AUGUST 2026

Connected and Automated Vehicle **Strategic Plan**

Division of Traffic Operations
California Department of Transportation

Caltrans

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List of Acronyms

ATMS	Advanced Traffic Management System
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
AV	Autonomous Vehicle
CATMS	California Advanced Traffic Management System
C-V2X	Cellular Vehicle-to-Everything
CAV	Connected and Automated Vehicle
CTI	Connected Transportation Interoperability
CV	Connected Vehicle
DSRC	Dedicated Short-Range Communication
DOT	Department of Transportation
DMV	California Department of Motor Vehicles
DRISI	Division of Research, Innovation and System Information
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FMVSS	Federal Motor Vehicle Safety Standards
HQ	Headquarters
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
MPO	Metropolitan Planning Organization
MMITSS	Multi-Modal Intelligent Traffic Signal System
NHTSA	National Highway Traffic Safety Administration
NTCIP	National Transportation Communications for ITS Protocol
OBU	Onboard Unit
OEM	Original Equipment Manufacturer
PATH	Partners for Advanced Transportation Technology
RTK	Real-Time Kinematic
RTMC	Regional Transportation Management Center
RSU	Roadside Unit
SCMS	Security Credential Management System
SPaT	Signal Phase and Timing
SDX	Situation Data Exchange
SAE	Society of Automobile Engineers
SHOPP	State Highway Operation and Protection Program
SR	State Route
STIP	State Transportation Improvement Program
TMC	Transportation Management Center
TIM	Traveler Information Message
USDOT	U.S. Department of Transportation
V2X	Vehicle-to-Everything
V2I	Vehicle-to-Infrastructure
VRU	Vulnerable Road Users

Executive Summary

Connected and Automated Vehicle (CAV) technology represents a transformative opportunity for California's transportation system. This document establishes a foundation for the California Department of Transportation (Caltrans) to lead the continued development and deployment of CAV enabling technology within California's State Highway System.

There are national-level efforts by the U.S. Department of Transportation (USDOT) to accelerate Vehicle-to-Everything (V2X) deployments to save lives through connectivity. As industry advancements and federal initiatives accelerate the integration of smart road technologies, it is crucial for Caltrans to remain at the forefront in fostering this rapid progress within California.

This document describes various district and headquarters (HQ) deployments of connected vehicle (CV) infrastructure. District 4 demonstrates the successful migration of connected vehicle applications into production environments, with staff developing in-house expertise for system installation and maintenance. District 11 highlights the operationalization of Roadside Unit (RSU) deployments by embedding V2X messaging into daily Transportation Management Center (TMC) procedures, establishing a repeatable model for other regions. District 12 showcases the scalability of connected vehicle infrastructure, integrating nearly 200 RSUs into advanced traffic management systems and exploring next-generation V2X applications. These are complemented by research activities in partnership with Caltrans HQ Division of Traffic Operations, the Division of Research, Innovation and System Information (DRISI) and UC Berkeley Partners for Advanced Transportation Technology (PATH).

As districts begin deploying CV infrastructure project by project, they face new challenges and learning opportunities: navigating procurement processes for unfamiliar technologies,

equipping staff with the skills to configure and maintain various CV components, and planning for long-term operations and maintenance. These efforts represent critical steps in building institutional knowledge and statewide readiness. The following district-level assessments illustrate how this transition is unfolding on the ground.

Collectively, these deployments along with planned activities listed above reflect the diversity of approaches across Caltrans districts, while building a shared foundation of knowledge, skills, and operational practices. They mark the transition from **isolated pilots** to a **statewide culture of connected infrastructure deployment,** setting the stage for California to lead the nation in connected vehicle readiness.

Serving as both a guide and a framework, this document offers an overview of Caltrans' current investments and planned activities, and charts the course for future development.

Photo 1: Driverless car equipped with LiDAR sensors and cameras. Editorial credit: Michael Vi / Shutterstock.com.

