is uploaded to the intersection's SCM, then no data translation is necessary. The binary Map message is sent to the Road Side Unit for broadcast to connected vehicles.

Q14: Can you elaborate how the Multimodal Intelligent Traffic Signal System (MMITSS) are used? For TSP?

A14: The MMITSS system was developed for the Connected Vehicle Pooled Fund Study (CV PFS) by Dr. Larry Head of the University of Arizona and Dr. Kun Zhou of the University of California Berkeley Partners for Advanced Transportation Technology (PATH). MMITSS is a system which uses connected vehicle data to balance and prioritize the requests for signal priority from various vehicles. A priority request server within the software uses a hierarchical control policy for different modes. UDOT obtained the MMITSS software in 2015 and used elements of the software for our early TSP deployments. MMITSS was an important part of our system development. More information on MMITSS can be found on the Past Projects page of the CV PFS here: https://engineering.virginia.edu/cv-pfs-projects-and-research An early conflict we encountered was that MMITSS removes control of signal operations from the signal controller - something that our signal engineering team was not comfortable with. We removed those elements from MMITSS and, over time, modified the software significantly for our use.