CONNECTED VEHICLE PILOT
Deployment Program

Performance Measurement and Evaluation Support Plan
ICF/Wyoming CV Pilot

Kate Hartman, Program Manager & ICF/WYDOT Site COR
Deepak Gopalakrishna/ICF, Project Manager
Fred M Kitchener/McFarland Management, PM Lead

TODAY'S AGENDA

- Purpose of this Webinar
  - To share the Performance Measurement and Evaluation Support plan from the ICF/Wyoming team with the stakeholders of connected vehicle technologies.

- Webinar Content
  - Connected Vehicle Pilot Deployment Program Overview
  - ICF/Wyoming Performance Measurement and Evaluation Support Plan
  - Stakeholder Q&A
  - How to Stay Connected

- Webinar Protocol
  - Please mute your phone during the entire webinar
  - You are welcome to ask questions via chatbox at the Q&A Section
  - The webinar recording and the presentation material will be posted on the CV Pilots website

CONNECTED VEHICLE PILOT DEPLOYMENT PROGRAM

PROGRAM GOALS

STAY CONNECTED

- Participate in Concept Development Phase Webinars for the three Pilot Sites (see website for exact dates and times)

Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016
◆ ◆	◆		◆ ◆ ◆			◆ ◆ ◆

Concept of Operations Webinars | **Performance Measurement Webinars** | **Comprehensive Deployment Plan Webinars**

- Visit Program Website for Updates: http://www.its.dot.gov/pilots
- Contact: Kate Hartman, Program Manager, Kate.hartman@dot.gov

PILOT SITES

ICF/Wyoming DOT

NYCDOT

Tampa (THEA)

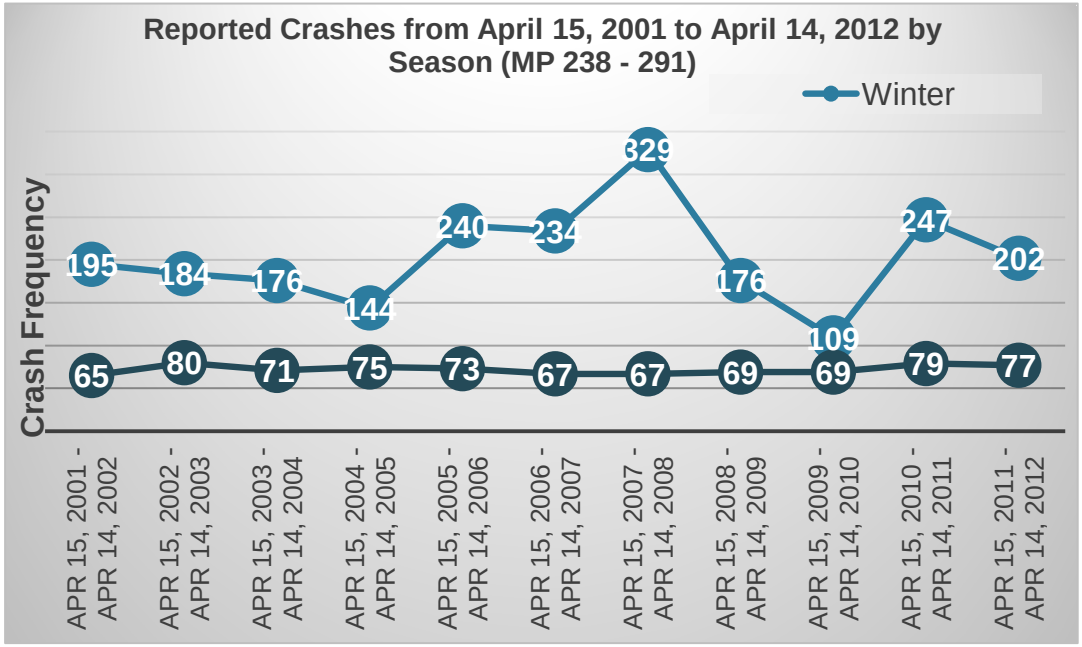
ICF/Wyoming

Project Overview

Deepak Gopalakrishna - ICF

High Crash Rates

- Winter crash rate (October to April) has been found to be 3 to 5 times as high as the summer crash rates
- Speed management is critical



4/13/2014 - Between Laramie and Rawlins - Speeds reduced to 45 mph in VSL zone – **0 Fatalities - 70+ vehicles**

4/15/2015 - Between Cheyenne and Laramie - Speeds reduced to 45 mph in VSL zone – **0 Fatalities - 65+ vehicles**