Background

Within recent years, the importance of connected vehicle infrastructure has grown significantly due to two main factors:

- **Accelerating Autonomous Vehicle (AV) Deployment:** The federal administration has identified AV deployment as a national priority through the National Highway Traffic Safety Administration's (NHTSA) AV Framework,[1] including initiatives to modernize Federal Motor Vehicle Safety Standards (FMVSS), streamline the Part 555 exemption process, update its voluntary AV safety guidance, and develop behavioral competency standards for AVs. Correspondingly, AV companies are scaling operations, expanding service zones, building robotaxi production facilities, and partnering with mobility platforms to speed adoption. As AV deployments expand beyond limited pilot areas to encompass larger operational areas including highways and freeways, connected vehicle technology provides increasingly valuable situational awareness data to support safe and efficient operation. California is a national leader in autonomous vehicle testing, with 28 Autonomous Vehicle Testing Permits issued by the California Department of Motor Vehicles (DMV) as of August 12, 2026, and over 1.3 million commercial robotaxi rides provided in California as of March 2026.[2]
- **Federal Communications Commission (FCC) action on C-V2X Spectrum:** In its Second Report and Order in the Matter of the Use of 5.850 – 5.925 GHz Band,[3] the FCC codified clear rules for Cellular Vehicle-to-Everything (C-V2X) communications. These rules phase out older dedicated short-range communications (DSRC) technology, designate spectrum for modern C-V2X, and created a licensing framework that gives both automotive original equipment manufacturers (OEM), connected vehicle device manufacturers, and infrastructure owners confidence in hardware standards.

Additionally, USDOT released Saving Lives with Connectivity: A Plan to Accelerate V2X Deployment on August 16, 2024. Although it was later withdrawn during the 2024–2025 federal transition, the Senate Committee on Appropriations directed USDOT in July 2025 to update and republish it, reaffirming the federal government's long-term commitment to advancing V2X nationwide.

Within California, the DMV adopted a major revision of its AV regulations in April 2026,[4] authorizing the permitting of heavy-duty AVs above 10,0001 pounds and updating many elements of its rules, including changes to data reporting, safety requirements, first responder interaction protocols, and remote operations standards.

Together, these actions underscore the urgency for Caltrans to modernize and expand its infrastructure and ensure California remains at the forefront of connected vehicle deployment.

1 https://www.nhtsa.gov/press-releases/cutting-red-tape-safely-fast-track-automated-vehicle
2 https://www.dmv.ca.gov/portal/vehicle-industry-services/autonomous-vehicles/autonomous-vehicle-testing-permit-holders/
3 https://docs.fcc.gov/public/attachments/FCC-24-123A1.pdf
4 https://www.dmv.ca.gov/portal/news-and-media/new-autonomous-vehicle-regulations-strengthen-oversight-and-enforcement-authorize-trucks-and-transit/

MISSION

As the Infrastructure Owner and Operator of the State Highway System, the Caltrans mission for CAV is to:

Transform the California transportation ecosystem to connect all users, modes, and vehicle types with advanced technology and digital infrastructure to achieve improved safety and mobility benefits.

VISION

A transportation ecosystem that serves all users, is equitably accessible, and is flexible, adaptable, and responsive to next-generation mobility needs.

Strategic Goals, Mission, and Vision

By investing in V2X infrastructure, such as connected traffic signals, roadside units, and data-sharing platforms, Caltrans will advance the priorities of its 2024 – 2028 Strategic Plan by:

Improving **Safety** by reducing crashes caused by human error, advancing California Toward Zero Deaths.

Advancing **Equity** by expanding safe mobility access to all, including those unable to drive themselves.

Taking **Climate Action** by lowering greenhouse gas emissions via more efficient coordination and cooperation between vehicles.

Advancing **Prosperity** by making transportation for Californians to their jobs, education, health care, and other essential services safer and more efficient.

Promoting **Employee Excellence** within Caltrans, developing skills and knowledge for a future of more intelligent and connected roads.

Standards and Guidance

As Caltrans districts deploy CV infrastructure, it is critical that all efforts are standardized and interoperable. This ensures not only consistency across Caltrans districts, but also seamless integration with local agencies, metropolitan planning organizations (MPOs), and ultimately with the broader national transportation network.

