




V2X Training and Technical Assistance

CV Pooled Fund Study (CV PFS) Annual Meeting

December 3, 2024

U.S. Department of Transportation

Accelerating V2X Cohort

- A community of practice of active deployers working together to accelerate the adoption and deployment of interoperable V2X technologies.
- Members are encouraged to share their experiences, challenges, best practices, and documentation for the purpose of addressing technical implementation questions among cohort members.
- Members are limited to infrastructure owners and operators.

Accelerating V2X Cohort | Federal Team

- ITS Joint Program Office (JPO)
- FHWA Office of Operations
- FHWA Resource Center
- FHWA Division Offices
- Turner-Fairbank Highway Research Center (TFHRC)

The USDOT's **V2X Support Services** team provides infrastructure owner operators (IOOs), equipment manufacturers, and device vendors with technical assistance and equipment loans to support V2X deployments. For more information, email CAVSupportServices@dot.gov .


Seattle
NDOT
marysville
CITY OF DUBLIN, OHIO
1810
STATE OF OHIO DEPARTMENT OF TRANSPORTATION
nittec
Travel Smart.
MaineDOT
KENTUCKY TRANSPORTATION CABINET
W
CITY OF BELLEVUE WASHINGTON
UMTRI
MDOT
LakeCounty
Division of Transportation
MoDOT
PENNA TURN PIKE
DelDOT
UDOT
Keeping Utah Moving
Oregon Department of Transportation
DENVER
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CDOT
WYOMING TRANSPORTATION DEPARTMENT
DEPARTMENT OF TRANSPORTATION
THE STATE OF NEW JERSEY
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MARYLAND DEPARTMENT OF TRANSPORTATION
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DEPARTMENT OF TRANSPORTATION
STATE OF HAWAII
BALTIMORE COUNTY MARYLAND
MARICOPA COUNTY TRANSPORTATION
CVAG
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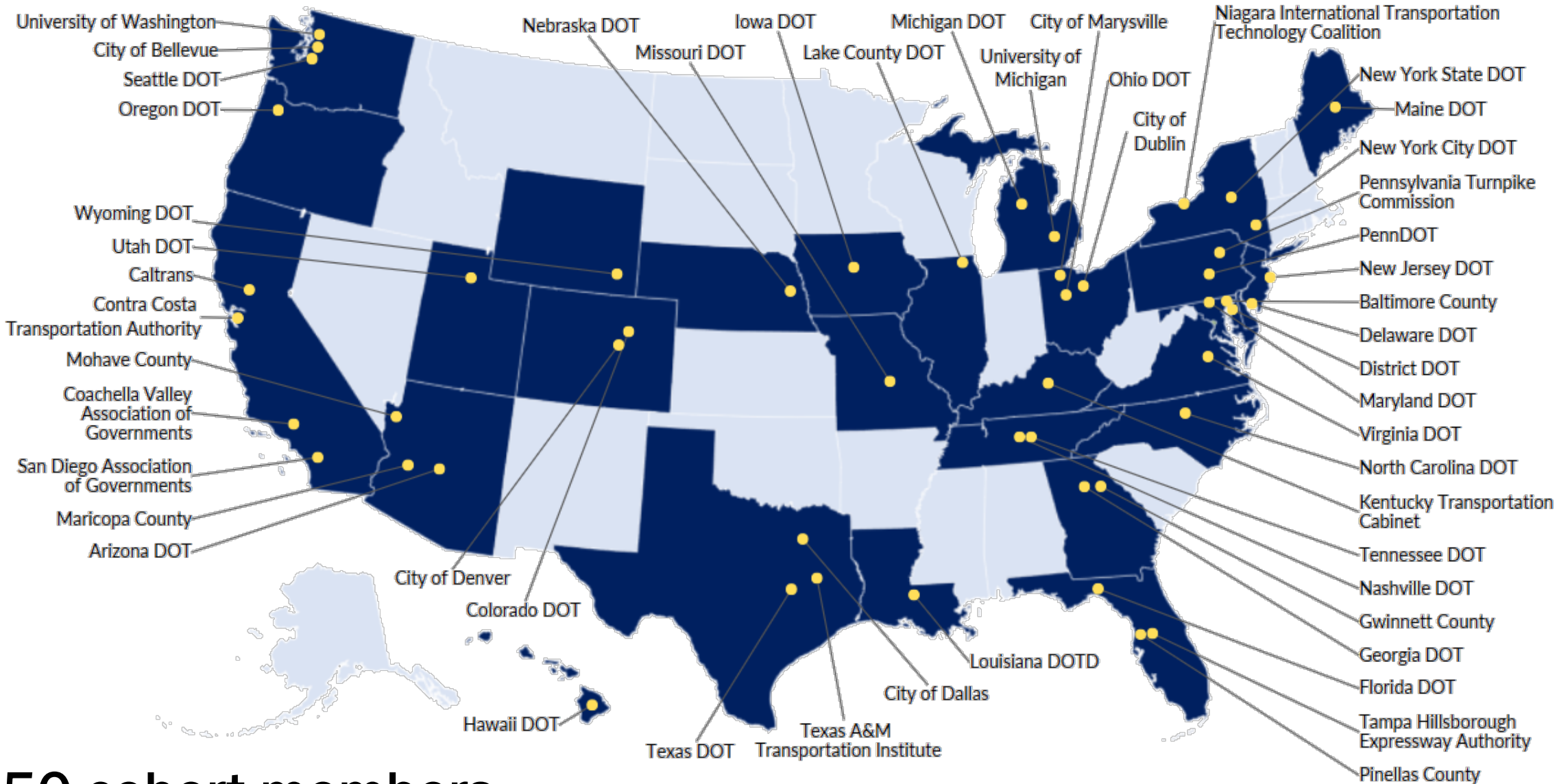
City of Dallas
Texas Department of Transportation
NEW YORK CITY DOT
Gwinnett
Pinellas County
SANDAG
d.
District Department of Transportation
Texas A&M Transportation Institute
FDOT
TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY



