WYDOT Connected Vehicle Pilot Project

NATIONAL RURAL ITS CONFERENCE

OCTOBER, 5 2016

WYOMING DEPARTMENT OF TRANSPORTATION

AND

McFARLAND MANAGEMENT, LLC

Agenda

Wyoming CV Pilot Demonstration Project Overview

- Solving a Real Need
- Deployment Summary
- Partnership Framework

Wyoming CV Pilot Performance Measurement

- Measures
- Evaluation Designs
- Data
- Confounding Factors

The Connected Vehicle Pilot

Phase 1
12 Months

- Planning (COMPLETED)

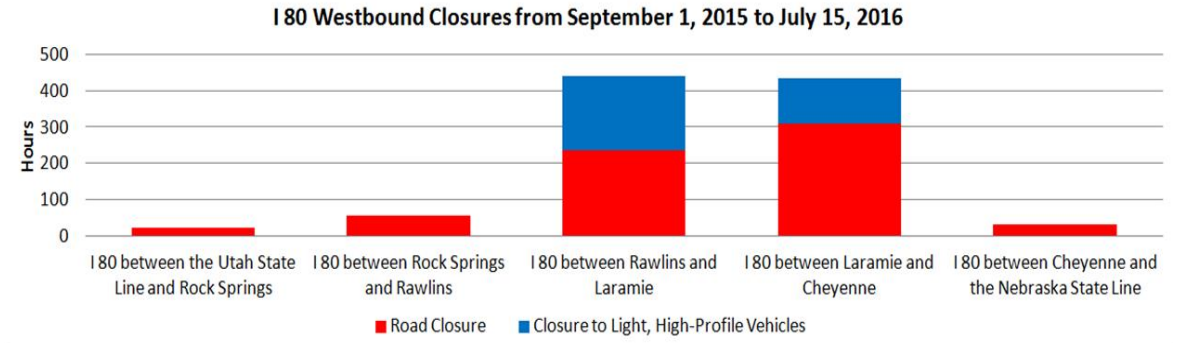
Phase 2
20 Months