To achieve this, Caltrans will require that deployments adhere to the following standards:

- **ARC-IT[5]:** The National Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) provides a foundational framework for planning, defining, and integrating Intelligent
- Transportation Systems (ITS) and CV applications.
- **ITE CAV/CTI Standards[6]:** The Institute of Transportation Engineers (ITE) and the Connected Transportation Interoperability (CTI) program have developed a suite of standards that define how roadside and intersection-based connected vehicle equipment should function. These include:
    - **CTI 4001:** Ensures RSUs conform to standardized design and performance specifications.
    - **CTI 4501:** Establishes requirements for implementing connected intersections that support safety-critical applications.
    - **CTI 4502:** Provides procedures to test and validate connected intersections for interoperability and compliance.
- **USDOT Best Practices for TIM Deployment:** This USDOT document will make sure that traveler information messages (TIM) being broadcast have standardized fields and can be understood by multiple Onboard Unit (OBU) manufacturers.

ARC-IT Architecture Overview

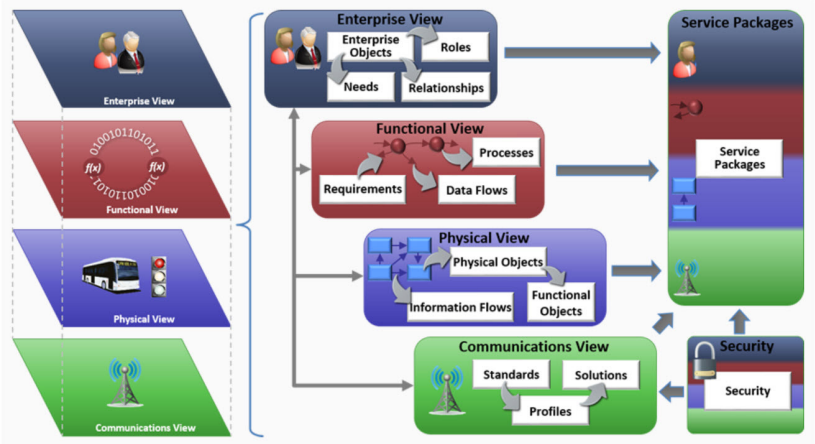

Photo 2: ARC-IT Architecture Overview flowchart. Source: The National Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT).

5 https://www.arc-it.net/
6 https://www.ite.org/technical-resources/topics/standards/cav-cti-standards/

- **FHWA Guidance for MAP Message Preparation[7]:** Federal Highway Administration (FHWA) guidance should be followed to guarantee consistency and accuracy in intersection map development and broadcast.
- **OmniAir Certification:** RSUs and OBUs should meet the industry-standard V2X certification.
- **Society of Automobile Engineers (SAE) Standards:** Standards such as J2735[8] for the V2X Communications Message Set Dictionary and J3224[9] for V2X Sensor-Sharing for Cooperative and Automated Driving are internationally-recognized standards that set the communication syntax for interoperable V2X messaging.