4/20/2015 - Between Laramie and Rawlins - Speeds 75 mph (no VSL available) – **2 Fatalities - 65+ vehicles**

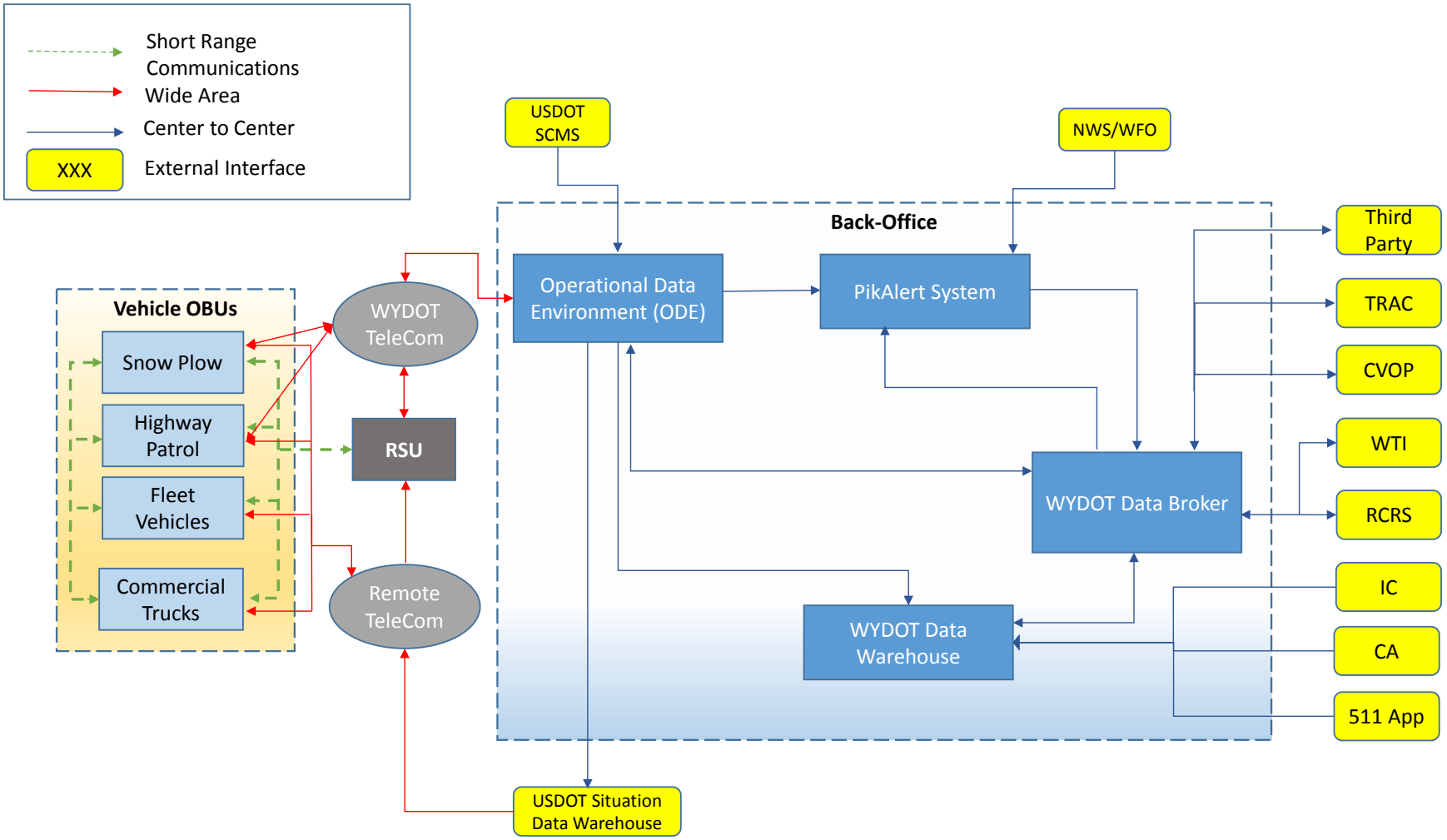
Five Focus Areas

- Manage following speed and distance between vehicles by alerting trucks to slowing traffic ahead to prevent multiple-vehicle crashes.
- Provide custom alerts and advisories for vehicles that are at risk due to their weight, profile or traveling speeds due to high-winds, near work zones, include alerting drivers if their vehicles are too tall for bridges.
- Provide location-based parking information with a focus on directing drivers to safe parking areas in the event of a road closure.
- Allow first responders to be notified of a crash automatically based on vehicle metrics, such as airbag deployment.
- Use data collected from vehicle's weather sensors such as the status of windshield wipers and if anti-lock brake systems are activated. This information will be used to develop advisories and forecasts for travel to fleet management centers and the general public.

