



***Saving Lives with Connectivity:
Accelerating Vehicle to Everything (V2X) Deployment***

Connecting the West (CTW): Miles & Milestones: Phase 1 Progress and Lessons

August 25, 2026



1. *Saving Lives with Connectivity: Accelerating V2X Deployment Initiative*
2. CTW Deployment Concept
3. CTW Road to Operational Readiness
4. CTW Operational Readiness Demonstration and Results
5. CTW Lessons Learned
6. Stakeholder Q&A
7. Contact

Webinar Protocol

1. Please mute your phone during the entire webinar.
2. You are welcome to submit questions through the Q&A feature.
3. The webinar recording and the presentation material will be made available on the Connecting the West and ITS America websites.

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Saving Lives with Connectivity: Accelerating V2X Deployment Initiative

Initiative Goals

01

**Deploy, operate,
and showcase
integrated,
advanced
interoperable
deployments.**

02

**Inform and
educate the ITS
community and
the general
public regarding
these impacts.**

03

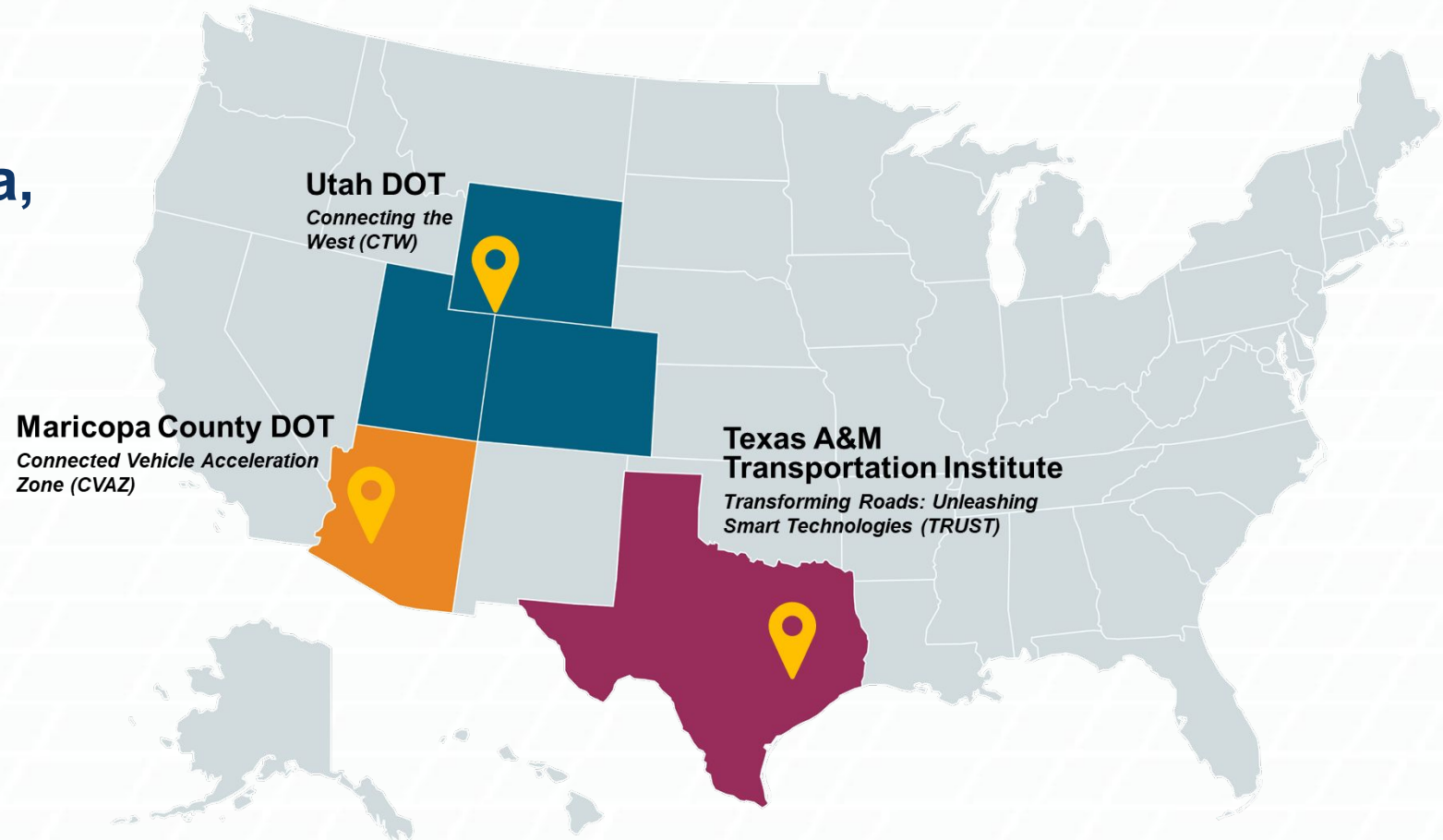
**Support the
development,
evaluation, and
documentation
of a suitable
reference
implementation.**