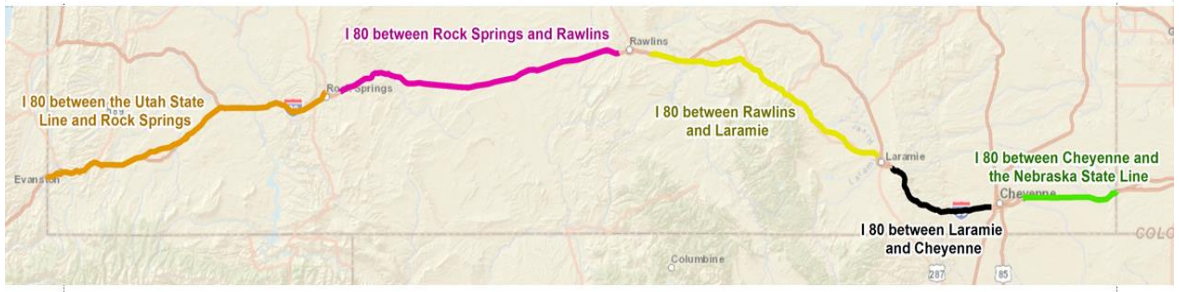
- Designing
- Building
- Testing

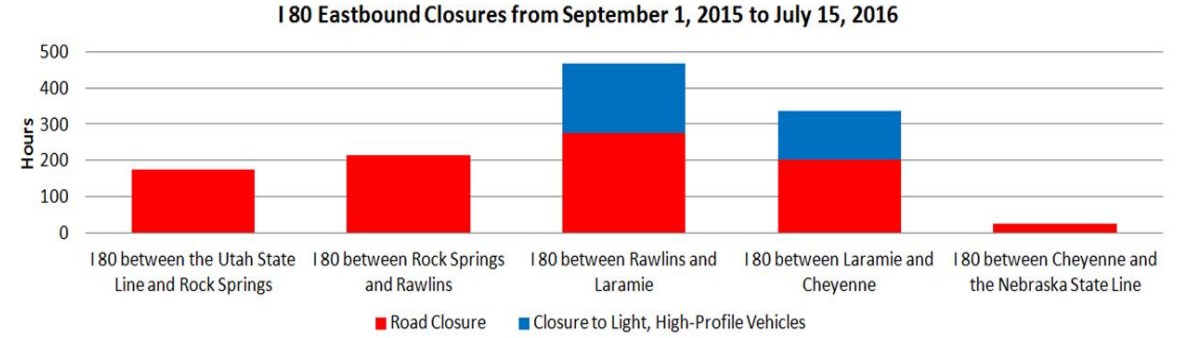
Phase 3
18 Months

- Maintenance and Operation

Wyoming CV Pilot: Solving a Real Need







- 250 hours

Full Closure

- ~180 hours

High Profile Vehicle Restriction

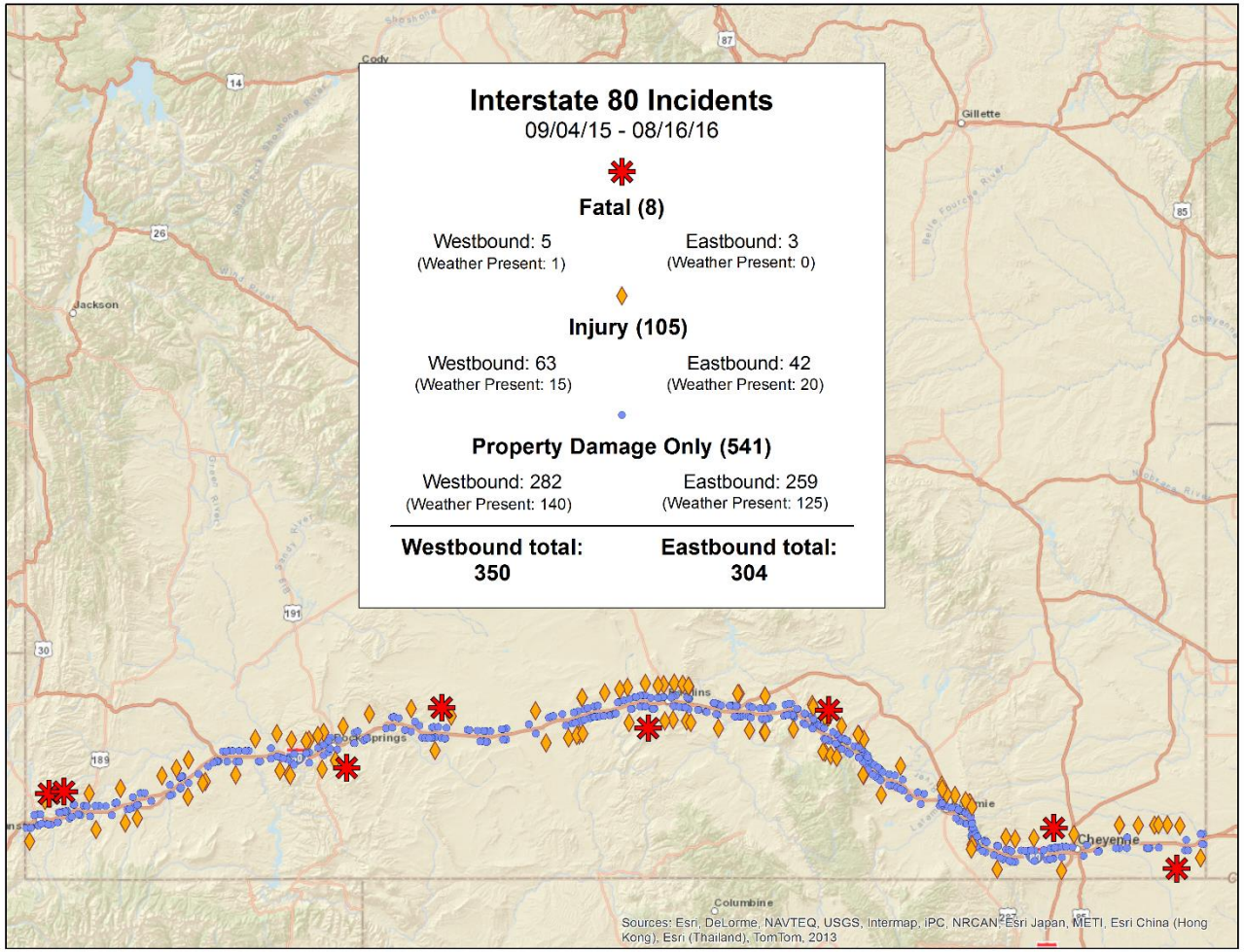
- 37 Days

Inclement weather

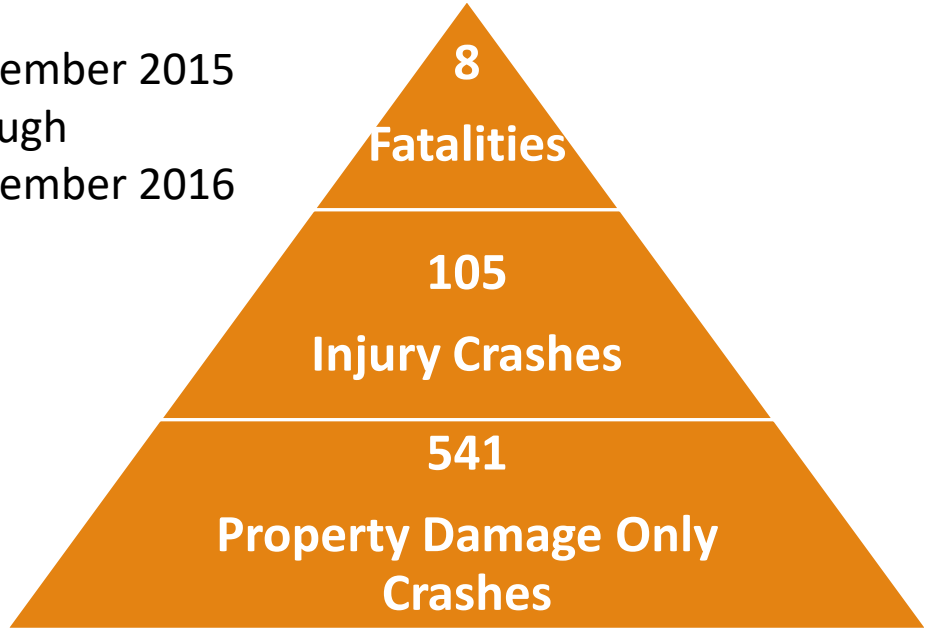
Driving a light truck between Rawlins and Laramie, I-80 drivers would have experienced a total of more than 2 weeks with closures in this 10 month period