50 cohort members

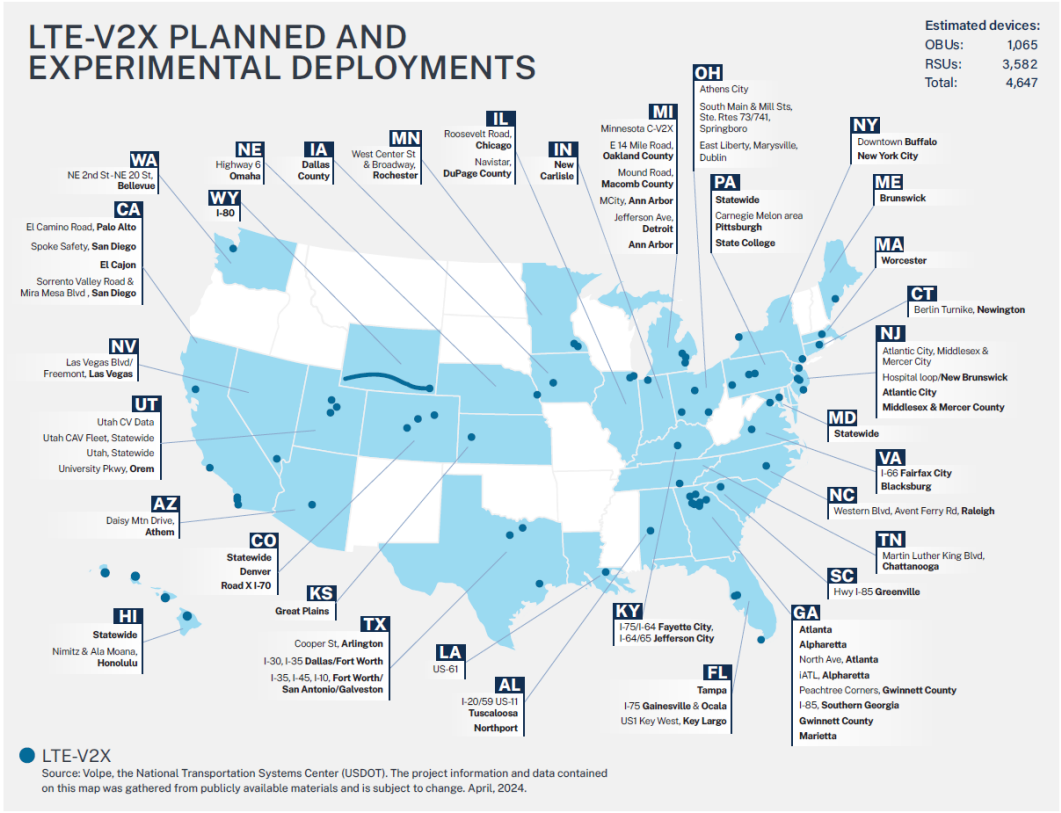
Moving Forward

- What to expect in 2025:
  - Leverage insights and technical lessons from deployers including V2X Accelerator Sites
  - Internal presentations from cohort members
  - Opportunities for external / public webinars to inform the industry
  - Updates on USDOT resources and tools
  - Continued collaboration with the Technical Working Group for Interoperability Tests
- For more information or to join the Accelerating V2X Cohort, contact john.schneeberger@dot.gov.

Initial Prototype V2X Deployment Map

A “comprehensive” online tool to track V2X deployments including:

- Agencies deployment V2X
- V2X Projects
- Roadside Unit (RSUs)
- Fleet onboard units (OBUs)
- V2X Applications
- Other information

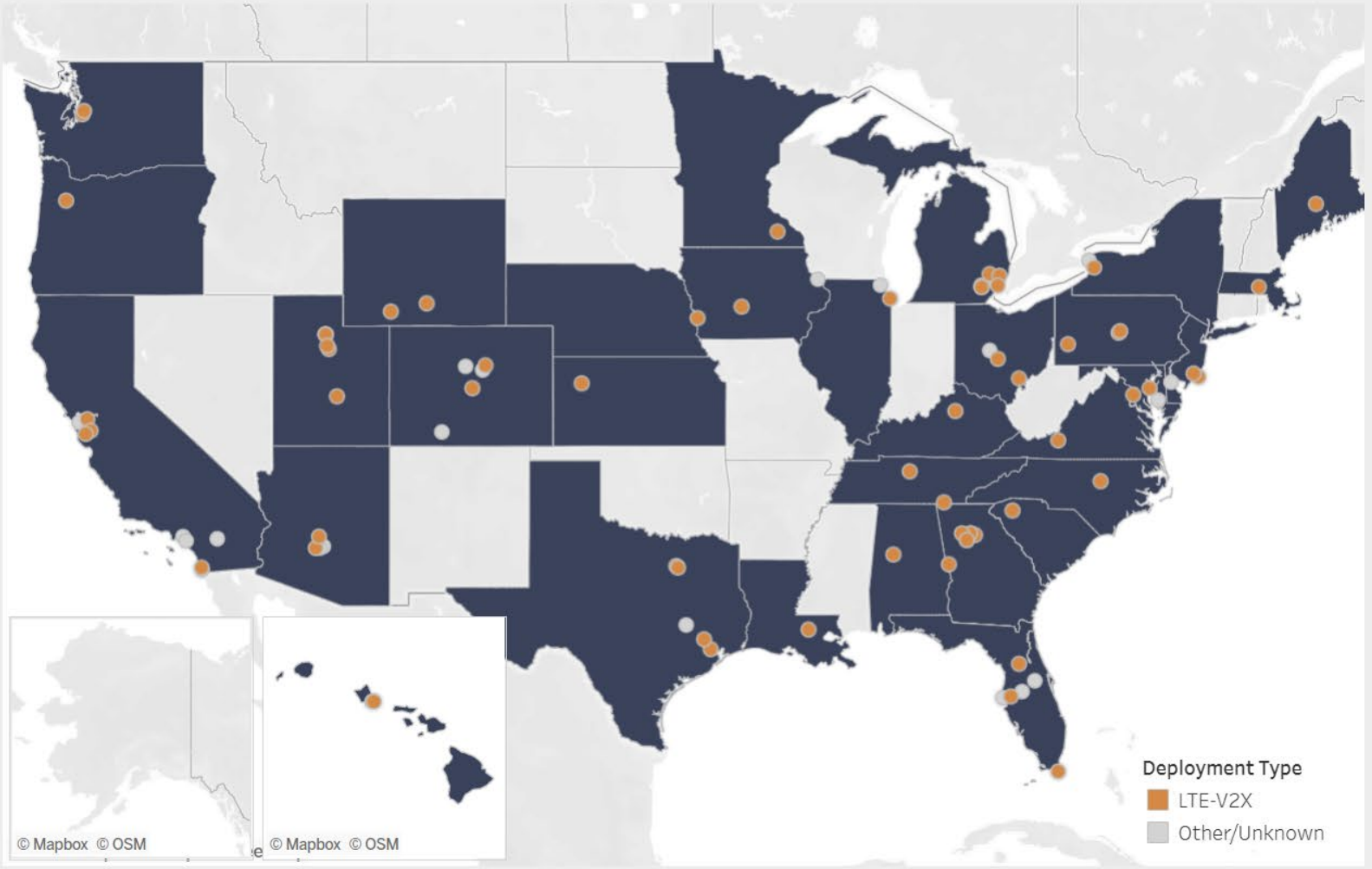


Vehicle-to-Everything (V2X) Deployments

V2X Applications | Licensing and Devices

Click a state to view more details

October 22, 2024



Click switch to filter dashboard

All Deployments | Cohort Members

Estimated V2X Devices

Roadside Units (RSUs) XX

Onboard Units (OBUs) XX

XX
States Deploying V2X Technologies

XX
Agencies Deploying V2X Technologies

XX
Number of V2X Projects

XX
Number of FCC Licenses

V2X Deployment Map Tool

- An *Initial* Prototype Map was developed in Tableau; a more robust tool will be developed.
- The tool is only as good as its data – we know we have gaps!
  - Initial data based on:
    - Volpe V2X Deployment Tracking Map
    - USDOT Grants (SMART, ATCMTD, ATTAIN)
    - FCC Universal Licensing System (ULS)
    - Initial Accelerating V2X Data Calls
- The initial prototype map has been shared with a variety of entities for input.