Structure and Phasing



V2X Accelerator Awardees

In Fall 2024, the USDOT awarded a collective \$60 million to sites in Arizona, Texas, and Utah.



CTW Deployment Concept

CTW Team Members



Existing V2X System

Three States with Mature V2X Systems

Utah:

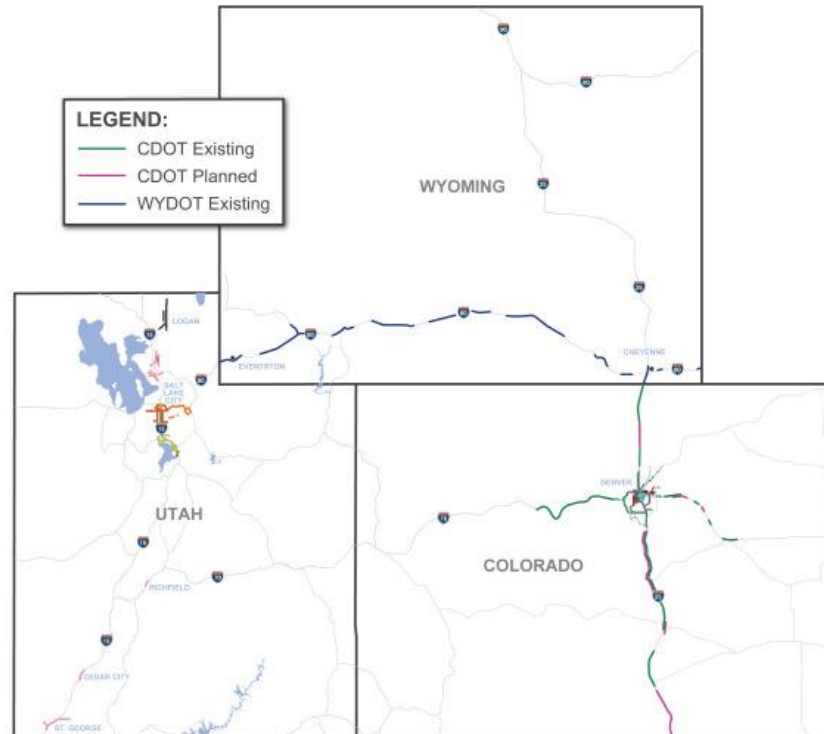
866 RSUs

752 at intersections

114 along roadways

527 OBUs

Transit buses, snowplows,
emergency vehicles,
UDOT and city fleets



Wyoming:

75 RSUs

along Interstate 80

10 OBUs

WYDOT fleet vehicles

Colorado:

503 RSUs

477 along roadways

26 at intersections

98 OBUs

Snowplows, CDOT fleet
vehicles

The Challenge

- **Long-term goal is safety**
 - Reduced crashes, injuries, fatalities by warning drivers
 - V2X is a “**digital seatbelt**” – and will save lives
 - V2I requires participation of the auto manufacturers
- **Secondary goal is mobility**
 - Improved transit performance
 - More efficient snowplow and emergency vehicle operations
- **Leveraging the system to demonstrate safety features**