Truck Driver

Wyoming CV Pilot: Solving a Real Need



September 2015
through
September 2016



655 incidents involving commercial vehicles on I-80

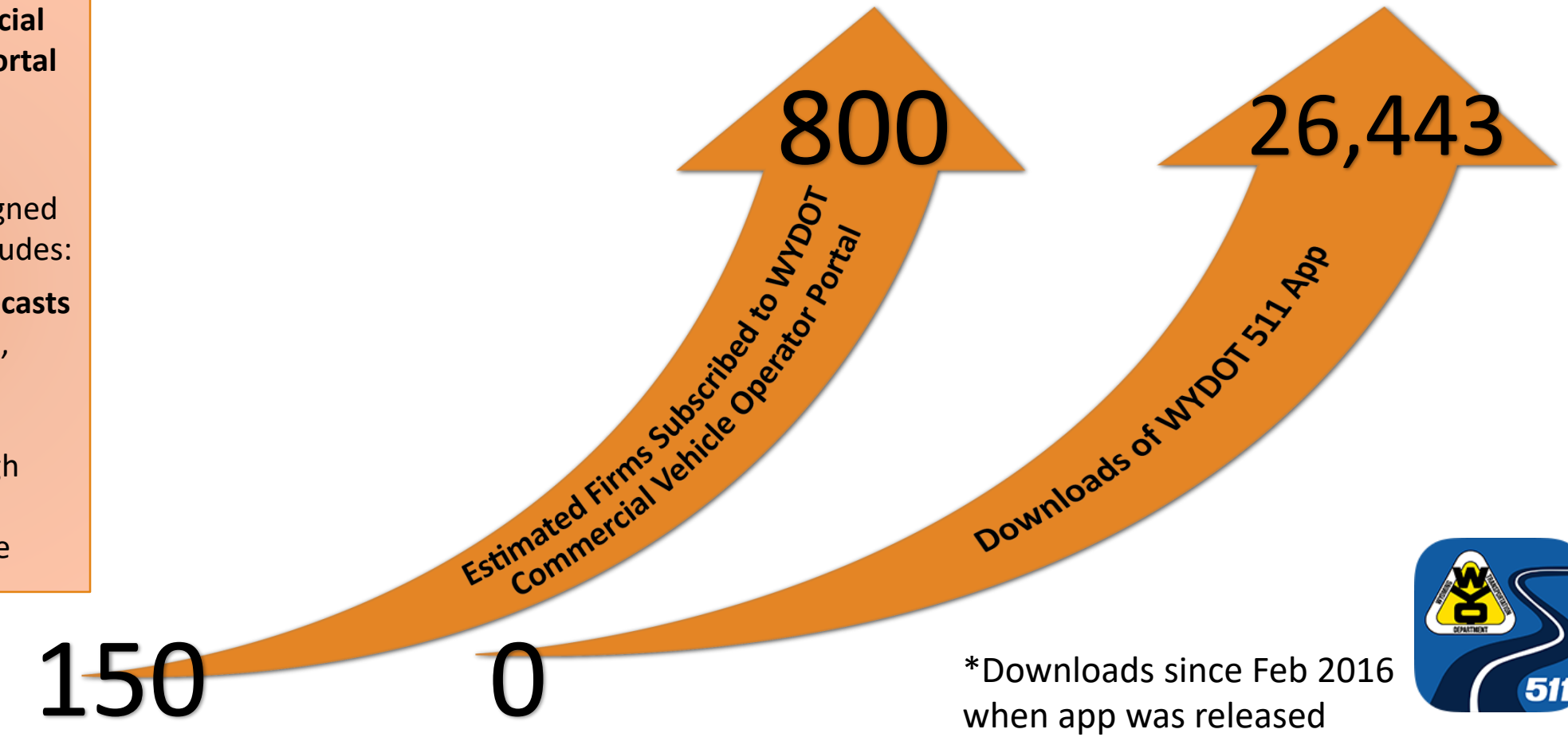
Wyoming CV Pilot: Solving A Real Need

The need for actionable information is growing

WYDOT's Commercial Vehicle Operator Portal (CVOP)

Created for trucking community and designed with their input. Includes:

- **Road weather forecasts** (surface conditions, visibility, wind)
- **Pre-event forecast** information through FHWA's RWMP's Pathfinder initiative



*Downloads since Feb 2016 when app was released

The Wyoming Connected Vehicle Pilot

DSRC Based

Freight-Focused

Integrated with TMC

Integrated with WYDOT Fleets

Forward Looking

The Wyoming Connected Vehicle Pilot

DSRC Based

- 75 Roadside Units on I-80
- 400 Vehicles with DSRC Connectivity

CV Environment

- V2V Applications
  - Forward Collision Warning
  - Distress Notification

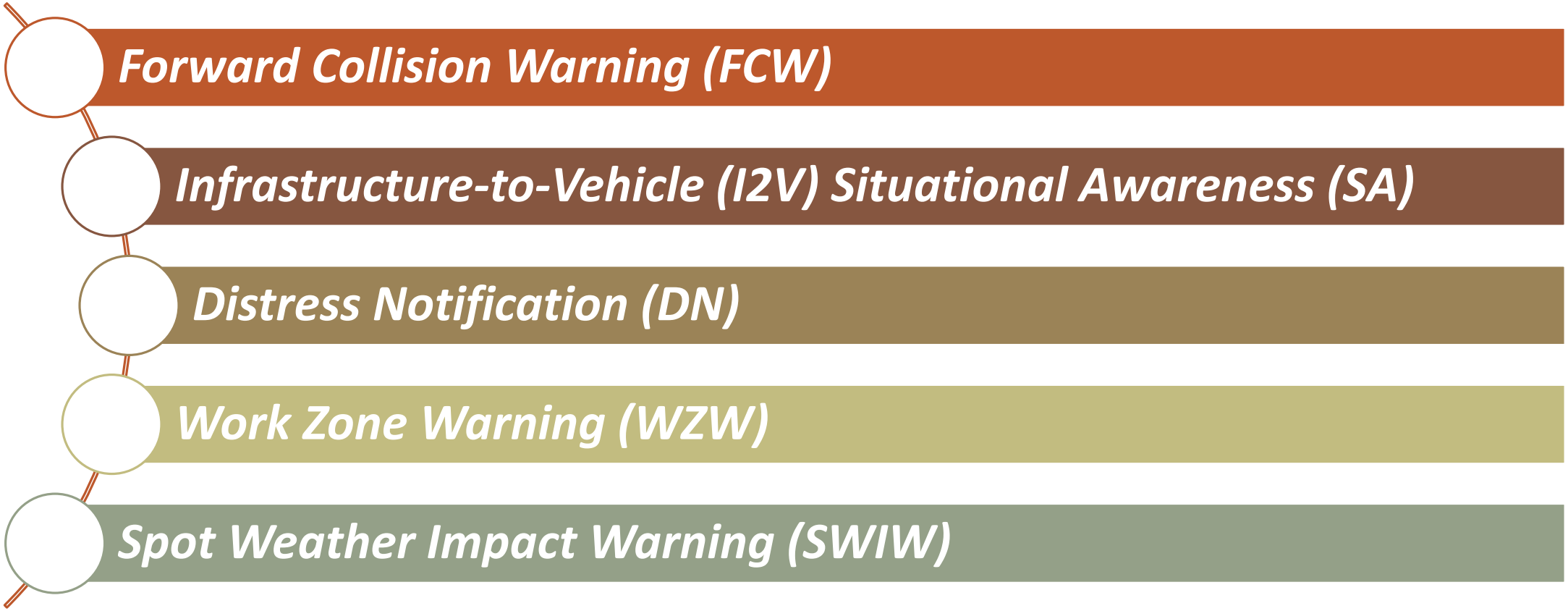
V2V Applications

- V2I Applications
  - Situational Awareness
  - Spot Weather
  - Work Zone Warning