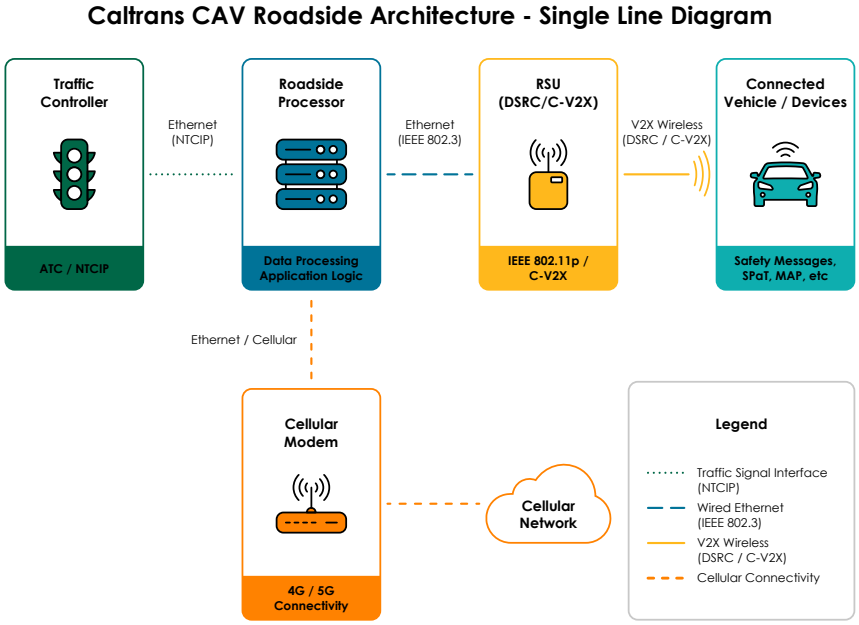

Photo 3: Depiction of Caltrans CAV Roadside Architecture – Single Line Diagram.

In addition to these core requirements, Caltrans will:

- **Maintain alignment with evolving national standards** by continuously monitoring updates from USDOT, ITE, SAE International, Institute of Electrical and Electronics Engineers (IEEE), and other standard-setting bodies.
- **Promote interoperability testing and certification** in partnership with USDOT and other departments of transportation (DOTs), standards organizations, and industry partners to validate that California's deployments integrate smoothly within the state and with deployments in other states.
- **Adopt cybersecurity best practices** embedded in federal standards to safeguard the integrity of CV communications and protect user privacy.

7 https://engineering.virginia.edu/sites/default/files/Connected-Vehicle-PFS/Projects/(MAP)%20Guidance/MAP%20Guidance%20Document%20-%20Revision%204%20FINAL.pdf
8 https://www.sae.org/standards/j2735_202409-v2x-communications-message-set-dictionary
9 https://www.sae.org/standards/j3224_202208-v2x-sensor-sharing-cooperative-automated-driving

Assessment of Caltrans Readiness

Caltrans' readiness to deploy CV infrastructure is built on nearly two decades of foundational research. The Connected Vehicle Testbed on El Camino Real (State Route 82) between Palo Alto and Mountain View, developed in partnership with the California PATH program at UC Berkeley, local agencies, and industry partners, served as one of the earliest national sites for testing DSRC, RSUs, and vehicle-to-infrastructure (V2I) applications. While the testbed was originally research-focused, it provided and continues to provide valuable technical insights into system architecture, communications reliability, and multi-agency coordination.

Today, Caltrans is entering a new phase: shifting from research testbeds to operational deployments **that must be** scalable, maintainable, and integrated into the State Highway System.

As districts begin deploying CV infrastructure project by project, they face new challenges and learning opportunities: navigating procurement processes for unfamiliar technologies, equipping staff with the skills to configure and maintain various CV components, and planning for long-term operations and maintenance. These efforts represent critical steps in building institutional knowledge and statewide readiness. The following district-level assessments illustrate how this transition is unfolding on the ground.

DISTRICT 4 – BAY AREA

The The current El Camino Real CAV Corridor, spanning seven miles along State Route 82, from Stanford University in Palo Alto to State Route Mountain View, features 31 consecutive signalized intersections outfitted with C-V2X roadside units. Roadside processors are also deployed and running the Multi-Modal Intelligent Traffic Signal System (MMITSS) to interface with 2070 traffic signal controllers, populate Signal Phase and Timing (SPaT) messages, and manage adaptive signal and priority timing. Although district engineers will take ownership of operations and maintenance, the corridor will still serve as an important testbed for evaluating National Transportation Communications for ITS Protocol (NTCIP) compliant traffic signal controllers, advanced traffic detection sensors, and open V2X data sharing.

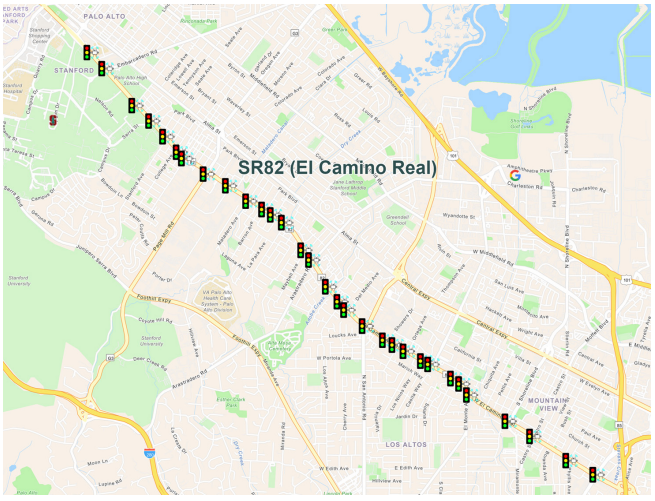

Photo 4: D4 Corridor Map

District 4 has taken an early leadership role in transitioning from the research foundation of the El Camino Real Testbed toward real-world operational deployment. Applications

