ITS AMERICA

V2X Decoded: Frequently Asked Questions

ITS AMERICA V2X AND CONNECTED TRANSPORTATION COMMITTEE

An Introduction to V2X

Vehicle-to-everything (V2X) technologies allow vehicles to communicate with other vehicles, infrastructure, and road users to avoid crashes, fatalities, and injuries by providing near-instant, highly accurate alerts of hazards drivers may not be able to see, so that they can take action to avoid a crash. V2X is critical for safety because it allows road users to "see" beyond their line of sight. For example, a driver can be alerted to the position of a cyclist they cannot see (i.e., helping to avoid a collision) and a cyclist can be alerted to a vehicle about to turn into its path. These messages can contain key information about the location and actions of vehicles and other travelers, traffic conditions, and roadway conditions such as weather, pavement issues, upcoming work zones, or crashes. Digital alerts about the presence of incoming EMS vehicles or an upcoming traffic signal can allow road users to take measures that will improve road safety.

Sharing key information between the various parties in the transportation network allows responses that can improve safety, prevent crashes, optimize system performance, and reduce congestion.

FAQ: Connected Vehicles

What is a connected vehicle?

A connected vehicle (car, truck, bus, e-bike, etc.) is one equipped with wireless communication devices integrated within the vehicle as manufactured or installed aftermarket (not a smartphone). Vehicles typically use multiple modes of wireless communication to support many different use cases, including cellular vehicle to everything (C-V2X) technology which allows vehicles to communicate with roadside sensors and other technologies for enhanced safety and some local mobility services.

Are there different types of vehicle connectivity?

Yes, vehicles can come equipped with multiple connectivity technologies to support different use cases and applications. Vehicles can broadcast locally using C-V2X which operates in dedicated ITS spectrum to support safety applications in near real time. They can also connect to cellular networks and the cloud for broader information sharing, certificate management, and added data-driven intelligence. Together these connectivity technologies enhance safety for road users and make transportation systems more efficient. The following are examples of communication technologies that may be used for various CV applications, depending on application requirements:

- C-V2X over 5.9GHz
- Wi-Fi

- Bluetooth
- Cellular
- Satellite
- Powerline communication (I.e. Electric Vehicle applications when charging)

Can all applications work with different types of connectivity?
Certain applications, such as safety alerts that might instruct a driver to take immediate action, will be more sensitive to interference, network capacity, and speed. They cannot tolerate any delays, dropped signals, or garbled messages. C-V2X technology was specifically created to support these safety critical, low latency applications. Other, more tolerant applications can function where wireless communication options might be less than perfectly reliable but still capable of delivering the needed service, such as 5G which can help raise awareness of safety applications and make entire transportation systems more efficient.

Do automated vehicles require connectivity?
Many advanced driver assistance systems (ADAS) features use sensors to provide safety alerts. One example could include how a back-up camera can alert a driver to take action before reversing into something or someone. C-V2X takes safety alerts a step further by allowing the vehicle to see beyond its line of sight, adding a vital sensor for immediate safety warnings. Every vehicle can benefit from C-V2X technology because it enables collective intelligence that goes beyond the capability of a single vehicle.
Connected processing and precise positioning technologies will be essential to support the intelligence and lane-level accuracy required for automated vehicles.

What role does my local and state department of transportation (DOT) or Infrastructure Owner Operator (IOO) play in deploying C-V2X technologies?
The implementation of a C-V2X deployment requires both in-vehicle technology as well as road-side infrastructure. It is the responsibility of a local or state DOT to deploy both this infrastructure and the supporting technologies. Some agencies will build and manage V2X infrastructure themselves whereas others will outsource the entire operation including planning, building, and management to a private partner. The implementation model and role of the private partners will vary based on the experience and capabilities of the agency. In order to define the best partnership implementation model, it is helpful to understand the breadth of resources and building blocks that are part of the infrastructure of a C-V2X deployment. While project elements will be customized based on scope, these following categories will likely apply to all deployments:

Hardware: The physical infrastructure components required for project deployment. Depending on use case and project design, this category will include elements which may include but are not limited to:

- Roadside units (RSUs) (including upgrade of DSRC (dedicated short range communications) RSUs to C-V2X RSUs)
- Other roadside infrastructure, such as signal controllers, cameras, lidar, sensors, or other equipment including Edge Devices at or near the intersection.
- Back-office data management infrastructure
- Data transmission infrastructure
- In-vehicle hardware, such as onboard units (OBUs), Heads Up Displays (HUDs), audio alerts, and console alerts

Software: The software components required to operate and manage the C-V2X environment. Depending on use case and project design, this category can include elements such as:

- Vehicle-to-Everything (V2X) Hub and Plug-ins
- Connected V2X platform or communication technology.
- Software for specialized applications or use cases typically interacting with the V2X Hub
- Embedded security
- Security Credential Management Systems (SCMS)