V2I Applications

On-Board Applications

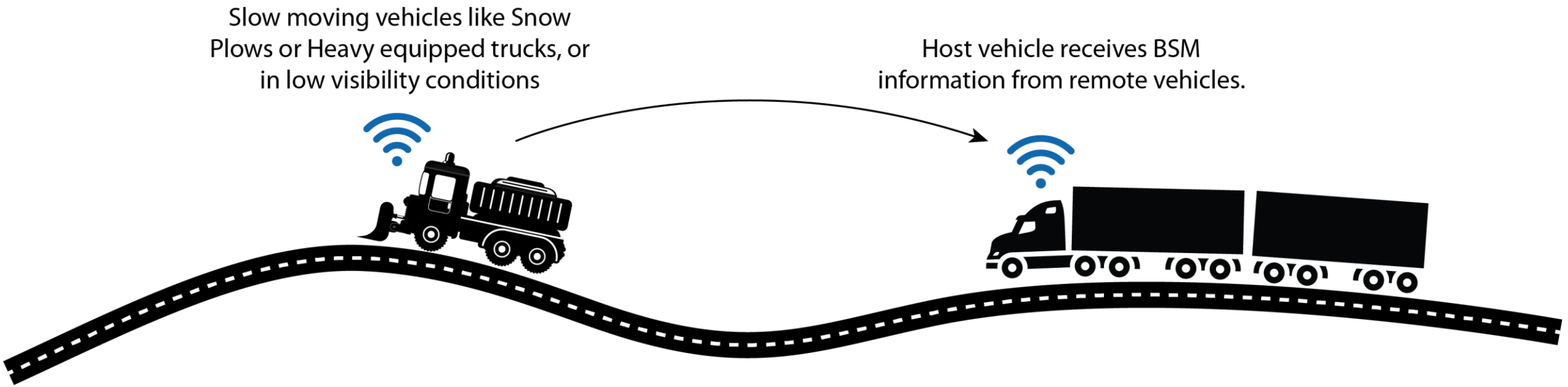
The pilot will develop five on-board applications that will provide key information to the drivers of equipped vehicles.



Forward Collision Warning

Application Summary: V2V communication-based safety feature that issues a warning to the driver of the connected host vehicle in case of an impending front-end collision with a connected remote vehicle ahead in traffic in the same direction of travel on both straight and curved geometry roadways

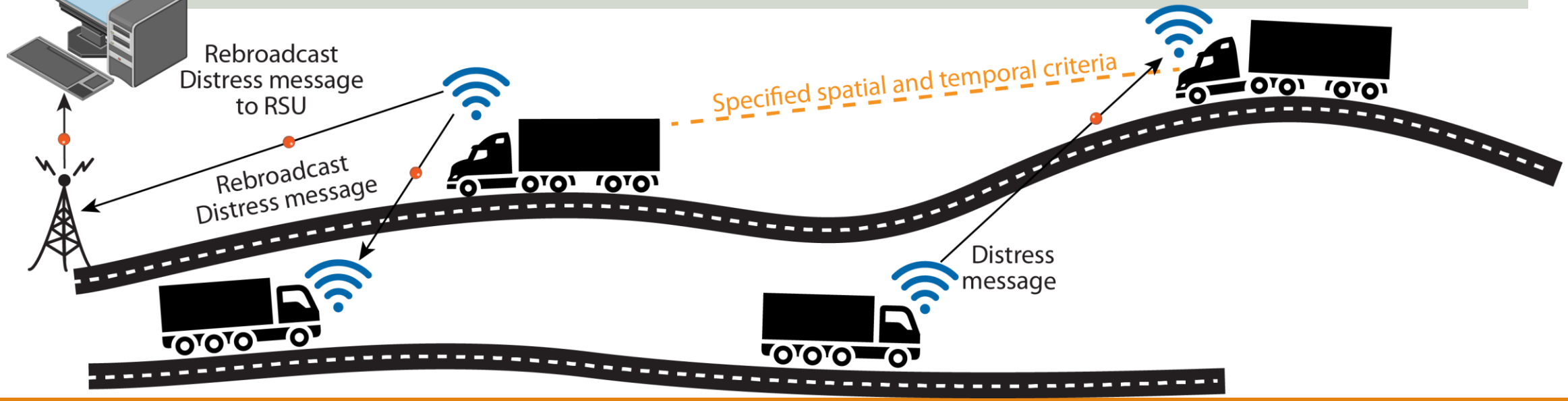
Relevant Standards: J2945/1 March 2016 Section 4.2.4



Distress Notification

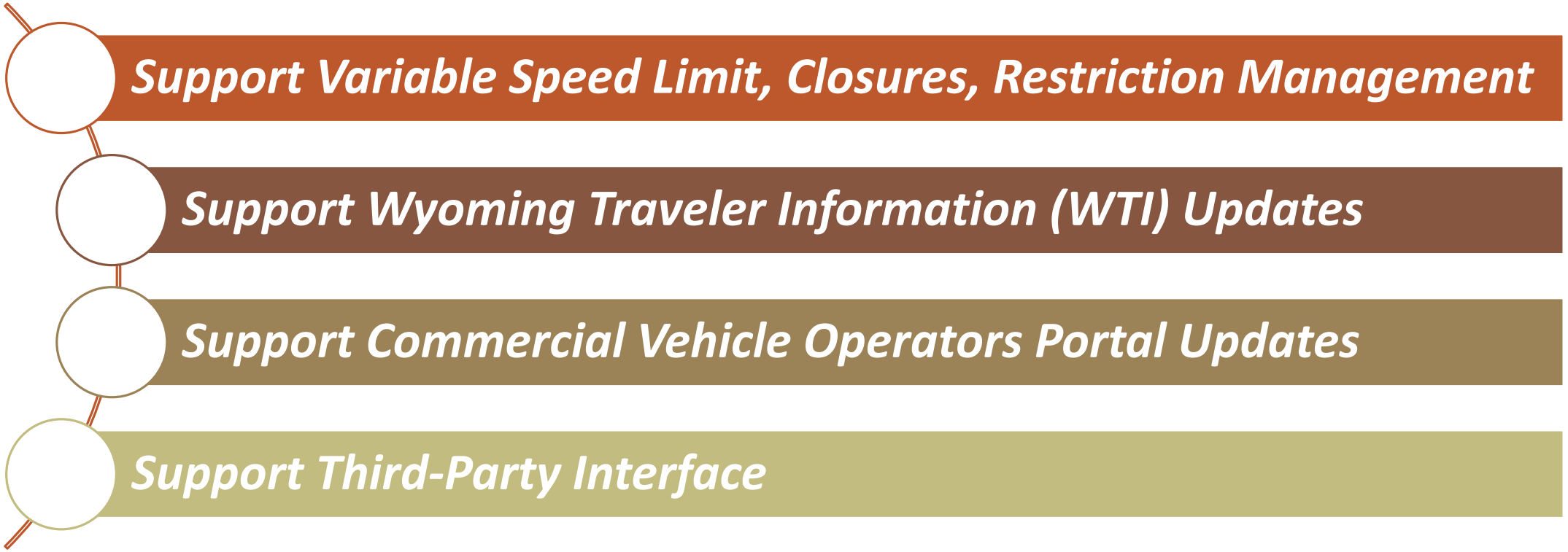
Application Summary: enables connected vehicles to communicate a distress status when the vehicle's sensors detect an event that might require assistance from others or the vehicle's operator manually initiates a distress status. The vehicle generates and broadcasts a distress message (e.g., Mayday) to the nearest RSU. When an RSU is not within communication range, the message is received by connected vehicles that are in the vicinity and forwarded other connected vehicles that are headed towards the event and then to an RSU. Messages drop off after specified spatial and temporal criteria

Relevant Standards: Application is loosely based on the Mayday application description from J3067 Section 3.5.9.2.1, it is built on a higher priority TIM communication using J2736 March 2016, Section 5.16, Part 3, Integrated Transport Information System (ITIS) advisory elements.