and server infrastructure previously hosted in a research environment at UC Berkeley are migrated to a production environment at District 4 Regional Transportation Management Center (RTMC). Staff are gaining hands-on experience with installing and maintaining connected vehicle hardware and software, shifting from reliance on external partners to developing internal capacity and expertise for long-term operations.

DISTRICT 8 – SAN BERNARDINO / RIVERSIDE REGION

Caltrans District 8 serves as a partner to the Coachella Valley CV Sync project,[10] which aims to upgrade existing traffic signal controllers and install more than 400 C-V2X RSUs across Riverside County. As some of the upgraded equipment is located along or intersects through the State Highway System, the district serves as a key partner in ensuring that the whole region deploys interoperable V2X infrastructure across not only Caltrans, but eight individual cities and the entire County of Riverside.

DISTRICT 11 – SAN DIEGO REGION

District 11 has deployed a total of 78 C-V2X RSUs along three major interstates (I-5, I-8, I-15), spanning a total of 33 miles of coverage north of the city of San Diego. At intersections, these RSUs interface with 2070 traffic signal controllers to broadcast SPaT messages. Aside from connected intersections, the RSUs are also installed along highways, serving as general-purpose broadcasters of TIMs.

The district has also participated in long-running pilot projects, such as the three-year I-805/SR 94 Part-Time Transit-Only Lanes Pilot Demonstration project,[11] allowing South Bay Rapid buses to use selected road shoulders between National City and Downtown San Diego during peak travel times and giving them priority over cars entering the roadway from an onramp via vehicle-to-infrastructure communication. Another

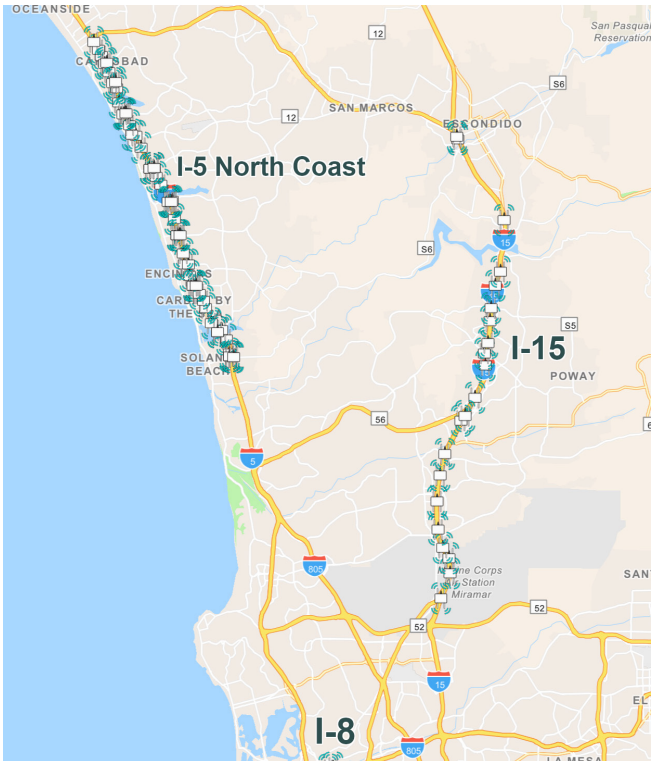

Photo 5: D11 Corridor Map

10 https://www.cv-sync.com/
11 https://www.sandag.org/projects-and-programs/transit/transit-projects/part-time-transit-only-lanes

ongoing pilot project is the usage and evaluation of the Trihydro CORVUS and Situation Data Exchange (SDX) solutions, which are key to broadcasting traveler information via multiple communication channels in an interoperable format used by the nationwide DOT community.