Deployment Plan

480 Intersection
RSUs

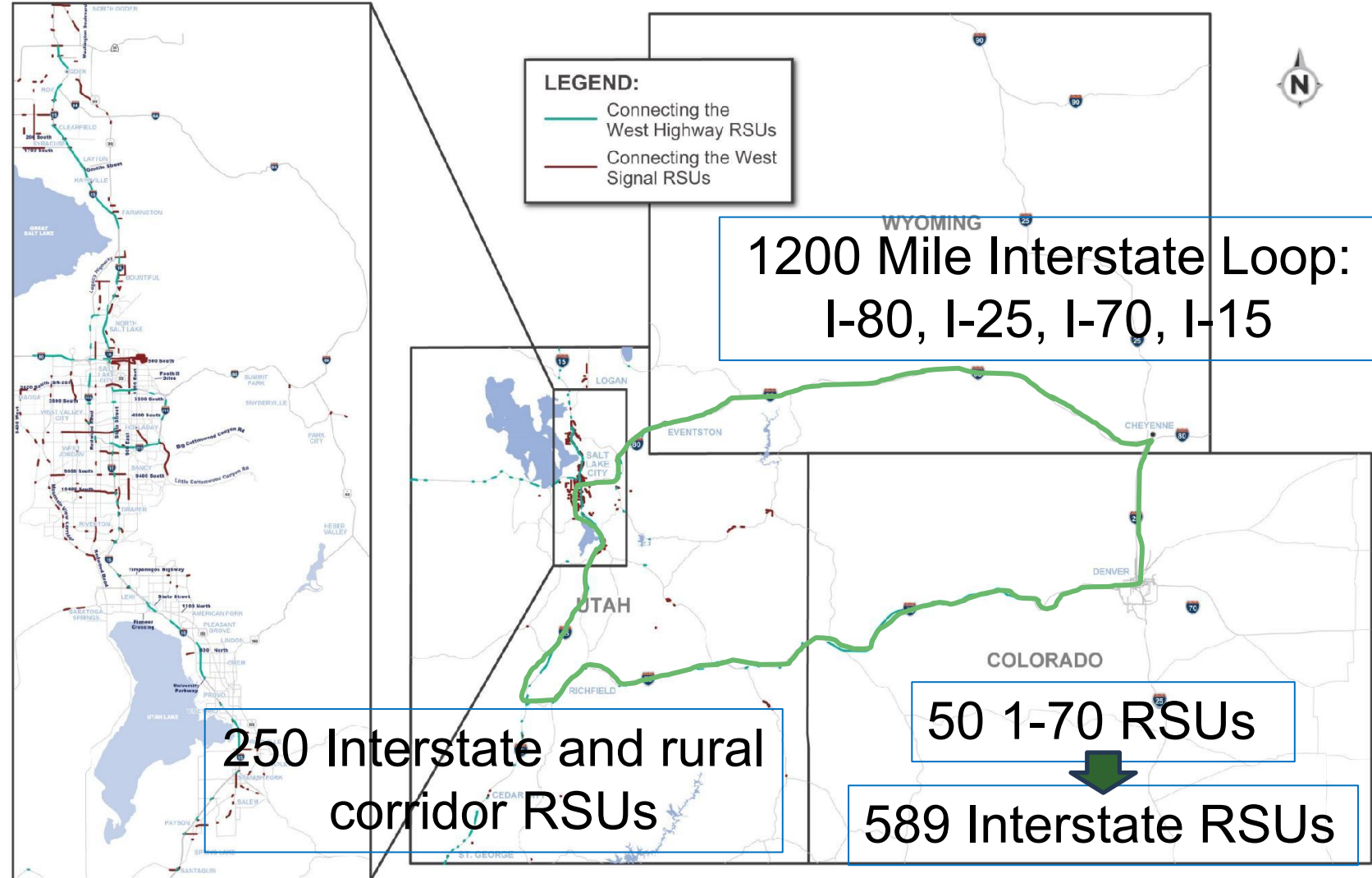


91% of UDOT-owned
signals with an RSU

215 OBUs
(buses, plows)

20 VRU Warning
Sites

Interoperable Traveler
Information Messaging



V2X Use Cases

- **Current use cases:**

- Transit Signal Priority (TSP)
- Snowplow and emergency vehicle preemption
- Vulnerable Road User Warning using LiDAR
- Vehicle insights (weather / hard braking)

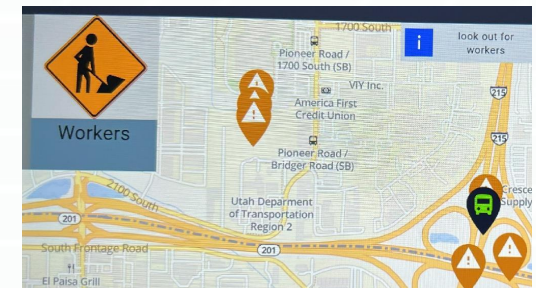
- **Traveler Information Messaging:**

- Curve Speed Warning
- Weather Impact Warning
- Variable Speed Limits
- Work Zone Alerts
- Lane Closure