TMC Ops Applications

CV Data will support several TMC functions for traffic management and traveler information on I-80. All these applications will be enabled by external interfaces to the existing TMC Systems from the Wyoming CV System



The Wyoming Connected Vehicle Pilot

Freight-Focused

- ~150-200 are large trucks
- ~ 100 are small/medium trucks

CV Trucks

- Trucking Companies of various sizes

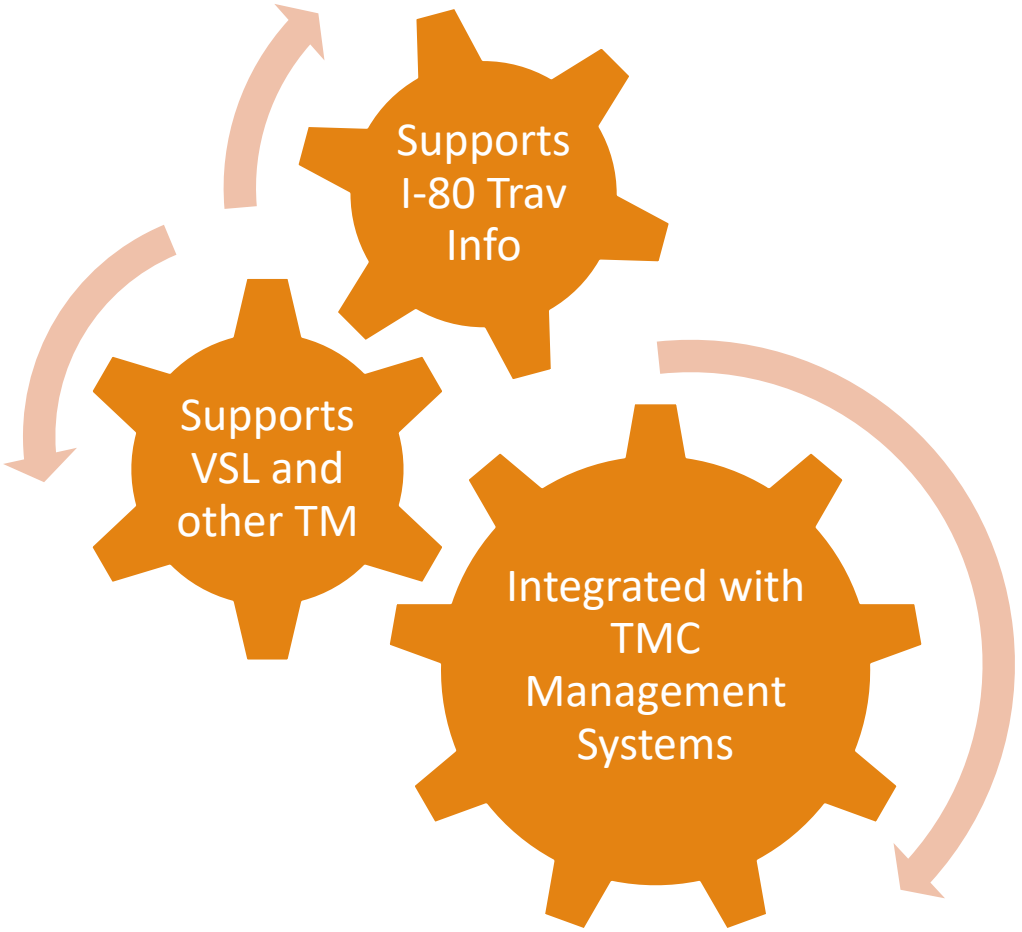
Fleet Partners

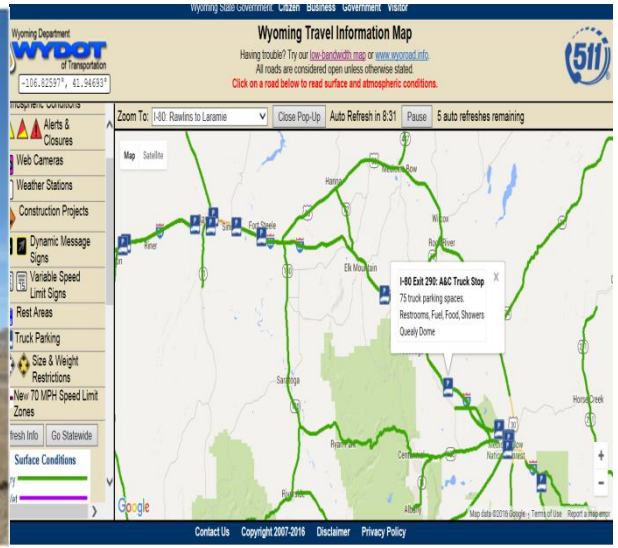
- CVOP Users (800 firms)
- Wyoming Trucking Association
- Third Party Intermediaries

