Advancing V2X Communications for Connected Interoperable Transportation Environments

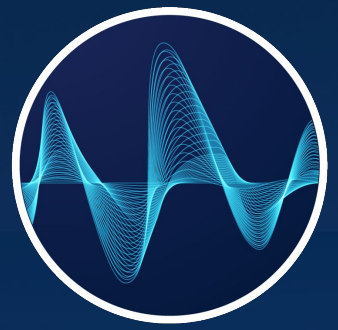
U.S. DOT V2X Spectrum Team

December 12, 2022 @ ITS America V2X Committee

December 14, 2022 @ Connected Vehicle Pooled Funds Study

U.S. Department of Transportation

ITS / V2X Communications Summit



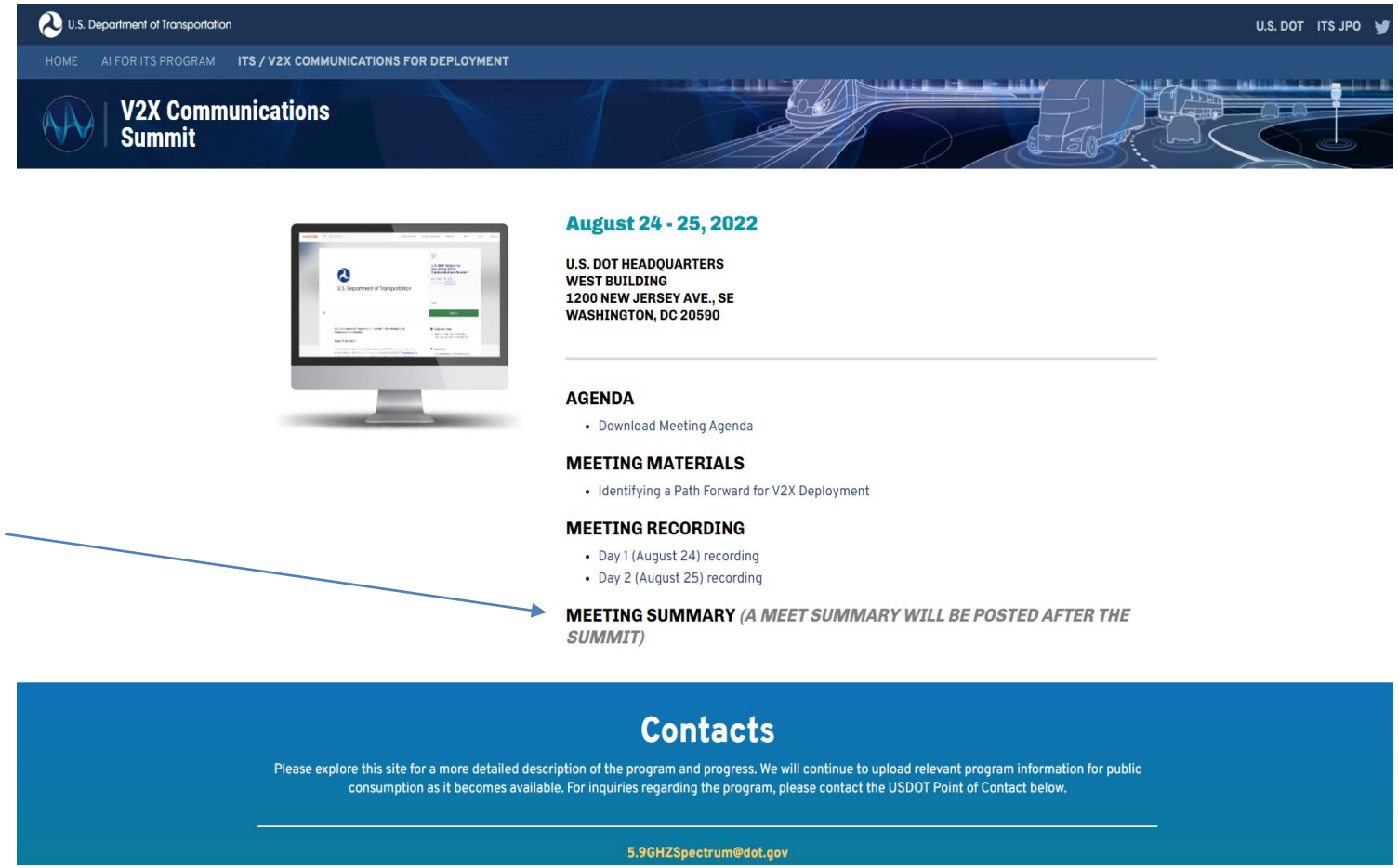
Vehicle-to-Everything (V2X) Communications