45 Unique Messages

Our work was basis for FHWA TIM
Best Practices Guidance Document

- **Red-Light Violation Warning (GM)**



CTW Road to Operational Readiness

Execution of Deployment

- **Due to the short timeline, system engineering and procurement proceeded in parallel**
 - Existing systems in Utah and Colorado were replicated
 - System engineering documents:
 - Concept of Operations
 - System Requirements Specifications
 - System Architecture Design
 - System Design Document
 - Comprehensive Acquisition Plan
 - Comprehensive Installation Plan
- **Procurement:**
 - Used existing UDOT / CDOT / WYDOT contracts
 - Consultant support and procurement

Phase 1 Concept of Operations (ConOps)

Vehicle-to-Everything (V2X) Accelerator
Connecting the West – Utah Department
of Transportation

www.its.dot.gov/index.htm

Final Report – May 22, 2025
FHWA-JPO-25-160



U.S. Department of Transportation

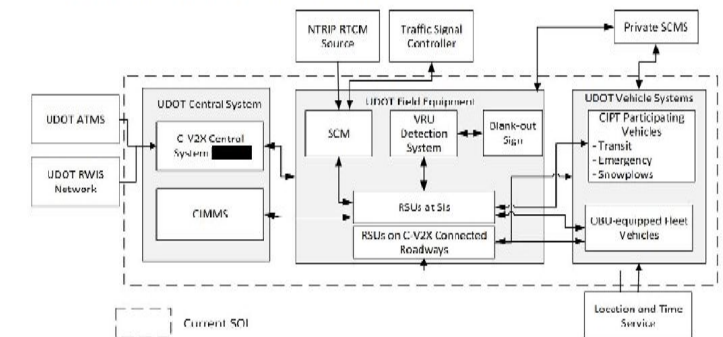


Figure 1. Utah Existing System of Interest Physical Architecture
Source: Athey Creek Consultants, February 2025

Execution of Deployment

- **Due to the winter deployment risks, RSU installation proceeded early in the schedule**
 - Existing systems in Utah and Colorado were replicated
- **Functional / Performance Testing**
 - Hardware already in use so generally not necessary
- **Interoperability between UDOT / CDOT / WYDOT**
 - Central systems not connected
 - Each state operates their own central system
 - Traffic event data and TIMs **shared** through Situation Data Exchange (SDX) platform
 - Primary focus on TIM message consistency



Deployment Challenges - UDOT

- **Replacement of V2X Maintenance / Management System (outside of CTW) caused delays**
 - Procurement process had to be repeated
 - Cloud set-up / implementation took time
- **Fiber switch availability / challenges**
 - Primary vendor stopped offering preferred switch
 - New vendor switch had issues
 - Found a switch from another vendor that met requirements
- **Rural RSU locations required solar enhancements**
 - Most locations had line power
 - Solar locations (cameras / RWIS) didn't have capacity



Deployment Challenges - CDOT

- **Rural RSU locations were not always suitable**
 - Pole structures not available
 - Locations not accessible
 - Fiber or cell network connections not available
 - Reduced number of sites but retained functionality along corridor



System Test Plan

- **Nine System Test Plans (STPs)**
 - 32 Test Cases within the STPs
 - Some Test Cases involve all CTW states
 - Some Test Cases only involve 1-2 CTW states
 - Breakdown of Test Cases:
 - 32 Test Cases in Utah
 - 24 Test Cases in Colorado
 - 14 Test Cases in Wyoming
 - Test Cases tied to specific system requirements
 - 66 System Requirements needed to be verified
 - Multiple members of the team engaged in these tests
 - Test Case Verification Report Template created for consistency

Connecting the West: Test Verification Report Test Case: 2-6 (Utah)

This report documents the execution and verification of the test case as detailed in the following sections, for the Connecting the West (CTW) program.

1. Test Case Information

System Test Plan Reference	STP-2 Central Systems Support TIM Exchanges
Test Case ID	2-6: Receive and Process J2735 Messages at Central Systems
Test Case Title	Receive and Process J2735 Messages at Central Systems
Executing Organization	Utah Department of Transportation (UDOT)
Requirement(s) Verified	CS-7.1 Central Systems Receive J2735 Messages: Central systems shall be capable of receiving and processing messages as defined in J2735 standards in all of the following versions: 2016, 2020, and 2024.
Verification Method(s)	Inspection / Demonstration / Analysis / Test
Test Location	UDOT Central System
Central System Platform	UDOT V2XMM5 / Connected Utah
Report Prepared By	Arman ~~Shahmoradian~~
Date Prepared	July 16, 2026
Version	1.0

2. Test Team

Role	Name	Organization	Contact
Test Lead	Ziyi Ma	Parsons	Ziyi.Ma@parsons.com

3. Pre-Test Setup Verification

Existing production messages were used for the review. No new TIMs or BSMs were created for this test.