Freight Partners

The Wyoming Connected Vehicle Pilot

Integrated with TMC

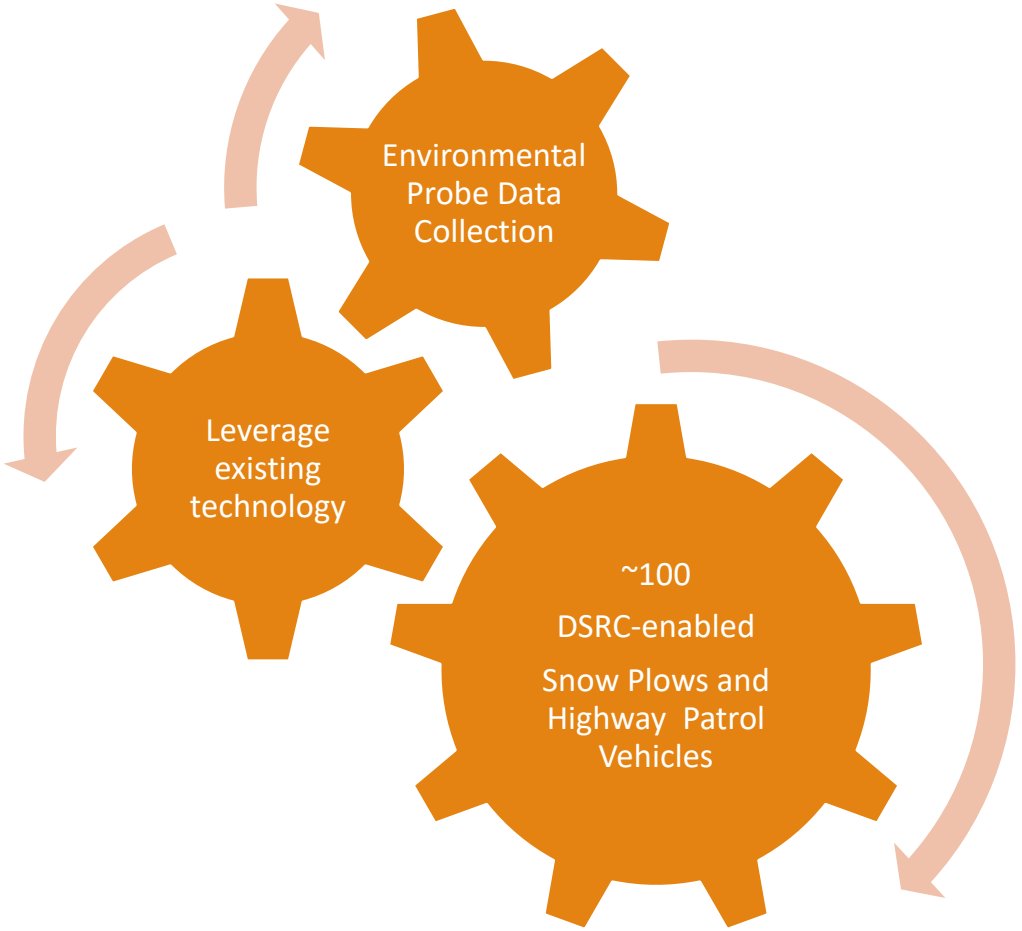




WYDOT's VSL, 511 and other services will rely on CV data for updates

The Wyoming Connected Vehicle Pilot

Integrated with WYDOT Fleets



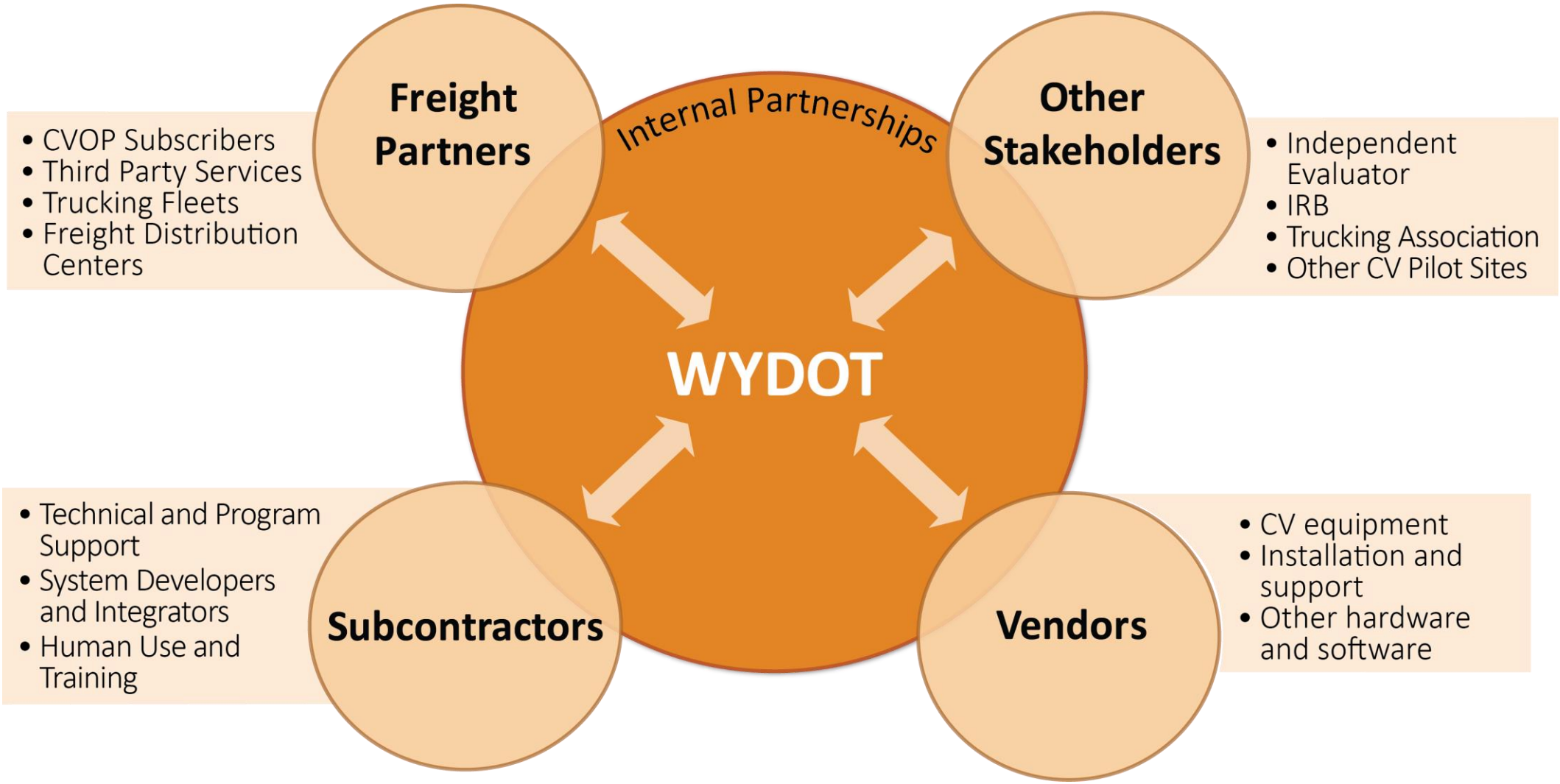
WYDOT's use of its own fleets in CV pilot allows continued operations post pilot