Goals for WYDOT

Operational	• Not an R&D effort. To be used by WYDOT Operations for immediate needs
Scalable and Sustainable	• Ability to incorporate new fleets and applications
Evolutionary	• Ability to start with a few applications/services but grow to an eco-system of services
Replicable	• Be a model deployment for rural freight-heavy corridors
Leveraged	• Maximize use of already created federal investments and state initiatives. Do not recreate the wheel

Physical Architecture



ICF/Wyoming

CV Pilot Performance Measures

Fred M. Kitchener - McFarland Management

PMs Are Represented in 9 Categories

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		

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

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

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)

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

ICF Wyoming CV Pilot Confounding Factors

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

ICF/Wyoming CV Pilot Impact Evaluation Design

Five 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 Performance Measurement Data

- 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

Importance of Establishing Baseline

- Many PMs will use Before-After evaluation design method
- Establishing a baseline (prior to CV technology deployment) is essential to successful evaluation
  - Phase II activity
- Examples of baseline data
  - Traffic characteristics – truck and cars
  - Road weather condition reports
  - TMC operator time to conduct key actions
  - Baseline surveys of key stakeholders
  - Vehicle speed, speed variation
  - 5-year history of crash data

ICF/Wyoming CV Pilot Data Collection Plan

Data Collection

- Data types
  - System
  - Non-System
  - Survey
  - Modeling and simulation
  - Interview
- Frequency of data collect is dependent on type and system
- Stored in WYDOT Data Warehouse
- Baseline data collection
- Data available to evaluate Performance Measures

Data Types

Data Type	Elements
System	BSMs, alerts/advisories, RSU logs, DSRC logs, OBU logs, PikAlert logs, TMC logs, WTI updates, crash notifications, partner fleet manager data, security breaches, mobile road weather observations, other connected vehicle alerts
Non-System	Traffic data, crash records, road closures, RWIS data, DMS logs, Construction and maintenance event logs
Survey	Participant survey results pre and post deployment
Model and Simulation	VISSIM simulation model results, UW driver simulator analysis results
Interviews	Stakeholder interview results pre and post deployment

ICF/Wyoming CV Pilot Performance Reporting and Data Sharing

Data Sharing

- System performance data will be shared with USDOT and Independent Evaluator on a regular basis
  - System data – as appropriate
  - Crash and other outcome data – seasonally, focused on weather events
- Templates and dashboards will be created for efficient data sharing
  - USDOT and Independent Evaluator
- Appropriate data will be uploaded to RDE at appropriate times during the Pilot

ICF/Wyoming CV Pilot
Next Steps

Schedule and Next Steps

Activity	2016	2017				2018				2019			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase II													
- Document Baseline Conditions													
- Support System Design and Build Activities													
- Revise PM & ES Plan, with baseline													
Phase III													
- Execute PM & ES Plan													
- Data Collection													
- Data Management/Performance Reporting													
- Prepare Performance Measurement Report													

Next Steps

- Complete Phase 1 activities – Deployment Plan
- Baseline data collection and documentation
- Revise Performance Measurement and Evaluation Support Plan
- Execute during demonstration
  - 2017 – 2018 winter – WYDOT and TriHydro vehicles
  - 2018 – 2019 winter – add other commercial vehicle partners

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

STAY Connected

Contact for CV Pilots Program:

Kate Hartman, Program Manager

Kate.Hartman@dot.gov

Join us for the *Getting Ready for Deployment* Series

- Discover more about the CV Pilot Sites
- Learn the Essential Steps to CV Deployment
- Engage in Technical Discussion

Website: http://www.its.dot.gov/pilots

Twitter: @ITSJPODirector

Facebook:
https://www.facebook.com/USDOTResearch

CV Pilot Sites' Performance Measurement Webinars

- 6/6/2016, 2:00 pm – 3:00 pm ET
  ICF/WYDOT Performance Measurement Webinar
- 6/6/2016, 3:30 pm – 4:30 pm ET
  NYCDOT Performance Measurement Webinar
- 6/7/2016, 12:00 pm – 1:00 pm ET
  Tampa (THEA) Performance Measurement Webinar

Please visit the CV pilots website for the recording and the briefing material of the previous webinars.