#	Setup / Configuration Item	Status (Complete / Incomplete)	Verified By	Date	Notes
1	J2735 2016, 2020, and 2024 ASN.1 definitions and native <u>coders</u> available for comparison.	Complete	Test team	July 13, 2026	All three editions were included.
2	Production TIM and BSM records available in UDOT V2XMM5 for decode and re-encode testing.	Complete	Test team	July 13, 2026	Duplicate payloads were removed before analysis.

4. Test Execution Details

Planned Start Date / Time	July 13, 2026 10:00 AM MDT
Actual Start Date / Time	July 13, 2026 10:00 AM MDT
Planned End Date / Time	July 13, 2026 11:00 AM MDT
Actual End Date / Time	July 13, 2026 11:00 AM MDT
Data Collection Duration	N/A - production data reused

System Test Plan – Coverage by State

System Test Plan	Test Cases	Utah	Colorado	Wyoming
STP-1 Central Systems Create and Exchange Event Reports	3	All apply	All apply	All apply
STP-2 Central Systems Support TIM Exchanges	7	All apply	All apply	All apply
STP-3 Central Systems Create and Disseminate TIMs	4	All apply	All apply	Some apply
STP-4 Central Systems Support Data Storage	5	All apply	Some apply	Some apply
STP-5 Central Systems Monitor Field Equipment Health	3	All apply	Some apply	N/A
STP-6 Field Equipment Compatibility	3	All apply	All apply	N/A
STP-7 Field Equipment Deployment Locations Support Use Cases	2	All apply	Some apply	N/A
STP-8 SCMS Top-Off Without Cellular Communications	2	All apply	N/A	N/A
STP-9 Vehicle System Compatibility	3	All apply	N/A	Some apply
Total test cases executed by state	32	32	24	14

Coverage differs because the deployments differ, not because the testing was uneven.

Utah — connected intersections, VRU/LiDAR safety sites, and an equipped OBU fleet, so every STP applies.

Colorado — CTW scope is connected roadway RSUs along the I-70 corridor. No CTW connected intersections, so the intersection and vehicle cases do not apply.

Wyoming — participates in the interstate exchange layer, event reports and TIMs through the SDX, rather than new field deployment.

System Test Plan: What Each STP Verifies

System Test Plan	What It Verifies	Requirements
STP-1 Central Systems Create and Exchange Event Reports 3 test cases	• Create 10 ngTMDD-formatted event reports from local data sources • Send to the SDX within one minute; retry until SDX confirms • Send updates and expirations within one minute of the change • Retrieve events from the SDX inside each state's own boundary	CS-1.1 – CS-1.4 CS-2.1, CS-2.2 CS-3.1, CS-3.2 CS-15.1, CS-15.2
STP-2 Central Systems Support TIM Exchanges 7 test cases	• Create three ASN.1 UPER-encoded TIMs per state • Send, update, and expire them through the SDX; confirm receipt • Retrieve TIMs another state posted near the shared border • Process J2735 versions 2016, 2020, and 2024	CS-4.1, CS-4.2 CS-5, CS-6 CS-7.1, CS-7.2
STP-3 Central Systems Create and Disseminate TIMs 4 test cases	• Ingest BSMs from the newly deployed RSUs • Generate Curve Speed Warning TIMs near those RSUs • Generate TIMs for downstream conditions, statewide coverage, and adjacent-state events • Confirm third parties can access those TIMs through the SDX	CS-8, CS-9 CS-10.1 – CS-10.3
STP-4 Central Systems Support Data Storage 5 test cases	• BSM storage from expanded sites • TIM storage from expanded sites • SRM / SSM storage for preferential treatment • Persistent MAP / SPaT storage from connected intersections • SDSM storage from VRU safety sites	CS-11.1 – CS-11.4
STP-5 Central Systems Monitor Field Equipment Health 3 test cases	• One week of message counts against theoretical rates (1 Hz MAP and TIM, 10 Hz SPaT) • Sample size: UDOT 10% of new RSUs, CDOT 15 RSUs • Power down RSUs and confirm the Central System reports them offline	CS-12