The district has also initiated training for TMC staff to broadcast TIMs through the existing Advanced Traffic Management System (ATMS). This represents an important step: moving from pilot demonstrations to the integration of V2X broadcasting as a **standard operating procedure.**

DISTRICT 12 – ORANGE COUNTY

District 12 has deployed 136 RSUs along its freeways as well as 52 RSUs at Caltrans ramp intersections along the Anaheim Triangle area, bounded by the I-5, State Route (SR) 91 and SR-57 Corridors, which support the Disneyland Resort Area and other high-capacity entertainment venues that experience high traffic and pedestrian volumes that fluctuate significantly throughout the day and seasonally. The RSUs are currently managed by central software enabling corridor-wide connectivity within its Integrated Corridor Management framework.

Caltrans D12, in collaboration with Headquarters Traffic Operations and DRISI, has also deployed video detection cameras along with DERQ video analytics application at the 52 ramp intersections. In addition, 22 of the latest Bosch cameras with their video analytics application are installed along the Triangle's mainline freeways. These combinations of video analytics and CV technology deployments in these locations provide travelers and vulnerable road users (VRUs) with traveler information and safety warnings, alert operations personnel of potential incidents and congestion, and more.

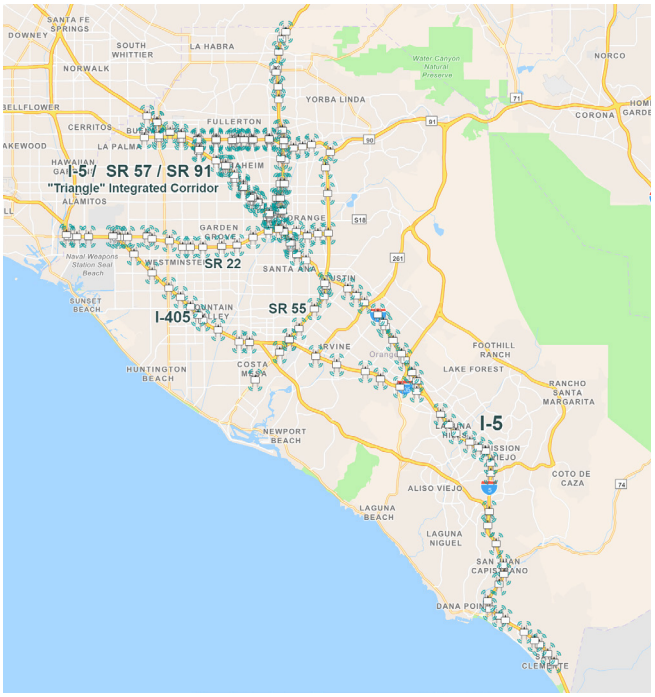

Photo 6: D12 Corridor Map

HEADQUARTERS TRAFFIC OPERATIONS

At the statewide level, Headquarters Traffic Operations has established a uniform Security Credential Management System (SCMS) portal for all V2I hardware installed in California. This allows hardware such as RSUs and OBUs to have their communications signed by a nationally-trusted certificate authority, thus ensuring integrity, authenticity, privacy, and interoperability of V2X communications.

In collaboration with Districts 6 and 12, DRISI and PATH, a Real-Time Kinematic (RTK) position correction server was set up in the District 12 TMC. This allows RSUs across Southern California to provide decimeter-level positioning to vehicle OBUs, enabling critical safety use cases requiring lane-level positioning. With an expansion to Northern California at the District 4 TMC underway, the entire state will be able to receive and transmit highly accurate positioning for connected vehicle applications.

DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

DRISI, with a long-standing partnership with UC Berkeley PATH, has established a mature CAV research and deployment program that has advanced from early technology demonstrations to deployment-ready connected vehicle infrastructure and applications. Through investments in the El Camino Real connected corridor, V2X communications, intelligent traffic signal systems, data infrastructure, and statewide interoperability initiatives, Caltrans has developed and validated the technical foundation needed to support broader C-V2X deployment.