ITS AMERICA

ALLIANCE FOR AUTOMOTIVE INNOVATION

5GAA Automotive Association

Feedback Received to Date

- Consider how to differentiate between corridor deployments, and different size/scale of deployments.
- Account for (and differentiate between) planned and operational deployments.
- Look beyond federally funded projects to include state/region/city sponsored activities.
- Include Network V2X solutions across the U.S.
- To track progress toward National V2X Deployment Plan milestones, identify and track metrics such as the percentage of intersections covered by V2X, etc.
- Contact RSU and OBU suppliers to gather data on quantities and deployments.
- Contact consulting firms to gain greater insight into V2X deployments across their clients' networks.

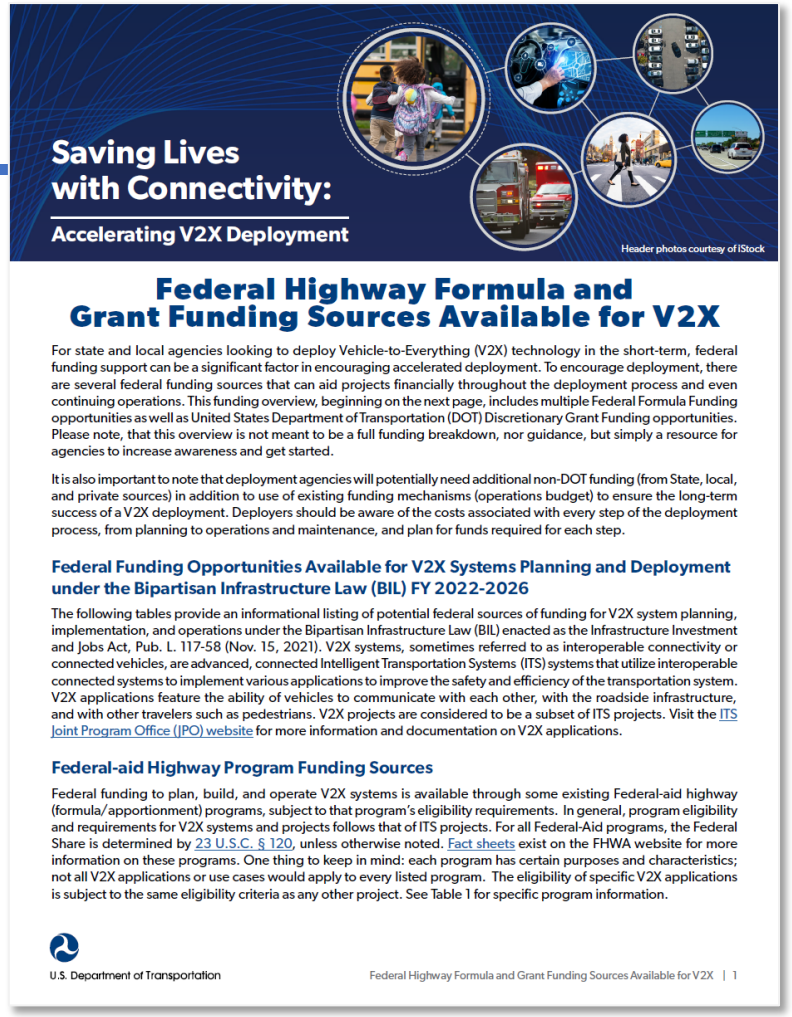
Data Collection and Verification

1. Start with Cohort Members (and other IOOs)!
2. Provide each agency with a spreadsheet to provide inputs or verify the data. The data call will be used to clarify ambiguities related to deployments/projects, deployed/planned RSUs and OBUs, and V2X applications.
3. If requested, USDOT can schedule a meeting to walkthrough the spreadsheet with each agency.
4. For agencies that provide input, your agency will be marked as verified on the V2X Deployment Map.

Federal Highway Formula and Grant Funding Sources

- Provides an informational listing of potential federal sources of funding for V2X system planning, implementation, and operations under the Bipartisan Infrastructure Law (BIL) enacted as the Infrastructure Investment and Jobs Act, Pub. L. 117-58 (Nov. 15, 2021).
- V2X projects are considered a subset of ITS.
  - Federal-aid Highway Program Funding Sources
  - Discretionary Grant Funding Sources

https://its.dot.gov/scrc/index.html#/ic



Saving Lives with Connectivity:

Accelerating V2X Deployment

Header photos courtesy of iStock

Federal Highway Formula and Grant Funding Sources Available for V2X

For state and local agencies looking to deploy Vehicle-to-Everything (V2X) technology in the short-term, federal funding support can be a significant factor in encouraging accelerated deployment. To encourage deployment, there are several federal funding sources that can aid projects financially throughout the deployment process and even continuing operations. This funding overview, beginning on the next page, includes multiple Federal Formula Funding opportunities as well as United States Department of Transportation (DOT) Discretionary Grant Funding opportunities. Please note, that this overview is not meant to be a full funding breakdown, nor guidance, but simply a resource for agencies to increase awareness and get started.

It is also important to note that deployment agencies will potentially need additional non-DOT funding (from State, local, and private sources) in addition to use of existing funding mechanisms (operations budget) to ensure the long-term success of a V2X deployment. Deployers should be aware of the costs associated with every step of the deployment process, from planning to operations and maintenance, and plan for funds required for each step.

Federal Funding Opportunities Available for V2X Systems Planning and Deployment under the Bipartisan Infrastructure Law (BIL) FY 2022-2026

The following tables provide an informational listing of potential federal sources of funding for V2X system planning, implementation, and operations under the Bipartisan Infrastructure Law (BIL) enacted as the Infrastructure Investment and Jobs Act, Pub. L. 117-58 (Nov. 15, 2021). V2X systems, sometimes referred to as interoperable connectivity or connected vehicles, are advanced, connected Intelligent Transportation Systems (ITS) systems that utilize interoperable connected systems to implement various applications to improve the safety and efficiency of the transportation system. V2X applications feature the ability of vehicles to communicate with each other, with the roadside infrastructure, and with other travelers such as pedestrians. V2X projects are considered to be a subset of ITS projects. Visit the ITS Joint Program Office (JPO) website for more information and documentation on V2X applications.

Federal-aid Highway Program Funding Sources

Federal funding to plan, build, and operate V2X systems is available through some existing Federal-aid highway (formula/apportionment) programs, subject to that program's eligibility requirements. In general, program eligibility and requirements for V2X systems and projects follows that of ITS projects. For all Federal-Aid programs, the Federal Share is determined by 23 U.S.C. § 120, unless otherwise noted. Fact sheets exist on the FHWA website for more information on these programs. One thing to keep in mind: each program has certain purposes and characteristics; not all V2X applications or use cases would apply to every listed program. The eligibility of specific V2X applications is subject to the same eligibility criteria as any other project. See Table 1 for specific program information.