The Wyoming Connected Vehicle Pilot

Forward Looking

- Standards-Driven
- Integration with Third-Party Intermediaries
- Integration with Satellite Delivery of TIMs
- Close coordination with other CV sites

Partnership Plan



Wyoming CV Pilot – Performance Measures

Purpose

- Measure project impacts and benefits
- Contribute to CV Program benefits database

Activities

- Establish Baseline
- Collect, manage data
- Analyze Performance during Demonstrations
- Report

Other

- Collect and share data with USDOT
- Support Independent Evaluators

Wyoming CV Pilot – Performance Measures

Road Weather Condition Input	TMC Information Dissemination	Vehicle/Roadside Alerts & Advisories	Outcomes
Improve road weather condition reports received into the TMC	Improve ability of the TMC to generate alerts and advisories	Effectively transmit and receive V2V messages	Improve speed adherence and reduce speed variation
	Efficiently disseminate broad area traveler information	Automate emergency notifications of a crash	Reduce vehicle crashes
	Effectively disseminate and receive I2V or V2I alert/advisory messages from TMC		
	Improve information to commercial vehicle fleet managers		

Wyoming CV Pilot – Performance Measures

Improve road weather condition reports received into the TMC	1. Number of road weather condition reports per road segment/day pre and post CV Pilot (quantity) 2. Miles with at least one reported road condition per hour pre and post CV Pilot (coverage) 3. Average refresh time of road condition reports in each segment pre and post CV Pilot (latency)
Improve ability of the TMC to generate alerts and advisories	4. Pikalert™ generated alerts and advisories that were accepted by TMC operators
Efficiently disseminate broad area traveler information	5. TMC staff time to disseminate broad area traveler information. Activities include log/process road condition reports and activate/update VSL, DMS, and HAR systems 6. Qualitative improvements in 0-6 hour road weather forecasting accuracy due to enhanced road condition data

Wyoming CV Pilot – Performance Measures

Effectively disseminate and receive I2V or V2I alert/advisory messages from TMC

7. Alerts/advisories sent from the TMC and received by the RSU
8. Alerts/advisories sent and received between the RSU and OBU
9. Connected vehicles that took action following receipt of an alert
    a. Parked
    b. Reduced Speed
    c. Came to a stop safely
    d. Detoured

Improve information to commercial vehicle fleet managers

10. Number of operational changes made by fleet managers due to information from TMC during CV Pilot
    a. Routing
    b. Timing
    c. Parking availability
    d. Canceled trips
11. Commercial vehicle managers are satisfied with information provided by the TMC during the CV Pilot
    a. Road conditions
    b. Road weather forecasts
    c. Parking information

Wyoming CV Pilot – Performance Measures

Effectively transmit and receive V2V messages

12. V2V alerts properly received in surrounding vehicles from sending vehicle
13. Connected vehicles that took action following receipt of a V2V alert
    a. Parked
    b. Reduced Speed
    c. Came to a stop safely
    d. Detoured

Automate emergency notifications of a crash

14. Number of emergency notifications that are first received in the TMC from connected vehicles (compared to alternate traditional methods, such as 911 caller)

Wyoming CV Pilot – Performance Measures

Improve speed adherence and reduce speed variation

15. Total vehicles traveling at no more than 5 mph over the posted speed (compare before and after CV Pilot)
16. Total vehicles traveling within +/- 10 mph of 85th percentile speed (compare before and after CV Pilot)
17. Speed of applicable connected vehicles are closer to posted speed when compared to non-connected vehicles

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Reduce vehicle crashes

18. Reduction of total and truck crash rates of along the corridor *
19. Reduction of the number of vehicles involved in a crash *
20. Reduction of total and truck crash rates within a work zone area *
21. Reduction of critical (fatal or incapacitating) total and truck crash rates in the corridor *
22. Number of connected vehicles involved in a crash
    a. Initial crashes
    b. Secondary crashes

* Compare a 5-year average before Pilot to CV Pilot data and track connected versus non-connected vehicles

Evaluation Designs

Before – After
- Comparison of pre and post deployment
- Key: documented baseline (planned in Phase II)

With – Without
- Compare with and without technology deployment during same conditions
  - Equipped vehicles compared to non-equipped vehicles at same time, location

System Performance
- Evaluate how well system worked
  - Alerts/advisories created, sent, received (I2V, V2I, V2V)

Behavior Assessment
- Measure driver's actions that result from CV technology application

Qualitative Assessment
- Surveys and Interviews with key stakeholders
- Supplemental to quantitative analyses
  - Learn details regarding perceptions, likes/dislikes, and the why, when, and how's

Evaluation Design Application

Evaluation Category	Before – After	With – Without	System Performance	Behavior Assessment	Qualitative
Improved road weather reports	●				
Improved alerts - advisories			●		
Disseminated broad area Traveler info	●				●
Sent, received V2I alerts-advisories			●	●	
Information to CVO fleet managers	●				●
Sent, received V2V alerts-advisories			●	●	
Automated emergency notifications			●		
Improved speed adherence/variation	●	●			
Reduced vehicle crashes	●	●			

Contextual PM data needs

Connected Vehicle Location at all times (time, location, direction)

Estimated connected vehicle penetration rate

Weather event and road condition characteristics at all times

Alert/advisory message details (number, type, content, time stamp, and location)

Connected vehicle incidents

Equipment reliability and up-time

Confounding Factors

CV Technology Penetration Rate

- 400 – 500 connected vehicles – known location and time
- Estimate penetration rate – support understanding evaluation results
- Simulation modeling will provide additional insights

CV Technology Adoption

- New technology = CHANGE (process, equipment, etc.)
- Myriad agencies, users, stakeholders
- Significant system training, follow-up
- Qualitative assessments will help to understand technology adoption

Freight and Passenger Vehicle Demand

- Freight demand dependent on economic conditions, fuel prices, construction, etc.
- Alternate routes are generally not practical
- Numbers of trucks and cars will be tracked throughout demonstration

Confounding Factors

Weather Condition Variability

- Need to conduct evaluation analysis during like conditions
- Before/after and with/without analysis methods
- Weather events will be logged and categorized (baseline and demonstration)
- Data comparisons will be for like weather events

Availability of Sensing in the Corridor

- Weather, speed sensing – focused in VSL corridors (35% of corridor)
- Roughly 6-7 mile spacing (heavily instrumented Interstate corridor)
- Supplement: Proposing mobile sensor trailers (budget permitting)

Limited Duration of Evaluation Activities

- Primarily focus on weather events – mostly winter seasons
- Aggressive project schedule allowing for two evaluation periods
  - 2017-2018 winter season
  - 2018-2019 winter season

More Information: http://www.its.dot.gov/pilots/

Questions?