System Test Plan: What Each STP Verifies

System Test Plan	What It Verifies	Requirements
STP-6 Field Equipment Compatibility 3 test cases	• RSUs receive messages compliant with J2735, CTI-4501, and J3224 • RSUs send signed messages; confirmed by OBU drive test • New RSUs interoperate with the legacy Central Systems • Message types: BSM, MAP, SPaT, SRM, SSM, SDSM, RTCM, TIM <i>One week of collection, with daily checks that 75% of tested RSUs are still ingesting.</i>	FE-1.1, FE-1.2 FE-4, FE-6, FE-8 FE-10, FE-11
STP-7 Field Equipment Deployment Locations Support Use Cases 2 test cases	• Expansion sites support transit signal priority, snowplow, and emergency vehicle preemption • Connected roadway sites placed against identified corridor needs	FE-2.1 – FE-2.3 FE-3, FE-5, FE-7 FE-9.1
STP-8 SCMS Top-Off Without Cellular Communications 2 test cases	• Wi-Fi certificate top-off at four DOT facilities • Four test OBUs: two pseudonym profile, two identity profile • Drive to a connected intersection; RSU receives and validates the signed BSM	FE-1.1, FE-12 VS-4
STP-9 Vehicle System Compatibility 3 test cases	• OBUs receive and process J2735 in the supported versions • OBUs generate and transmit in a supported version • Messages handled correctly across state lines	VS-1, VS-2, VS-3

Key Outcomes: STP Execution

- **Collaborate on the test procedures early**
 - Each DOT structures its data differently and monitors its devices its own way
 - A test case has to check state-specific conditions and still be written to apply everywhere
 - Break procedures into components and underlying data that exist regardless of how a site was deployed
 - Feedback that shows up during execution is too late; it forces design changes that push the schedule
- **Trust the Process**
 - Identified firmware upgrades required in Colorado - data quality increased
 - “Double Check Our Work” – intersection data quality increased in Utah
 - Cross-state collaboration and perspectives – increased quality of re-usable test assets
- **Use what the industry already built ; contribute back**
 - Open source gets you past the proprietary boundary when the data can be made available
 - USDOT JPO Conflict Monitor
 - TIM standardization work -> USDOT TIM Best Practice Guidance -> TIM Validator
 - ASN.1 Decoder

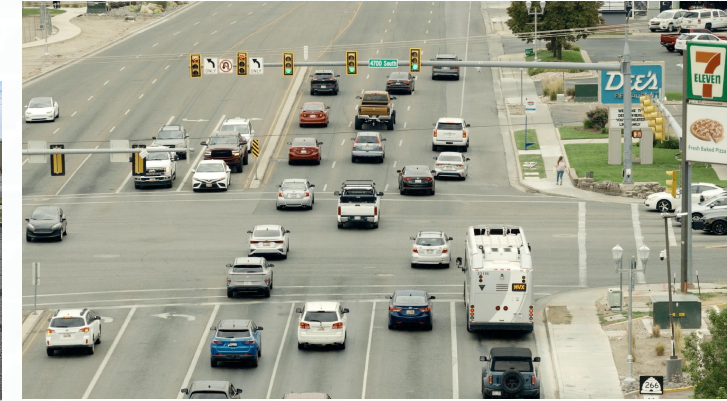
CTW Operational Readiness Demonstration and Results

- Demo 1: CIs Issuing Preferential Treatment for Transit Vehicles
- Demo 2: Vehicle Equipped with OEM RLVW Application Approaching Red Light
- Demo 3: C-V2X Equipped Vehicle at VRU Safety Intersection
- Demo 4: Vehicle That is Not C-V2X Equipped at VRU Safety Intersection
- Demo 5: Generation and Delivery of TIMs to C-V2X Equipped Vehicle
- Demo 6: Generation and Delivery of TIMs to Non-V2X-Equipped Vehicles
- Demo 7: C-V2X Equipped Vehicle Driving in UT, WY, and CO Receiving TIMs (Interoperability)