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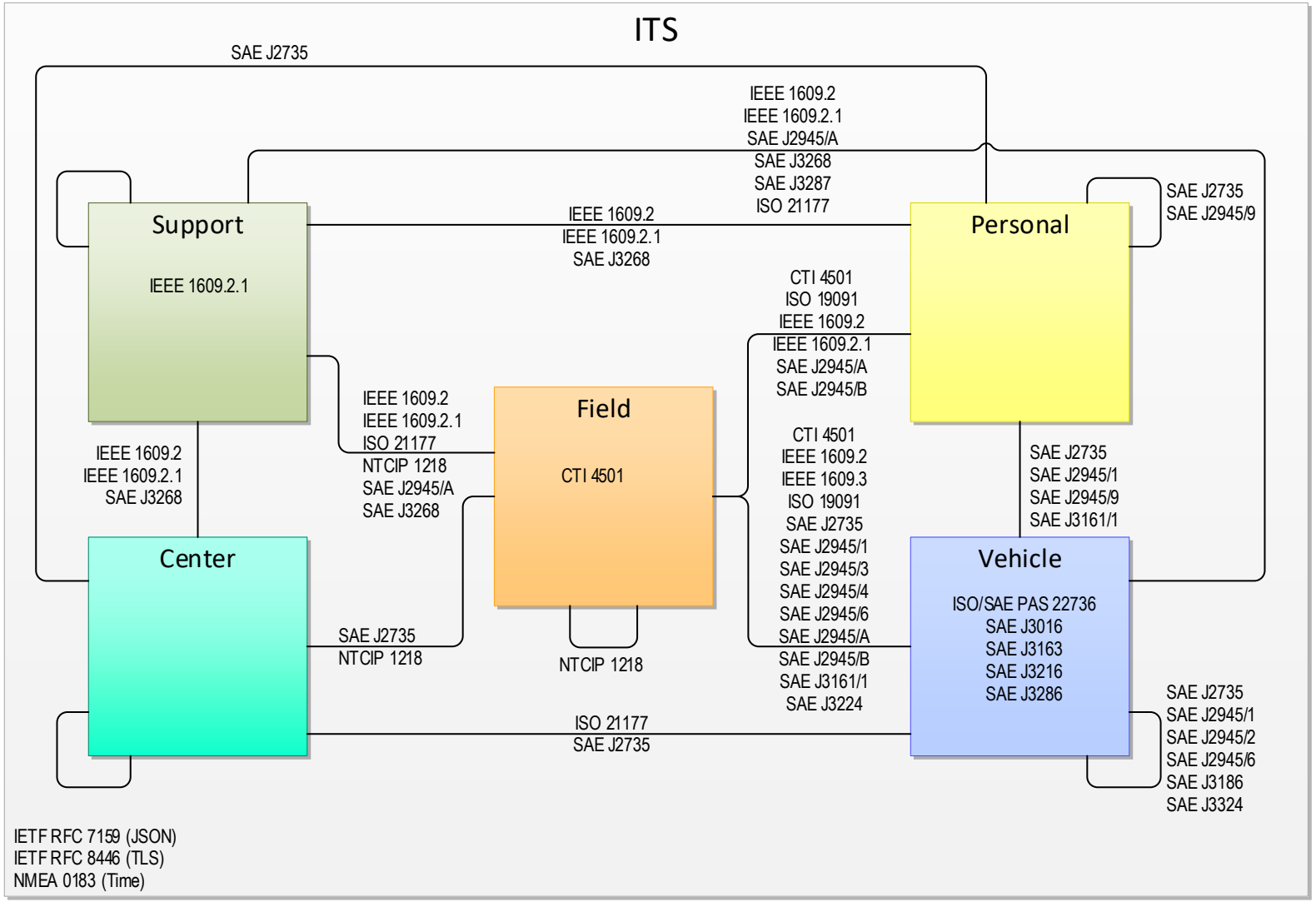
Federal Highway Formula and Grant Funding Sources Available for V2X | 1

V2X Standards Taxonomy

V2X Standards



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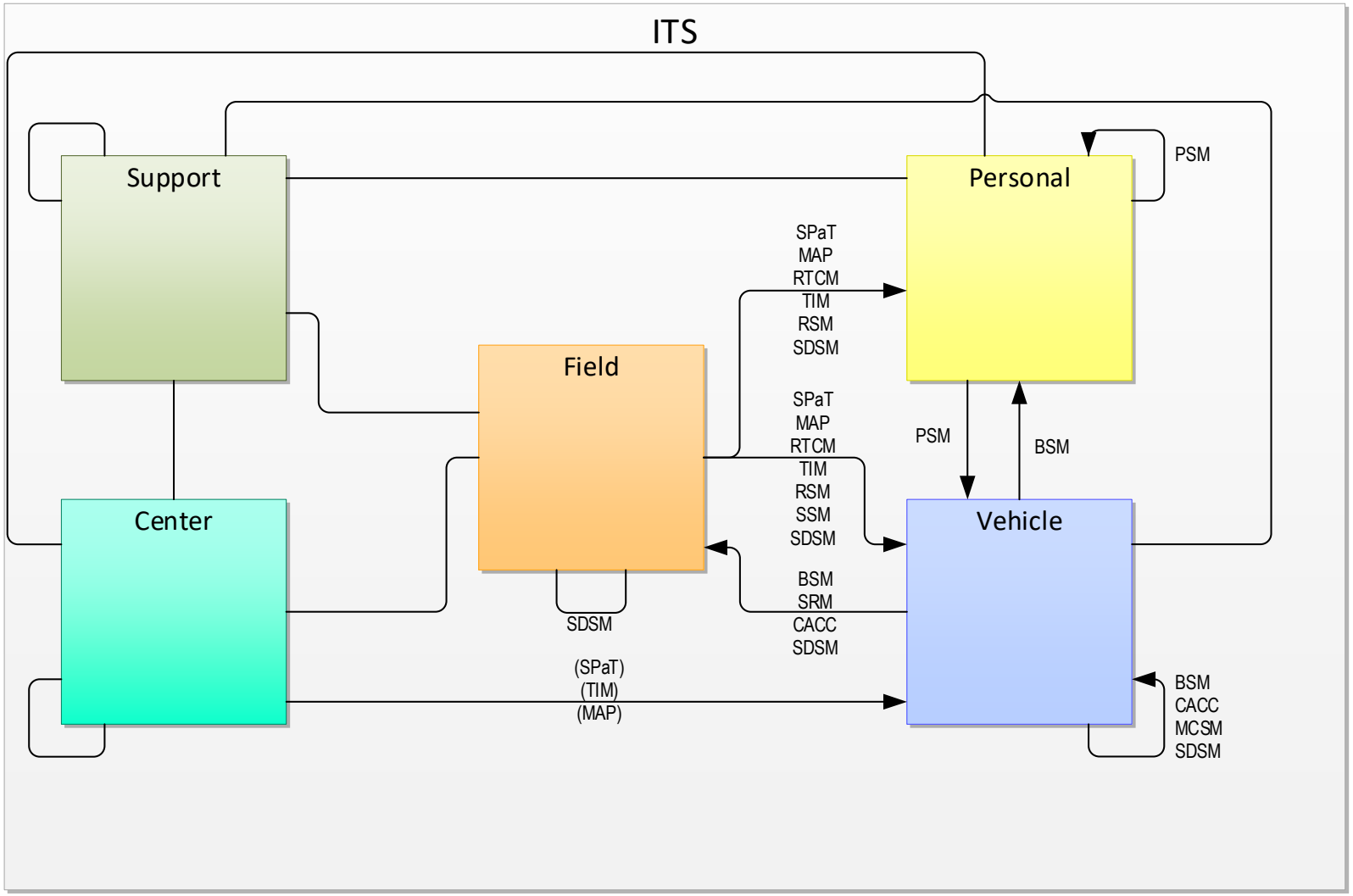
V2X Standards Taxonomy