Agenda

- V2X Communications Summit
- Post-Summit Activities Underway
- Update on Pending FCC Waiver Requests
- Engagement Opportunities

V2X Communications Summit

Summit Summaries will be available later this week



https://its.dot.gov/research_areas/emerging_tech/htm/ITS_V2X_CommunicationSummit.htm

V2X Summit Needs & Key Activities Underway

Short-Term Recommendations (0-6 months)

1. Resolving pending waivers

- See next slides

2. Completing U-NII interference testing

- Partnered with industry to develop joint test plan—lab tests + open-air tests
- Testing finalized December 16th; analysis of test results underway

3. Engaging U.S. DOT Leadership

- Aligned V2X communications with National Roadway Safety Strategy
- Working with Associations on deployment strategies

4. Engaging the ITS Community: Next Summit 2.0 and V2X Vision/Plan

- Working with ITS America and Associations on plan for gathering input

5. Funding for V2X

- ATTAIN and SMART Grant opportunities closed this Fall—evaluations are underway
- Both grants included funding to transition to LTE-V2X

V2X Summit Needs & Key Activities Underway

Longer-Term Recommendations (6 months+)

6. Evolving the Security Credential Management System (SCMS)

- Gathering input on needs and identifying next-step strategies

7. Demonstrating Day-One LTE-V2X Applications with LTE-V2X

- Identifying priorities will be part of Summit 2.0 and V2X Vision/Plan engagements

8. Developing LTE-V2X installation guidance and education

- Identifying needs will be part of Summit 2.0 and V2X Vision/Plan engagements

9. Ensuring comprehensive Standards and test procedures for LTE-V2X

- Identifying needs will be part of Summit 2.0 and V2X Vision/Plan engagements
- V2I deployment standards

10. Facilitating obtaining interoperable V2X connectivity outside of the 30 MHz for public V2X benefits

- Identifying needs and options to develop a scope of work that stakeholders can support
- Identifying where previous work has been done—for instance, in Europe, in standards development organizations, and other sources

11. Developing public V2X adoption campaign for broader audience

- Will be part of the Summit 2.0 and V2X Vision/Plan discussions

Waiver Status

- 18 Waivers submitted to date
- One waiver—from the Joint Waiver Party—asks for a national waiver for RSUs and OBUs
- 14 additional waivers point to Joint Waiver Party filing