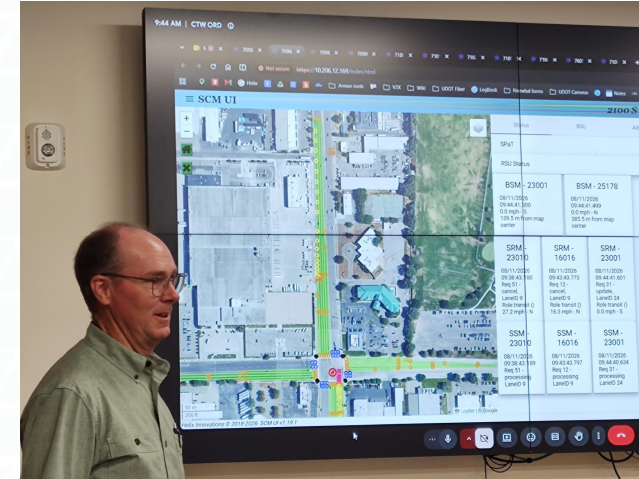
Operational Readiness Demonstrations

Demonstration Overview

- **Tuesday, August 11, 2026**
 - Demo 1: CI Preferential Treatment
 - SCM UI + Redwood Rd trip
 - Demo 2: RLVW w/ GM Vehicle
 - UDOT Test Track



- **Demo 1: CI Preferential Treatment**
 - Observed in-service transit vehicles operating via SCM user interface
 - Equipped Utah Transit Authority (UTA) transit bus with monitors to display Transit Signal Priority (TSP)
 - Drove approx. 8.5-mile Loop on SR-68 (Redwood Rd)
 - Passed through 14 V2X-equipped signalized intersections
 - Bus simulated a “late” status to request TSP
 - Devices: SCM, OBU, OBP, RSU



Demonstration Overview

- **Demo 2: RLVW w/ GM Vehicle**
 - Utilized UDOT's test track signal
 - Chevy Traverse ran the red light on all approaches of the test track signal to demonstrate the RLVW alert
 - GM-developed application displays RLVW warning



Demonstration Overview

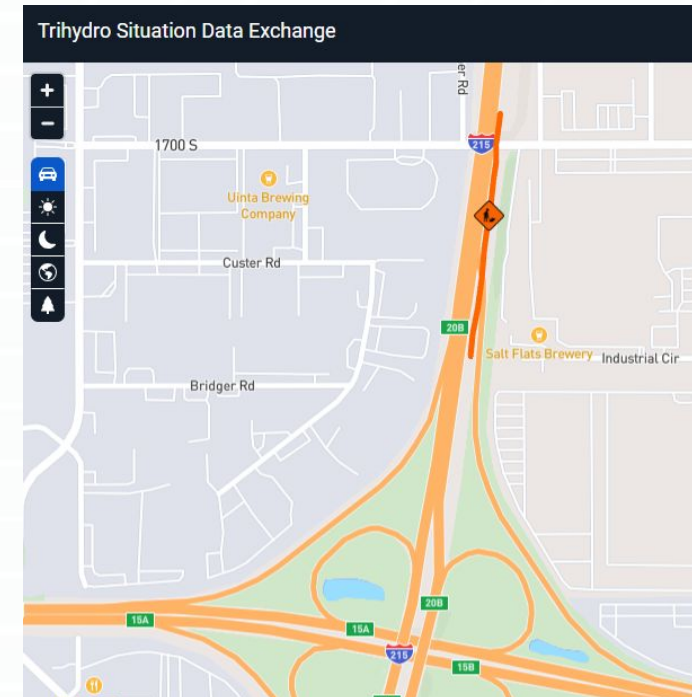
- **Wednesday, August 12, 2026**
 - Demos 3 & 4: VRU Safety Intersection
 - 5300 S & 700 W, Murray
 - Demos 5, 6 & 7: TIMs, Interoperability