V2X Messages



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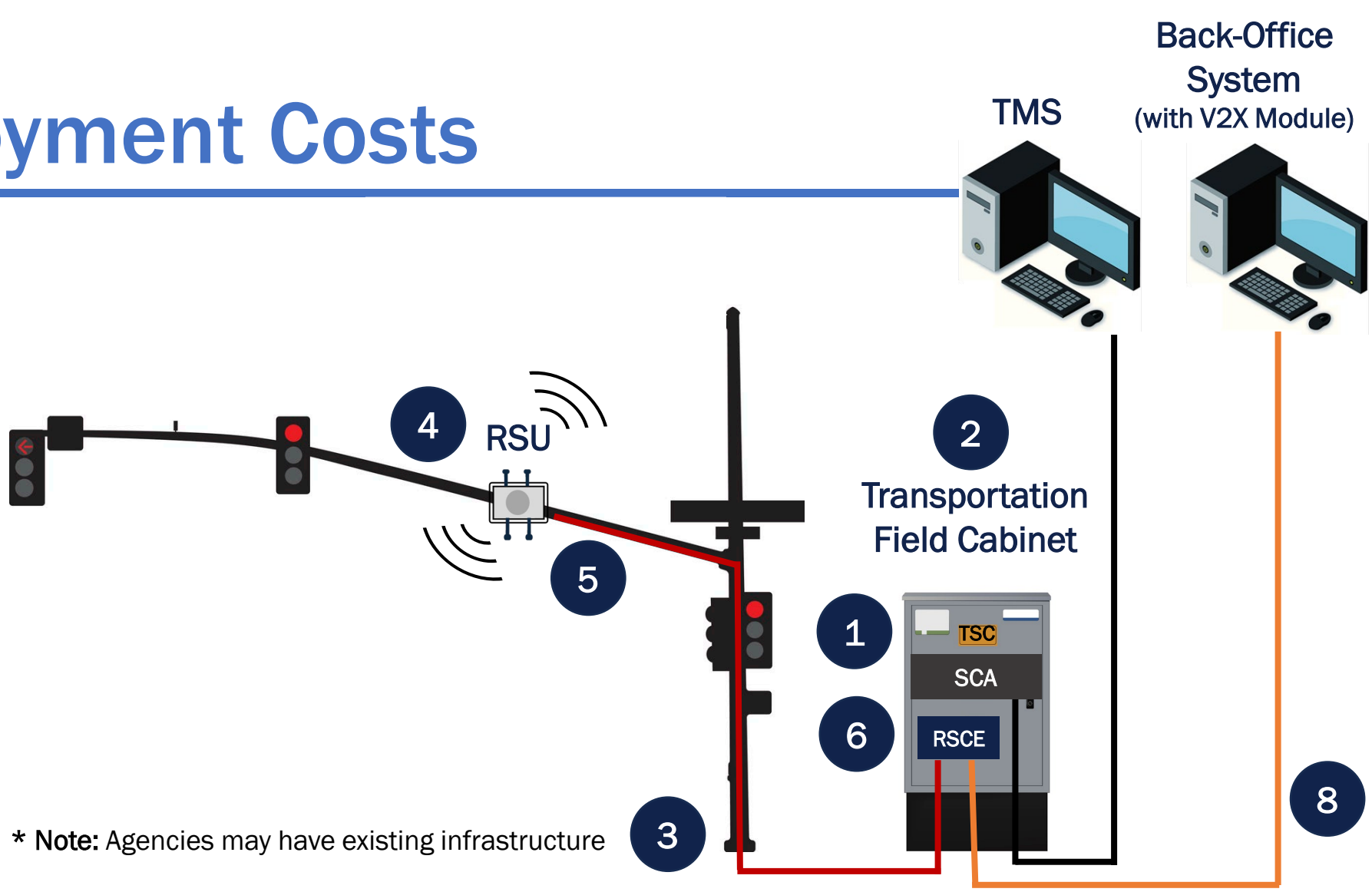
RSU Deployment Costs

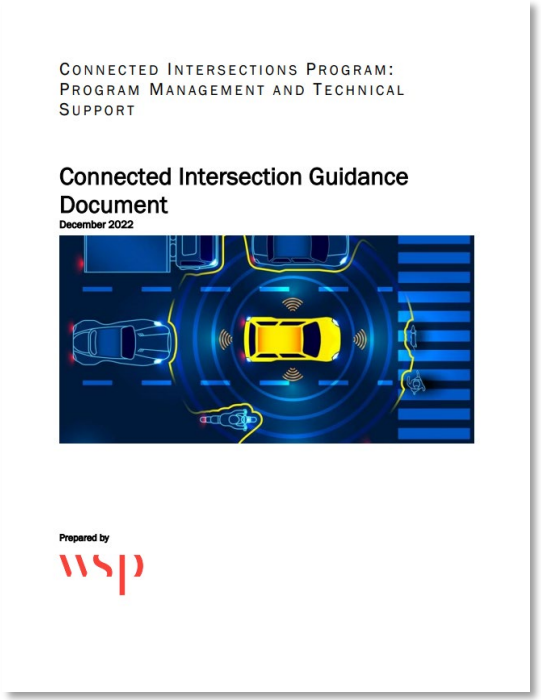
1	Traffic Signal Controller (TSC) - Upgrade * Cost: $2,000 to $4,000
2	Field Cabinet* Cost: $8,000 to $10,000
3	Pole* Cost: $XX to $YY
4	Roadside Unit (RSU) Cost: $2,800 to $4,000
5	RSU Mounting and Wiring Cost: $XX to $YY
6	Local Processing Cost: $XX to $YY
7	Power* Cost: $XX to $YY
8	Communications* Cost: $XX to $YY