Waiver Issues

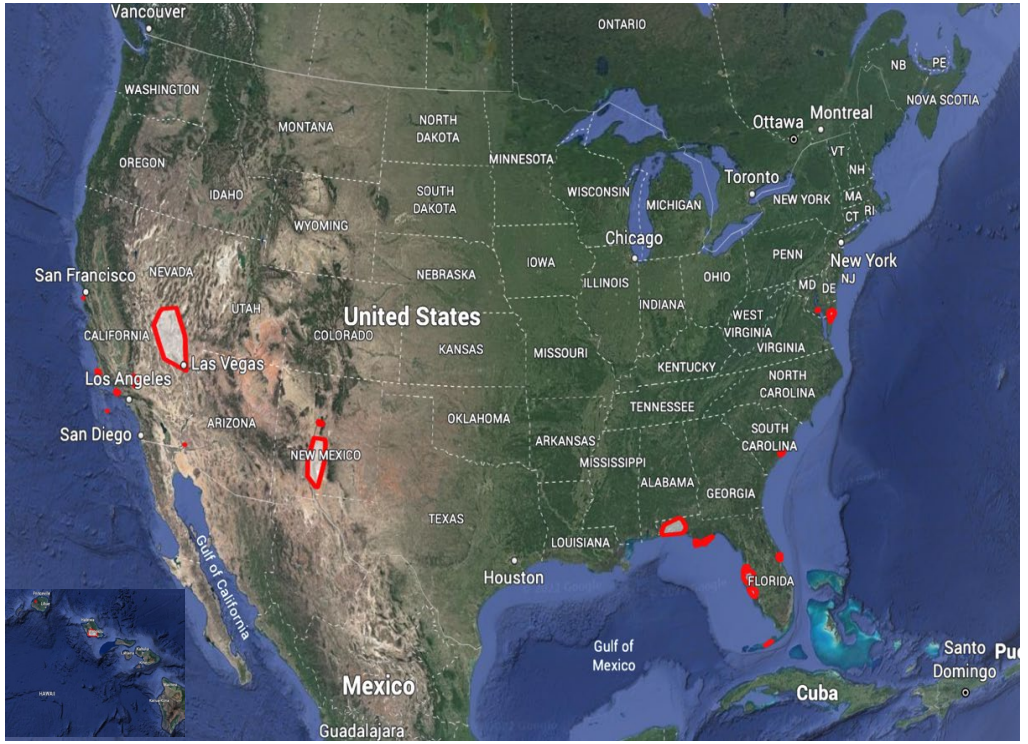
- Variations in power levels across waivers
  - US DOT and expert analysis determined that this should not be problematic if power levels stay under FCC identified thresholds
  - Need to verify with FCC
- Request for maximum 33 dBm directionally focused EIRP power for OBUs
  - Request is part of Joint Waiver Party, thus encompasses 15 waivers
  - Higher maximum EIRP power than identified in FCC's "streamlined waiver process"
  - Needs further technical quantification