Today, the program is focused on evaluating deployment-ready, commercial off-the-shelf C-V2X technologies and accelerating implementation of operational applications. Current assessments include virtual RSUs for TIMs, wrong-way driver alerts, work zone safety applications, and standardized data exchange to support scalable statewide deployment. Collectively, these efforts position Caltrans to transition from research and pilot projects to broader operational implementation of connected vehicle technologies.

SUMMARY

Together, these district-level efforts illustrate Caltrans' **progression from research to operational readiness.** District 4 demonstrates the successful migration of connected vehicle applications into production environments, with staff developing in-house expertise for in-system installation and maintenance. District 11 highlights the operationalization of RSU deployments by embedding V2X messaging into daily TMC procedures, establishing a repeatable model for other regions. District 12 showcases the scalability of connected vehicle infrastructure, integrating nearly 200 RSUs into advanced traffic management systems and exploring next-generation V2X applications.

Collectively, these deployments reflect the diversity of approaches across Caltrans districts, while building a shared foundation of knowledge, skills, and operational practices. They mark the transition from **isolated pilots** to a **statewide culture of connected infrastructure deployment,** setting the stage for California to lead the nation in connected vehicle readiness.

Next Steps and Direction

Caltrans has laid the groundwork for CV deployment through years of research, early district-level deployments, and alignment with national standards. To build on this foundation and scale deployments statewide, Caltrans will take next steps aligned with the following focus areas:

1. **CAV Strategic Guidance & Policies:** Establish clear strategies and policies to guide CAV adoption and integration across California's transportation system.
2. **CAV Projects:** Implement and evaluate CAV programs to test and demonstrate CAV technologies' safety, mobility, and environmental benefits.
3. **CAV Deployment Standards:** Develop and enforce guidelines and technical standards to ensure the safe, secure, and efficient deployment of CAV and related technologies statewide.
4. **CAV Funding Opportunities:** Enhance performance measures of all 9 core TMS elements to include connected infrastructure as a technology update and identify other funding opportunities through the CAV implementation plan.