* **Note:** Agencies may have existing infrastructure

V2X Deployment Costs Considerations

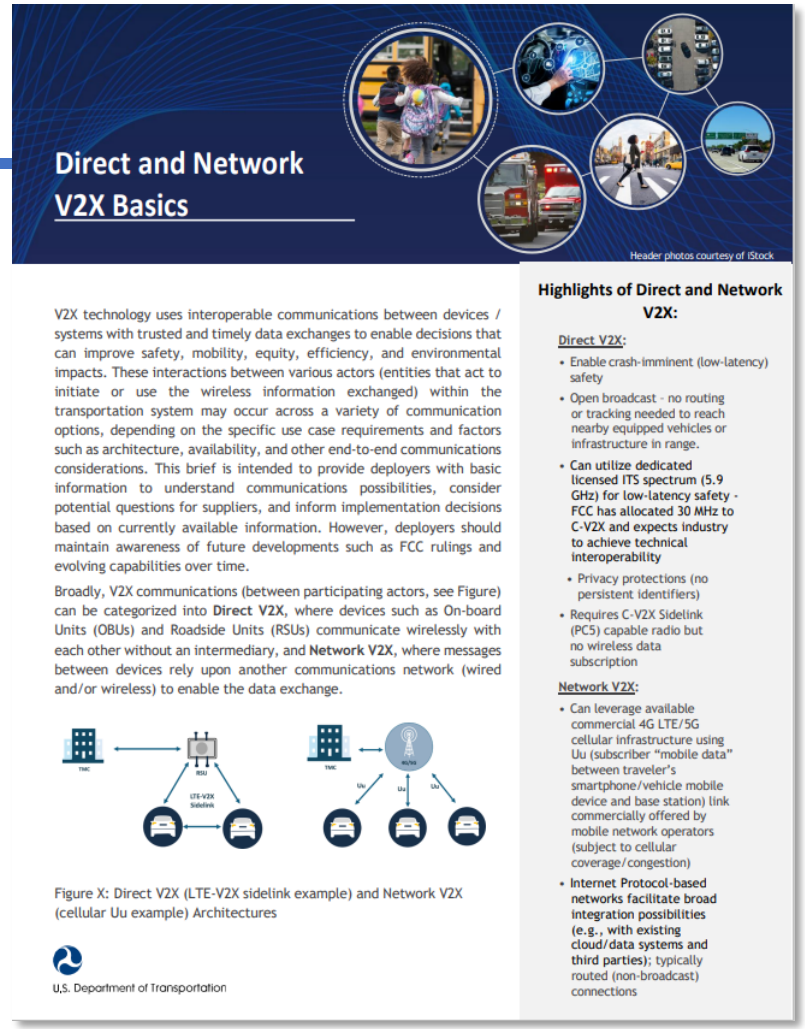
- Site Preparation and Readiness Assessment
- Obtaining a Federal Communications Commission (FCC) License
- Roadside Unit (RSU) Design
- Development of Procurement Documents
- Device Installation and Configuration
- Integration with Traffic Control Software (TCS)
- SCMS Services (certificates, enrollment, maintenance)
- Testing
- V2X Data Storage
- Operations and Maintenance (~20% of deployment cost)
  - SPaT, MAP, and RTCM Messages
  - Message Verification
  - Asset Management



Direct Users to the CI Guidance Document – and other key resources!

Other V2X Resources

- National V2X Deployment Plan Supplement – **Coming Soon!**
- V2X Deployer Resource Guide – **Coming Soon!**
- One-Pagers / Fact Sheets in Development
  - Direct and Network V2X
  - Roadside Unit (RSU) Costs
  - V2X for Transit
  - Other Outreach and Communications Materials (being developed by ITS America)



Direct and Network V2X Basics

Header photos courtesy of iStock

V2X technology uses interoperable communications between devices / systems with trusted and timely data exchanges to enable decisions that can improve safety, mobility, equity, efficiency, and environmental impacts. These interactions between various actors (entities that act to initiate or use the wireless information exchanged) within the transportation system may occur across a variety of communication options, depending on the specific use case requirements and factors such as architecture, availability, and other end-to-end communications considerations. This brief is intended to provide deployers with basic information to understand communications possibilities, consider potential questions for suppliers, and inform implementation decisions based on currently available information. However, deployers should maintain awareness of future developments such as FCC rulings and evolving capabilities over time.

Broadly, V2X communications (between participating actors, see Figure) can be categorized into **Direct V2X**, where devices such as On-board Units (OBUs) and Roadside Units (RSUs) communicate wirelessly with each other without an intermediary, and **Network V2X**, where messages between devices rely upon another communications network (wired and/or wireless) to enable the data exchange.

Figure X: Direct V2X (LTE-V2X sidelink example) and Network V2X (cellular Uu example) Architectures

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Highlights of Direct and Network V2X:

Direct V2X:

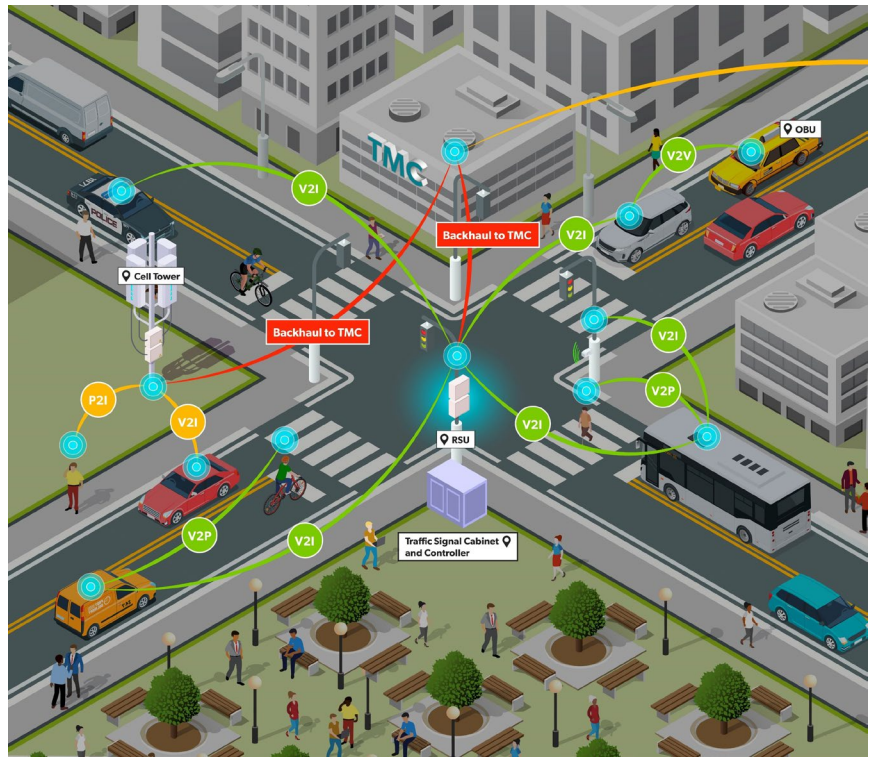
- Enable crash-imminent (low-latency) safety
- Open broadcast – no routing or tracking needed to reach nearby equipped vehicles or infrastructure in range.
- **Can utilize dedicated licensed ITS spectrum (5.9 GHz) for low-latency safety - FCC has allocated 30 MHz to C-V2X and expects industry to achieve technical interoperability**
- Privacy protections (no persistent identifiers)
- Requires C-V2X Sidelink (PC5) capable radio but no wireless data subscription