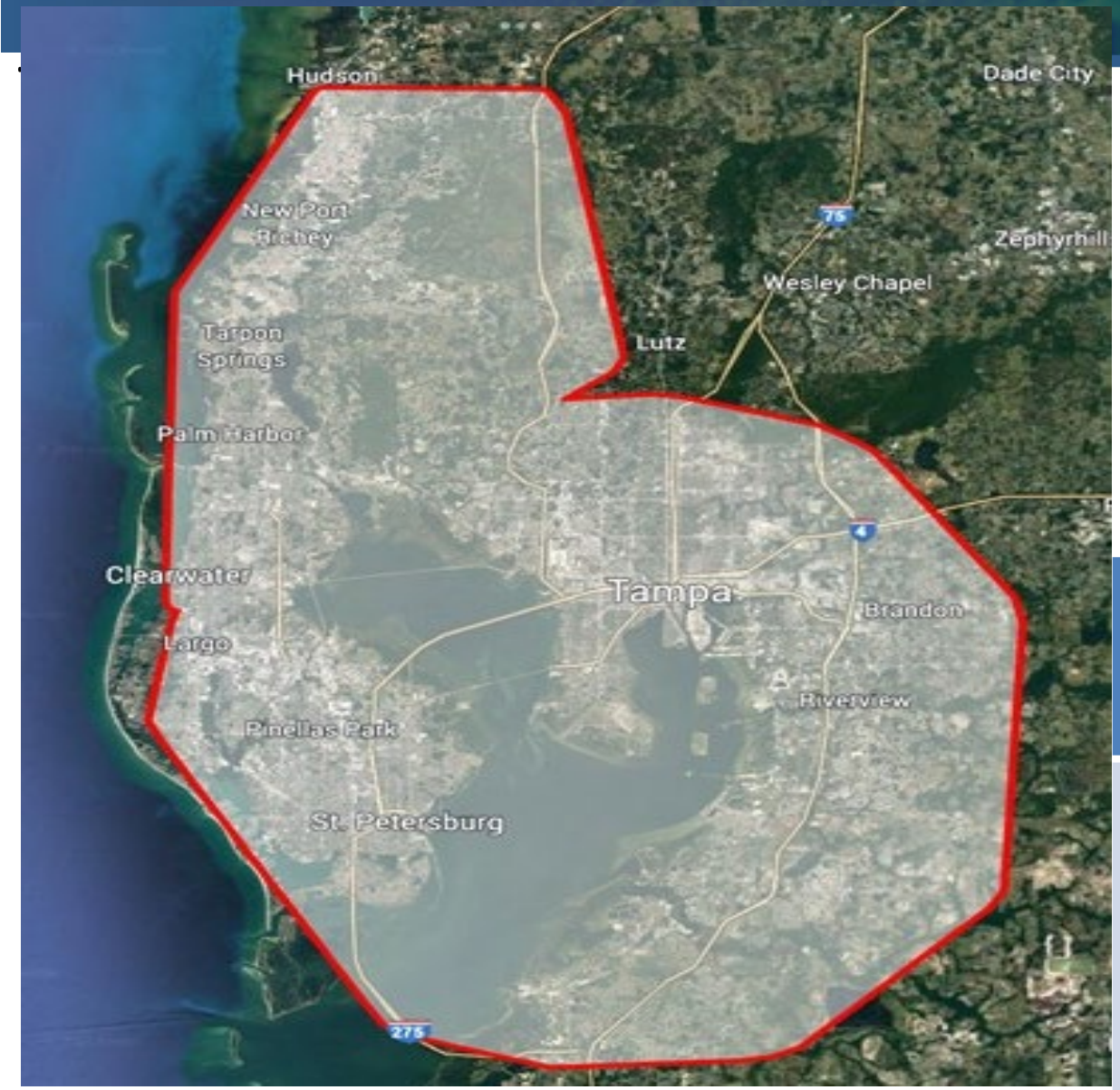
Waiver Filings

5.895-5.925 GHz C-V2X Waiver Requests Slide 2				
Filer	**Public Notice**	**Public Notice Date**	**Comments Due Date**	**Replies Due Date**
C-V2X Joint Waiver Parties (Audi, Ford, Jaguar Land Rover, UT DOT, VA DOT, AAEON Technology, Inc., Advantech Co., Ltd., Applied Information, Inc., Cohda Wireless Party Ltd., Comsignia, Inc., Danlaw, HARMAN Int'l Industries, Kapsch TrafficCom USA Inc., Panasonic Corp. of North America)	**DA 22-611**	June 7, 2022 87 FR 38403 (June 29, 2022)	July 28, 2022	August 29, 2022
Florida DOT (FL DOT)	**DA 22-617**	June 7, 2022 87 FR 49833 (Aug. 12, 2022)	Sept. 12, 2022	Oct. 11, 2022
Georgia DOT (GA DOT)	**DA 22-617**	June 7, 2022 87 FR 49833	Sept. 12, 2022	Oct. 11, 2022
Maryland DOT State Highway Admin. (MDOT SHA)	**DA 22-617**	June 7, 2022 87 FR 49833	Sept. 12, 2022	Oct. 11, 2022
Ohio DOT/Drive Ohio (OH DOT/Drive Ohio) New York City DOT (NYC DOT) Texas DOT (TX DOT) City of Arlington, TX North Central Texas Council of Governments Spoke Safety, LLC Hawaii DOT (HI DOT) Wyoming DOT (WY DOT) The Regents of the University of Michigan Locomation, Inc. Oregon DOT (OR DOT) Colorado DOT (CO DOT) New Jersey DOT City and County of Denver, CO	Pending			

Challenges with 33 dBm OBU power level

- LTE-V2X required to coexist with Department of Defense (DoD) radars in the 30 MHz
- Before issuing First Report and Order, FCC had NTIA run simulations using 23 dBm output power on OBUs
  - Need to update simulations to understand higher (33 dBm) output power effects on multiple types of military radars
  - Using 33 dBm for all OBUs appears to result in challenges with coexistence—likely to require at least 15 miles of separation from military radar sites
    - Immediate concerns with Florida, Nevada, California, Hawaii sites near well-used roadways
    - Potential concerns with Maryland, South Carolina, New Mexico
  - However, the 33 dBm request is more nuanced and the NTIA simulations can be reworked to reflect these nuances