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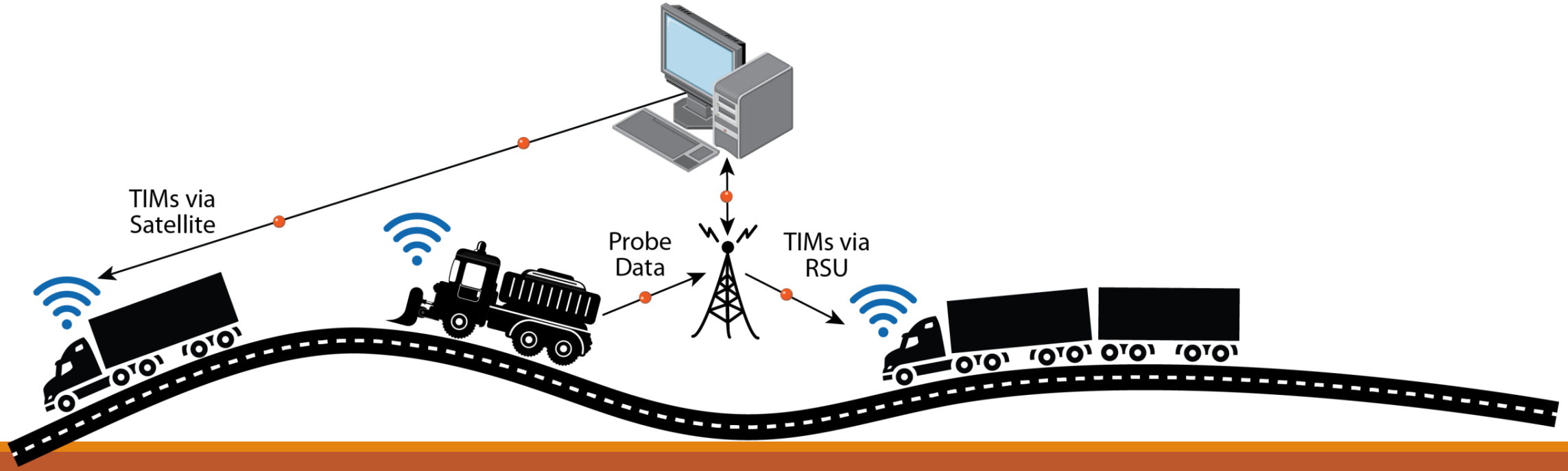
I2V/V2I Situational Awareness

Application Summary: Relevant downstream road condition information including weather alerts, speed restrictions, vehicle restrictions, road conditions, incidents, parking, and road closures to be broadcast from a roadside unit and received by the connected host vehicle. Information can be also provided by remote communications to vehicles equipped with Satellite Receivers from the Wyoming CV System. Probe data is collected via RSUs from fleet vehicles and use to generate alerts and advisories

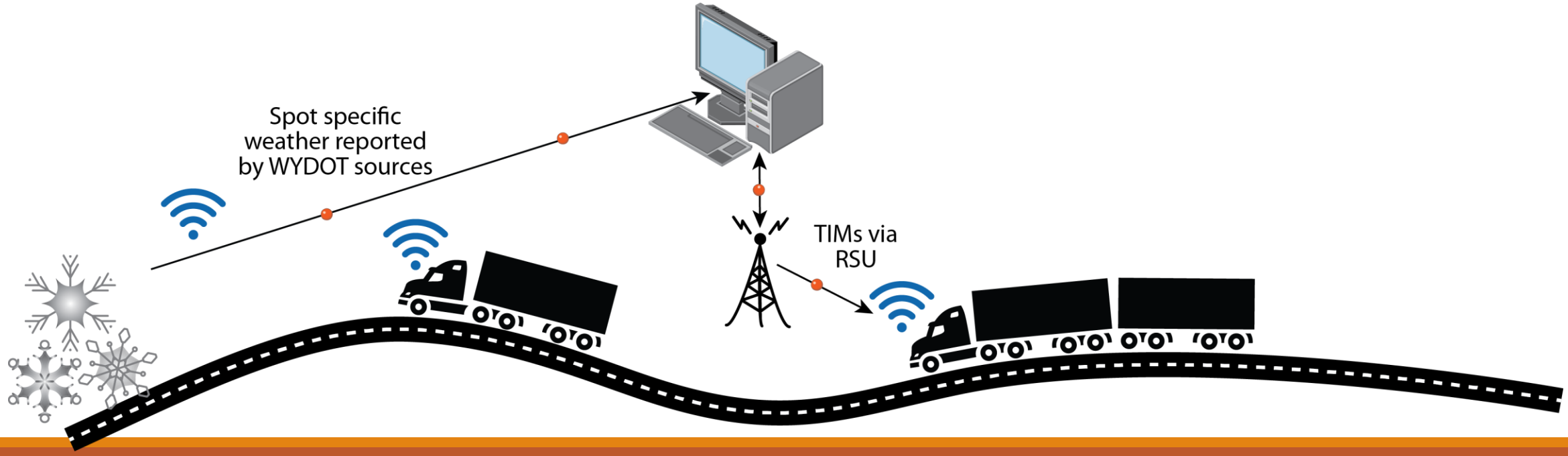
Relevant Standards: J3067 August 2014 Section 2.9.3.6.



Spot Weather Impact Warning (SWIW)

Application Summary: Similar to situational awareness, this application enables relevant road condition information, such as fog or icy roads, to be received by the connected host vehicle. This application, however, is distinct from situational awareness in that it provides more localized information (i.e., at the segment level instead of area wide or region wide).

Relevant Standards: This application will follow the TIM advisory content from part 3 defined in J2735 Section 6.142 for ITIS data elements 6.54 for weather conditions and 6.55 for winds defined in J2540_2.



Work Zone Warning (WZW)

Application Summary: This application provides information about the conditions that exist in a work zone toward which the vehicle is approaching. This capability provides approaching vehicles with information about work zone activities that could present unsafe conditions for the vehicle, such as obstructions in the vehicle's travel lane, lane closures, lane shifts, speed reductions or vehicles entering/exiting the work zone.

Relevant Standards: TIM work zone warning described in J2735 part 3 in Section 6.142.