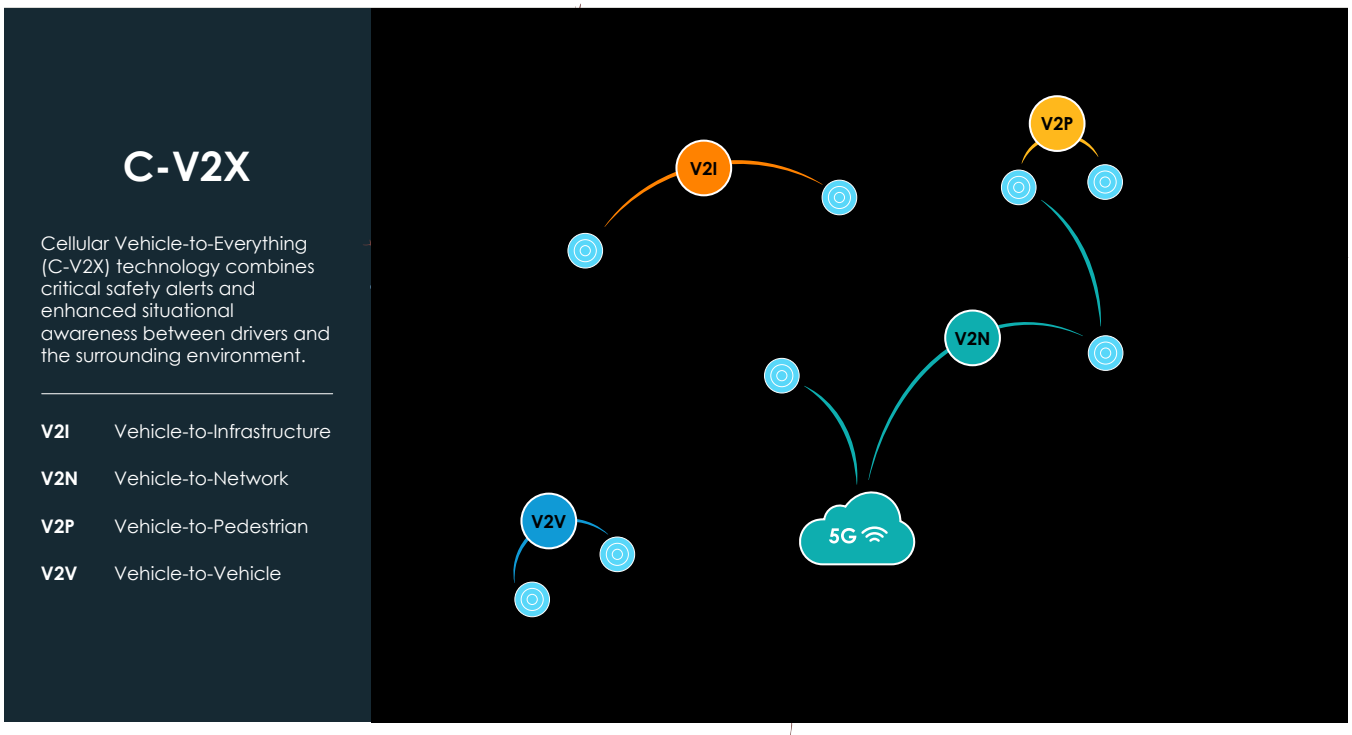

Photo 7: How cellular vehicle-to-everything (C-V2X) works at an intersection.

As high-level actions to meet the focus areas above, Caltrans will:

1. **Strengthen Internal Knowledge and Capacity**
    - Develop and share institutional knowledge across Caltrans by documenting lessons learned from district deployments via fact sheets, operating procedures, training videos, and webinars.
    - Foster collaboration among Traffic Operations, Safety, Maintenance, IT, Planning and Modal Programs, and Project Delivery at both Headquarters and the district level.
    - Create training programs and knowledge exchanges so that engineers, planners, and operators can build the skills needed for long-term RSU and CV system operations.
    - Gather appropriate centralized technical resources with the goal of supporting districts with limited resources and expertise.
2. **Expand Partnerships with External Stakeholders**
    - Form partnerships with other state DOTs, MPOs, transit agencies, and local jurisdictions to ensure interoperability across regional boundaries.
    - Engage private companies - vehicle manufacturers, technology providers, and telecommunications firms - to leverage innovation and align infrastructure with market-driven developments.
    - Build on successful examples such as District 11's integration of RSUs into ATMS and District 12's corridor-wide deployments to encourage cross-agency replication.
3. **Stay in Sync with National Initiatives**
    - Maintain alignment with federally led efforts such as Connecting the West and the I-80 Coalition, ensuring that California's deployments support seamless interstate connectivity.
    - Track and adopt updates to federal standards and guidance from USDOT, FHWA, and ITE so that

California remains interoperable with the national CV ecosystem.

- Actively participate in national working groups and industry associations to represent California's interests and shape emerging best practices.

4. **Integrate CV Capabilities into Core Caltrans Systems**

   - Deploy CV-enabled software as part of the California Advanced Traffic Management System (CATMS), ensuring that connected vehicle functionality is embedded within Caltrans' central traffic operations platform.
   - Ensure sufficient staffing and provide targeted training so that RSU management, TIM broadcasting, and advanced V2X use cases become standard operating procedures rather than one-off pilots.
   - Plan for long-term operations and maintenance, including firmware updates, cybersecurity protection, and integration with future V2X communication technologies.
   - Integrate CAV hardware and software into asset management planning, allowing it to be funded through programs like State Highway Operation and Protection Program (SHOPP) and State Transportation Improvement Program (STIP), as well as federal and state grants.

The actions above will be detailed, prioritized, and assigned to Caltrans divisions in a forthcoming CAV Implementation Plan.

MOVING FORWARD

These steps represent the transition from isolated district deployments to a coordinated, statewide program. By strengthening internal capacity, partnering broadly, aligning with national initiatives, and embedding CV functionality into Caltrans' core systems, the department will be positioned to lead the nation in connected vehicle deployment. This direction ensures that California's highways will not only be safer and more efficient than today, but also ready to adapt to the rapidly evolving mobility landscape of tomorrow.

Connected and Automated Vehicle Strategic Plan
California Department of Transportation