V2X Project Title	RSU Locations (100 installations; more planned)
Downtown Tampa Autonomous Transit Project and Tampa Hillsborough Expressway Authority (THEA) Connected Vehicle Deployment	Downtown Tampa (Marion road, Polk street RR crossing) and Intersection of Twiggs Street & Meridian Ave at Reversible Express Lanes Entrance/Exit; Entry/Exit Points Along Selmon Expressway and Reversible Express Lanes (REL); Midblock of Twiggs Street at Hillsborough County Courthouse

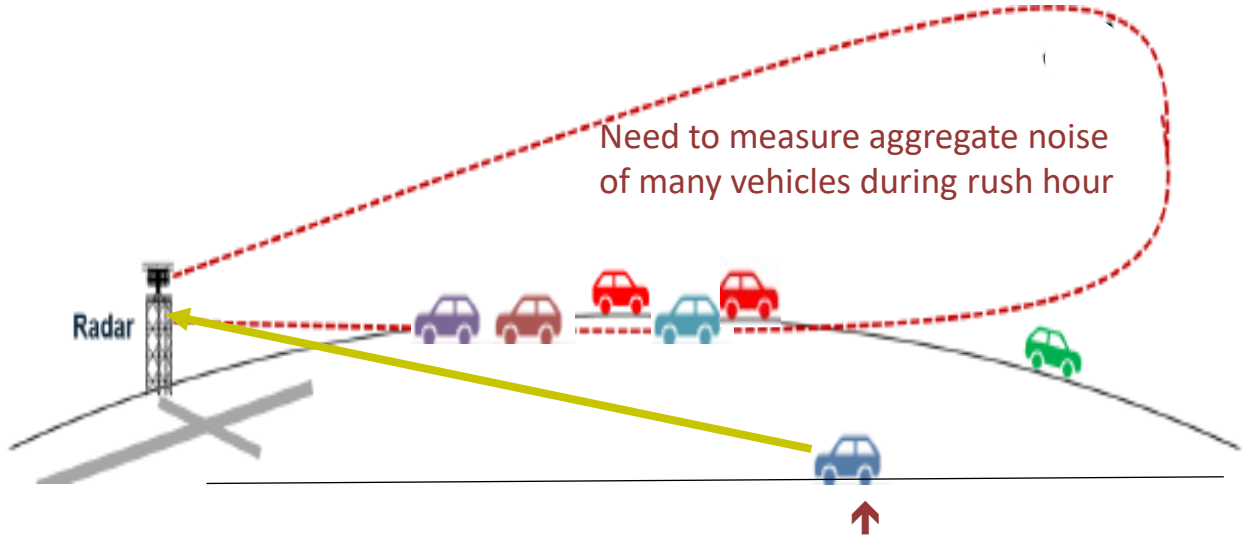
Military Site	Adjacent Interstates, State Routes, and Major Arterials	Estimated Traffic Counts (highs/lows, time of day, road segment length
NavAir Command Center, 6th Force Security Squadron, NTIA Report Pg 41 and MacDill AFB (see NTIA Report Pg. 47)	Routes 60, 92, 93, 600, 686, 699 Interbay Blvd, Selmon Expressway, Interstate 275, US-41	Route 60: H: 3,887 L: 1,792 Route 92: H: 5,100 L: 2,500 Route 93: H: 6,068, L: 2,913 Route 600: H 4,896 L: 2,219 Route 686: H: 2,752, L: 1,059 Route 699: H: 2,509 L: 1,222 Interstate 75 Interchange: H: 73,509 (Wed), Low (Sun): 60,517 US-41: H: 2,664 L: 1,325