Operations: The services required to operate and manage the C-V2X environment. Depending on use case and project design, this category will include elements such as:

- Day-to-day operations of software and systems
- Updates and integration with other systems
- Monitoring, reporting, and evaluation
- Revenue collection services

Maintenance: The services required to keep the C-V2X deployment working properly throughout its life cycle. Depending on use case and project design, this category will include elements such as:

- Preventive maintenance, such as testing or replacing common system components
- Corrective maintenance
- Major maintenance and capital refresh activities

Responsibility for these system components can be assigned to different project partners using a variety of contracting mechanisms. The implementation model that a public agency might consider will evaluate whether these responsibilities should be allocated to the implementing agency or a private project partner. This choice should consider: (a) who is best positioned to provide these services based on expertise, resources, and capacity; and (b) the extent to which system components should be "bundled" for efficiency and to mitigate interface risks.

Additional information about the responsibilities of an IOO implementing C-V2X infrastructure can be found in the Smart Intersections Project Implementation Guide which will be published in 2024.

What standards are in place to support uniform C-V2X deployments?
Standards are key to ensuring interoperability at well-defined performance levels. SAE International recently published a series of fundamental standards designed to promote interoperability and minimum performance among C-V2X devices. The standards will help smooth the way for the transportation stakeholder community to adopt C-V2X and create safety applications that can help to prevent crashes and fatalities. Following is a brief overview of the standards:

- **SAE** J3161 C-V2X Deployment Profiles — This is a reference system architecture based on C-V2X. The standard is meant for application developers and those interested in C-V2X system architecture. This standard defines how to prioritize and deliver different messages between vehicles (V2V) and between vehicles and roadside infrastructure (I2V/V2I) with one 20 MHz C-V2X radio channel at 5.9 GHz.

- **SAE** J3161/1 On-Board System Requirements for LTE V2X V2V Safety Communications — This addresses the exchange of Basic Safety Messages (BSM) among V2V applications. The standard aims to provide the minimum radio performance, interoperability, and data integrity needed for the parts to communicate with one another.

- **SAE** J3161/1A Vehicle-Level Validation Test Procedures for LTE-V2X V2V Safety Communications — This provides guidelines for verifying that an Instrument Under Test satisfies the vehicle-level requirements of J3161/1. The OmniAir Consortium will use this standard as the basis for certification testing, verifying device conformance and interoperability.

While the physical layer third generation partnership project (3GPP) global specifications for C-V2X have been available for some time, the latest "upper layer" SAE standards are designed to help vehicle manufacturers, Tier 1 suppliers, and software stack providers develop consistent safety systems and applications that are interoperable across devices. The same standards will apply to any OBU for a car or any RSU.

When will automakers deploy C-V2X technologies?
Many in the public and private sectors have come together to accelerate the deployment of safety services, demonstrating business and technical paths to deployment and providing insight into how to develop this pivotal technology and make it commercially viable and scalable for automakers, government agencies, and infrastructure providers.

Example: Audi, Virginia Department of Transportation, Virginia Tech Transportation Institute, American Tower, and Qualcomm Technologies, Inc. deployed C-V2X on the roadways of Virginia to demonstrate how connected transportation technology helps to protect roadside workers against potential hazards.

With the USDOT recently unveiling their plan to have 85% of urban intersections equipped with C-V2X technology in the next 12 years, automakers can start to deploy vehicles with C-V2X integrated, having confidence that the infrastructure to support their vehicles will have been deployed.

C-V2X is ready to deploy now, interested parties can apply for a waiver with the Federal Communications Commission (FCC) today.

Funding opportunities are also available as part of the Bipartisan Infrastructure Law. The USDOT has published a full list of funding opportunities on their website.

Will all automakers use the same approach to connectivity?
Safety-related messages and services are uniform across each vehicle type, but there could be additional connectivity enabled services that are unique to any given manufacturer. The industry is collaborating to ensure systems are interoperable regardless of manufacturer implementation.

What is a VRU? And why is VRU protection important?
VRU stands for Vulnerable Road Users, which includes micro-mobility such as electric and non-electric bikes and scooters as well as pedestrians who also share the road with cars. VRU-focused safety applications are key V2X use cases. With V2X, VRU accidents can be substantially decreased as most occur due to "failure to see". V2X makes drivers aware of cyclists, pedestrians, and micro-mobility users even if they are hidden behind the corner or obstructed by other vehicles.

Global Status of V2X
In Europe, VW equipped its Golf and all its electric models with V2X, and EuroNCAP added V2X to its grading system. It is currently giving points to vehicles for hazard warnings and in 2026, the grading will be enhanced. In China, several of the country's largest OEMs will deploy models equipped with V2X this year. China NCAP adopted V2X and will begin having it affect the safety score of vehicles starting in mid-2024.

America must remain competitive with the rest of the world, which is rapidly developing these lifesaving V2X technologies.