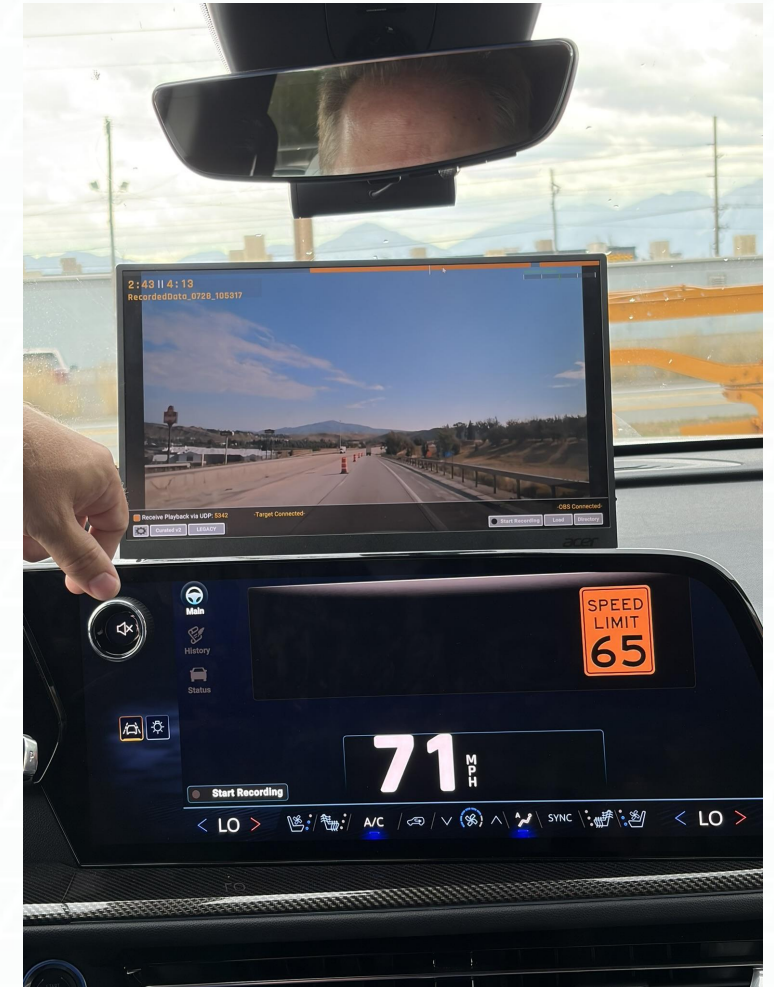
- **Demo 3: C-V2X Equipped Vehicle at VRU Safety Intersection**
 - LiDAR + RSU installed at signalized intersection
 - Demonstrated SDSM & TIMs for VRU warning alert
 - Equipped UDOT van with OBU and HMIs to view the VRU warning in the vehicle
- **Demo 4: Vehicle That is Not C-V2X Equipped at VRU Safety Intersection**
 - LiDAR + RSU + Blank Out Signs
 - Demonstrated Blank Out triggering with VRU in crosswalk and vehicle in the right turn lane



- **Demos 5 & 6: TIM Delivery to equipped vehicle & TIM Delivery through SDX**
 - Use Connected Utah (V2X MMS to create TIMs)
 - TIMs also appear in Situational Data Exchange (SDX)
 - GM Vehicle drives through each TIM region to display TIM on the HMI



- **Demo 7: TIM Delivery in UT, WY, and CO (Interoperability)**
 - Drove GM Vehicle to Wyoming (I-80) – 7/28/2026
 - Drove GM Vehicle to Colorado (I-70) – 7/30/2026
 - Captured TIM delivery to the GM vehicle HMI
 - Captured video of roadview
 - Showed recordings during CTW demonstrations within the GM Vehicle



CTW Lessons Learned

- **Subcontracts and Interagency Agreements take time**
 - Initiate these efforts early
 - Use existing relationships / contracts when possible
- **Early Intra-agency and inter-agency coordination is key to success**
 - Internal stakeholders (traffic signal team) need to understand what we are installing – keep them in the loop
 - Frequent communication with partner agencies about details is crucial
- **FCC Licensing of RSU is time consuming and cumbersome**
 - FCC is working on process improvements
- **Changing standards: CTI4501; ngTMDD; J2735 2016/2020/2024**
 - Standards are often in flux – Be aware and be involved
 - Plan system tests carefully to include standards you are using

- **TIM message structure / creation was inconsistent**
 - Decide which messages are most important to you
 - Follow best practices guidelines (CTW / FHWA pending)
- **RSU locations impact TIM broadcast**
 - Vehicles store TIMs once they are received, broadcast when vehicle enters TIM geofence
 - There may not be an RSU near the TIM area of interest – broadcast at an earlier RSU
- **SPaT need to be accurate and timely for RLVW (and other applications) to work properly**
 - Evaluate SPaT messages carefully against CTI4501 and other standards
 - A SPaT test tool available soon
 - Developed through a Utah SMART Grant effort

Lessons Learned

- **Coordinating around weather and traffic conditions is a must**
- **Be prepared to deviate from the original install location design**
- **Field conditions expose problems that lab/test environments don't**
- **Close collaboration with the other states was key**

Stakeholder Q&A

Stakeholder Q&A

- Please keep your phone muted.
- Please use chatbox to ask questions.
- Questions will be answered in the order in which they were received

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