NTIA Simulations

- NTIA has deep experience with modeling other communications in the presence of military radar. If interested:
  - NTIA Report TR-06-444 Effects of RF Interference on Radar Receivers
- NTIA relies on ITU Recommendations and best practices. If interested:
  - Technical and operational characteristics and protection criteria of radiodetermination radars in the frequency band 2 900-3 100 MHz; M Series; Mobile, radiodetermination, amateur and related satellite services; Recommendation ITU-R M.1460-2 (02/2015)
  - Procedures for determining the potential for interference between radars operating in the radiodetermination service and systems in other services; M Series; Mobile, radiodetermination, amateur and related satellite services; Recommendation ITU-R M.1461-2 (01/2018)
  - Performance measurements of interference into one example of a Radar operating under the aeronautical radionavigation service in the frequency band 2700-2900 MHz; M Series; Mobile, radiodetermination, amateur and related satellite services; Report ITU-R M.2414-0 (11/2017)
  - NTIA Report TR-06-444 Effects of RF Interference on Radar Receivers
- NTIA has modeled DSRC in the presence of military radar (with US DOT inputs). If interested:
  - NTIA Report 98-352 ELECTROMAGNETIC COMPATIBILITY TESTING OF A DEDICATED SHORT-RANGE COMMUNICATION SYSTEM
- NTIA recently modeled LTE-V2X @ 23 dBm in the presence of military radar (with US DOT inputs). If interested:
  - NTIA Technical Report 21-551 Compatibility of Federal Systems Operating in the 5850-5925 MHz Band with Intelligent Transportation Systems and Unlicensed National Information Infrastructure Devices

LTE-V2X is a complex technology

- NTIA is working with US DOT and industry member (WBK Law, Qualcomm, and Ford) to revise assumptions about LTE-V2X regarding:
  - Input power from device into antenna
  - Cable loss
  - Antenna gain
  - Duty Cycle
  - Channel usage/channel loads when congested
  - Traffic patterns/traffic counts during rush hour around military bases using land/terrain assumptions from previous modeling and ITU (looking at # of vehicles in 100-meter radius)



Potential Paths Forward with Simulation Results

- If reworked simulation results are positive with new assumptions, next step is gain concurrence from FCC and DoD and then work with FCC on waiver technical and operational service rules.
- If the results continue to suggest problems with coexistence, we (as an ITS community) may need to consider options with FCC:
  1. **Request that IOOs be allowed to deploy RSUs @ 33 dBm EIRP, with any OBUs @ 20 dBm maximum input power to the antenna terminal with nominal 3 dBi antenna gain (23 dBm EIRP), similar to FCC's streamlined language**
     - Leave Joint Waiver filing open so that the OBU @ 33 dBm directionally focused EIRP power can be further considered.
  2. Remain in "pending" mode and conduct more research/testing…potentially in direct line-of-sight with a military radar and/or with radar waveforms (which would require having DoD grant "test time")
  3. Request that IOOs be allowed to deploy only RSUs and leave the OBU request pending
  4. Other options??? (STAs)

Status and Next Steps

- NTIA is reworking the assumptions and reconfiguring the model
- U.S. DOT will be rerunning the simulations through December; hope to see results in early January
- Expect to meet with DoD and FCC to discuss results and next steps
  - Will be discussing the changes with FCC on December 14th to ensure that they agree with the reconfigurations
  - Will then have to present to DoD for concurrence
- If reworked simulations @ 33 dBm are acceptable, work with FCC on national waiver rules
- If reworked simulations @ 33 dBm are not acceptable, reconvene stakeholders to consider optional paths forward

Engagement Opportunities

- **December 14, 2022:** The US DOT V2X Spectrum and the FHWA Connected Vehicle Pooled Funds Study (CVPFS) meet to discuss pending waivers and ongoing activities (similar to this discussion).
- **January 9, 2023:** The ITS JPO will present on ongoing V2X communications activities during Transportation Research Board Session 2115, "*State of the Intelligent Transportation Systems*" (presented by Egan Smith, Acting Director, ITS JPO) at the TRB Annual Meeting; 1:30-3:15PM in Salon C of the Washington Convention Center.
- **January 9, 2023:** The US DOT V2X Spectrum team will host **open conversations from 3:30-5:00 PM in the TRB Convention Center Conference Room #302** with TRB meeting participants to gather additional inputs. Discussions will also focus on next steps and ideas for a follow-up engagements leading to another full Summit 2.0 for formulating a notional National Vision and Deployment Strategies.
- If you want further information on any of the activities listed here, please submit an email to 5.9ghzspectrum@dot.gov.