Network V2X:

- Can leverage available commercial 4G LTE/5G cellular infrastructure using Uu (subscriber "mobile data" between traveler's smartphone/vehicle mobile device and base station) link commercially offered by mobile network operators (subject to cellular coverage/congestion)
- **Internet Protocol-based networks facilitate broad integration possibilities (e.g., with existing cloud/data systems and third parties)**; typically routed (non-broadcast) connections

Foundational V2X Training

- Equip participants with a basic understanding of V2X concepts:
  - Introduce key components that enable a vehicle-to-everything (V2X) ecosystem
  - Discuss potential benefits of the technology
  - Provide an overview of example use cases, messages, and standards while ensuring security and privacy
- Intended for participants that are new to V2X, as well as individuals interested in refreshing their knowledge of key V2X concepts.



Summary of Foundational V2X Training

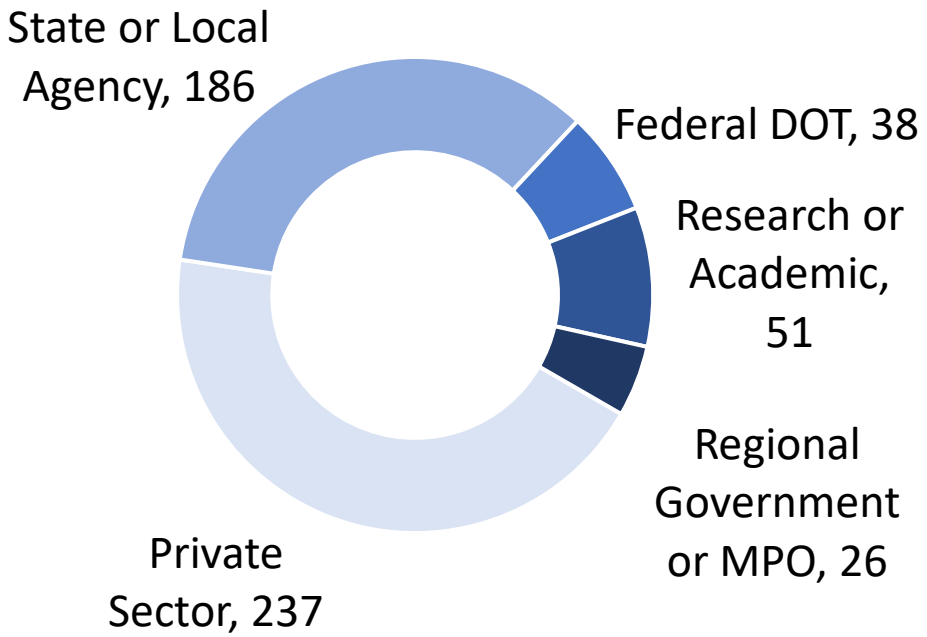
As of 11/25/2024…

11 trainings delivered

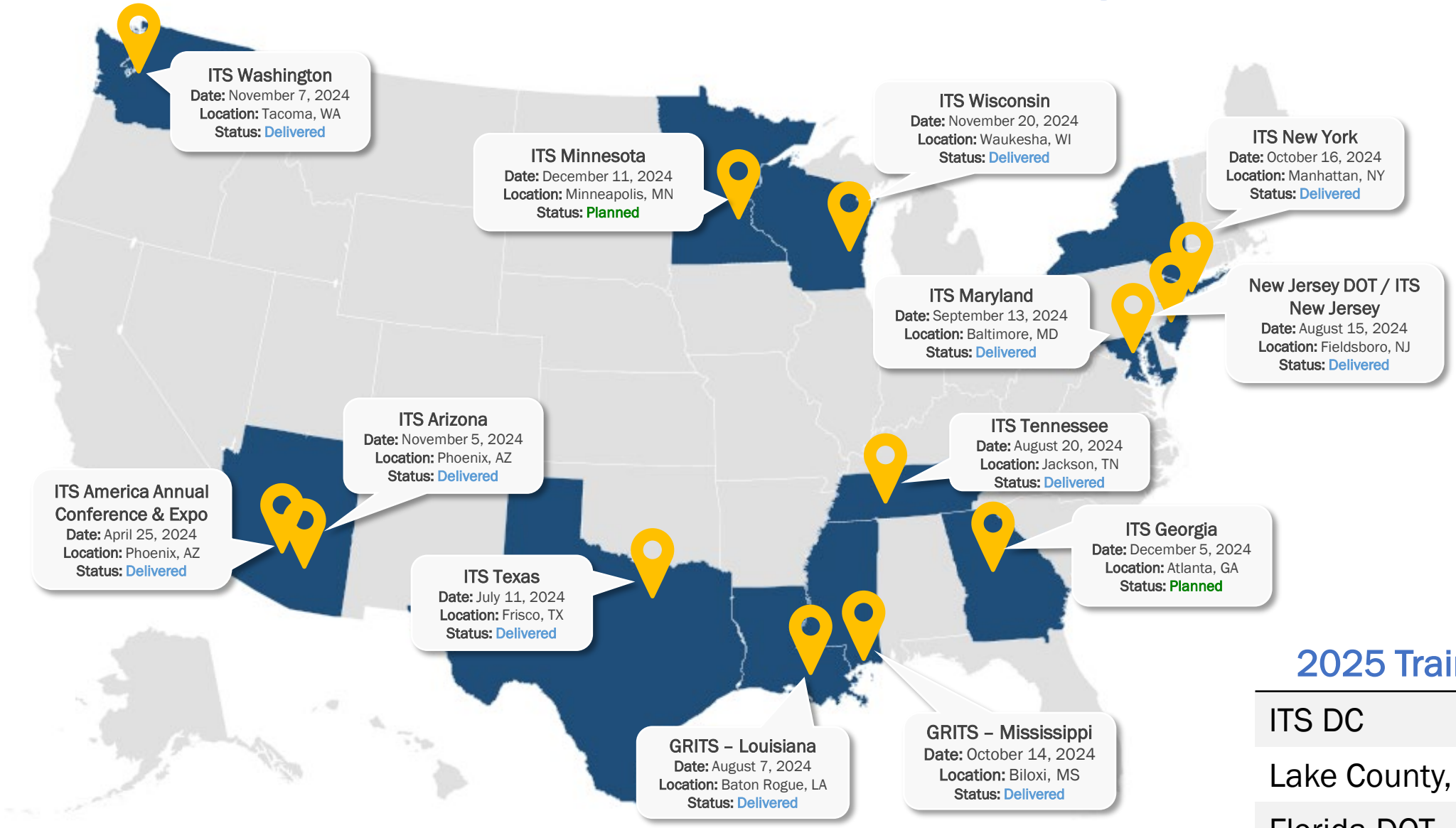
- 2 planned for December
- Several requests in 2025

538 participants trained

4.7/5 average evaluation



Foundational V2X Training Delivery



2025 Training Requests

ITS DC
Lake County, Illinois
Florida DOT

Feedback: V2X Training Evaluations

"Great introductory course, now have fundamental knowledge about V2X."

❖ Participant from Gulf Region ITS training event - 08/07/24

"Content was well prepared, good for those with limited knowledge; format was good balance of formal & informal."

❖ Participant from ITS Maryland training event - 09/13/24

"Very informative course. Gives an idea what all goes into safety. Very interactive."

❖ Participants from ITS New York training event - 10/16/24

"Content good for beginners. Topics were new but easy to follow. Basic comprehensive material of V2X."

❖ Participants from ITS Tennessee training event - 08/20/24

"Great examples from real-world deployments. Interactive and easy to follow."

❖ Participants from 2024 ITSA Annual Conference

"Content dove deep enough to provide clarity of understanding while still maintaining a course breadth of coverage."

❖ Participant from ITS New Jersey training event - 08/15/24

"Updated my understanding of CV technology, especially with reference to CV2X."

❖ Participant from ITS New Jersey training event - 08/15/24

"All information was valuable, and instructors were very knowledgeable and experienced."

❖ Participant from Gulf Region ITS training event - 10/14/24

"Good introduction into basics and foundations. Comprehensive learning opportunity."

❖ Participants from ITS Texas training event - 07/11/24

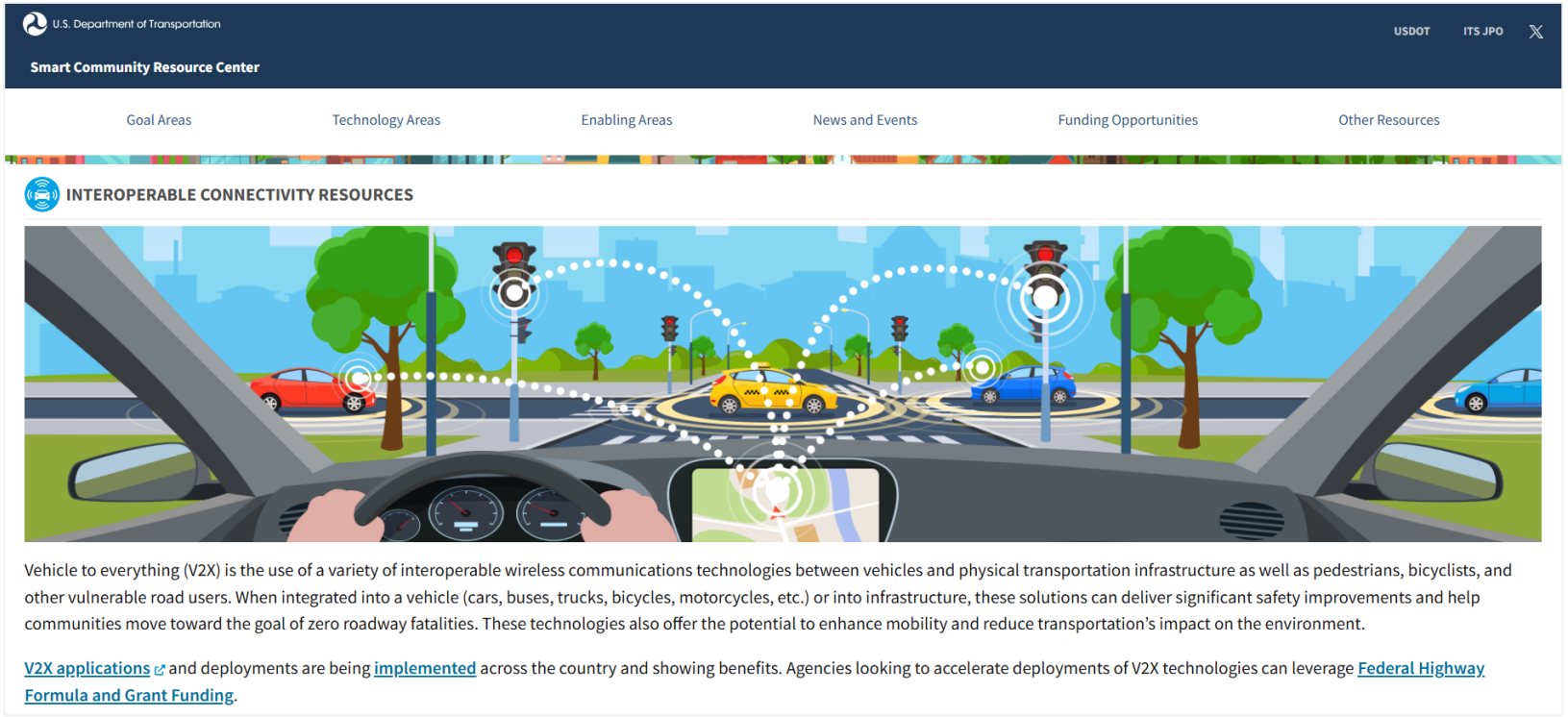
Feedback: Suggested Future Topics

Suggested Topic	Responses
Challenges & Limitations	2
Communication Technologies	5
FCC/V2X History & International Perspective	3
Guidance Documents	2
V2X Device Deployment & Integration	6
Live Demonstrations	13
More Technical Trainings	3
More Use Cases	6
OEM Related Information	2
Operations & Maintenance	1
Other Topics	3
SCMS Certificates	1
Standards	2
V2X Tools (e.g., MAP, SPaT, etc.)	8

Initial Thoughts for a "V2X 201" Training

Overview	An interactive, hands-on training to assist infrastructure owners and operators (IOOs) in planning, acquiring, installing, configuring, testing, validating, and maintaining V2X equipment (i.e., RSUs)
Format	Primers/guidance documents (promote existing resources!) and instructor-led training modules
Target Audience	IOOs and their consultants/technicians
Hands on Experience	• RSU configuration • MAP/SPaT/TIM creation • Message validation
Essential Resources	• Connected Intersection Guidance Document (developed by CV PFS) • Connected Intersections Implementation Guide (CTI 4501) • Roadside Unit (RSU) Standard (CTI 4001)

SCRC: Interoperable Connectivity (V2X)



www.its.dot.gov/scrc/index.html#/ic

Summary and Discussion

1. Contact J.D. Schneeberger (john.schneeberger@dot.gov) if interested in:
    1. Participating in the **Accelerating V2X Cohort**
    2. Providing input of validating **V2X Deployment Map** data
    3. Having USDOT deliver **Foundational V2X Training**
    4. Providing resources for the **Smart Community Resource Center (SCRC)**
2. **Discussion:** Thoughts on content for a V2X 201 Training Course?
3. **Discussion:** Opportunities for future collaboration with the CV PFS.

Thank you!

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