Next Generation Integrated Mobility:
Driving Smart Cities

www.itsworldcongress2017.org

ITS WORLD CONGRESS 2017
Montréal | OCTOBER 29 - NOVEMBER 2
SESSION 1: DEPLOYMENT STATUS AND DEMONSTRATION IMPACTS

Program Manager: Kate Hartman, ITS JPO, USDOT
SESSION AGENDA

- Session Introduction and CV Pilots Overview
  - Kate Hartman, Chief, Research, Evaluation, & Management, ITSJPO, USDOT
- NYCDOT Pilot Deployment Overview
  - Mohamad Talas, Program Management Lead, New York City Department of Transportation (NYCDOT) Pilot Project
- Wyoming DOT Pilot Deployment Overview
  - Tony English, System Design Lead, Wyoming Department of Transportation (WYDOT) Pilot Project
- Tampa (THEA) Pilot Deployment Overview
  - Bob Frey, Program Management Lead, Tampa Hillsborough Expressway Authority (THEA) Pilot Project
- Q&A
CV PILOT DEPLOYMENT PROGRAM GOALS
THE THREE PILOT SITES

- Reduce the number and severity of adverse weather-related incidents in the I-80 Corridor in order to improve safety and reduce incident-related delays.
- Focused on the needs of commercial vehicle operators in the State of Wyoming.

- Improve safety and mobility of travelers in New York City through connected vehicle technologies.
- Vehicle to vehicle (V2V) technology installed in up to 8,000 vehicles in Midtown Manhattan, and vehicle to infrastructure (V2I) technology installed along high-accident rate arterials in Manhattan and Central Brooklyn.

- Alleviate congestion and improve safety during morning commuting hours.
- Deploy a variety of connected vehicle technologies on and in the vicinity of reversible express lanes and three major arterials in downtown Tampa to solve the transportation challenges.
Phase 1: Concept Development (COMPLETE)
- Creates the foundational plan to enable further design and deployment
- Progress Gate: Is the concept ready for deployment?

Phase 2: Design/Deploy/Test (CURRENT PHASE - began September 1, 2016)
- Detailed design and deployment followed by testing to ensure deployment functions as intended (both technically and institutionally)
- Progress Gate: Does the system function as planned?

Phase 3: Maintain/Operate
- Focus is on assessing the performance of the deployed system
- Post Pilot Operations (CV tech integrated into operational practice)
CV PILOTS IN ITS WORLD CONGRESS

**USDOT Booth #1301 (near the exhibit hall entrance) Schedule**

<table>
<thead>
<tr>
<th>Mon., October 30</th>
<th>Tues., October 31</th>
<th>Wed., November 1</th>
<th>Thurs., November 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00 to 18:30</td>
<td>09:00 to 18:30</td>
<td>09:00 to 18:00</td>
<td>10:00 to 15:00</td>
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**Pilot Program Sessions at ITS World Congress**

**Mon., October 30, Room 515 ABC**

- **12:00 to 13:30** – SIS19: Connected Vehicle Pilot Deployment Program Session 1: Deployment Status and Demonstration Impacts
- **13:45 to 15:15** – SIS26: Connected Vehicle Pilot Deployment Program Session 2: Technical Challenges and Proposed Solutions
- **15:30 to 17:00** – SIS33: Connected Vehicle Pilot Deployment Program Session 3: Evaluating Performance and Long-Term Sustainment

**Pilot Program Representative Speaker Schedule at USDOT Booth**

**Tues., October 31**

- **Wyoming** - 14:00 to 15:00
- **Tampa** - 15:00 to 16:00
- **New York City** - 16:00 to 17:00

**Wed., November 1**

- **New York City** - 09:00 to 10:00
- **Tampa** - 10:00 to 11:00
- **Wyoming** - 11:00 to 12:00
Mohamad Talas
New York City Department of Transportation (NYCDOT)

NYC Pilot Deployment Overview
NYC CV Pilot Objective

“Traffic Death and Injury on City streets is not acceptable”

The NYC pilot will evaluate the safety benefits and challenges of implementing CV technology:

• With a significant number of vehicles

• In a dense urban environment
1. Manage Speeds
   - General within the project area
   - Work/speed zones within the project area
   - Ramp speed – to avoid roll-over
2. Reduce vehicle-to-vehicle Crashes
3. Reduce Vehicle-to-Pedestrian Crashes
   - Provide assistance in navigating intersections for the visually challenged
4. Reduce Vehicle-to-Infrastructure Crashes
5. Inform Drivers of Serious Incidents or emergency situations (e.g. blocked major arterials or evacuation)
6. Collect Mobility Data – for analysis and adaptive control
7. Manage System Operations
NYC TRANSPORTATION CHALLENGES
OVERALL PROJECT CONCEPT
**Pedestrian Application:**

- Navigation Assistance for the Visually Impaired
- Working cooperatively with NYU
Vehicle to Vehicle (V2V) applications work \textit{wherever} equipped vehicles encounter one another.

Vehicle to Infrastructure (V2I) applications work where \textit{infrastructure is installed} (highlighted streets)

\textit{The CV project leverages the City’s transportation investments}
CV DEPLOYMENT FLEETS – OUR STAKEHOLDERS

- Up to 8,000 **fleet vehicles** with Aftermarket Safety Devices (ASDs):
  - ~6,000 Taxis (Yellow Cabs)
  - ~700 MTA Buses
  - ~400 UPS vehicles
  - ~600 Sanitation & DOT vehicles

- Pedestrian **PID**s ~100 units
  - PED Detection – 10 Intersections

- Roadside Units (**RSU**) ~202 Manhattan Ave
  - ~79 Manhattan Cross
  - ~28 on Flatbush Ave
  - ~8 on FDR
  - ~36 Support locations (airports, river crossings, terminal facilities)
  - ~353 Total

Source: USDOT
Support RSUs, Include Airport Taxi Holding Areas
Aftermarket Safety Device

- Audio output only
  - Tones based on threat
  - Words based on situation
  - Mixture of both

- ASD includes
  - Inertial Navigation
  - GNSS Navigation
  - Connection to Vehicle data Bus

- Multi Channel DSRC support
  - Security Management Features

Source: NYCDOT

Verifies Proper Operation

Alerts, warnings & driver information

Left
Speakers

Right

MIC

Power

After Market Safety Device (ASD)

Vehicle CAN of J Bus

GPS

DSRC (2 channel)
Wire Shark Antenna
IN-VEHICLE ASD AND INSTALLATION KITS

- NYC DOT to develop installation and training procedures
- Training will include all aspects of vehicle installation and testing (extra RSUs acquired to setup installer testing)
- Installation kits will vary by each fleet.
  - Dot, TAXI, MTA, UPS, MTA
  - Buses, heavy vehicles, light vehicles
- Vendor provides on site engineering support for 6 months
- Vendor to provide up to 8 weeks of on-call engineering support
Vehicle-to-Vehicle (V2V) Safety Applications

- Vehicle Turning Right in Front of Bus Warning (VTRW)
- Forward Crash Warning (FCW)
- Emergency Electronic Brake Light (EEBL)
- Blind Spot Warning (BSW)
- Lane Change Warning/Assist (LCA)
- Intersection Movement Assist (IMA)

V2V applications based on existing demonstrations and prior developments and documentation
CV APPLICATIONS - 2

Vehicle-to-Infrastructure (V2I) Safety Applications

- Red Light Violation Warning
- Speed **Compliance**
- Curve Speed **Compliance**
- Speed **Compliance**/Work Zone
- Oversize Vehicle **Compliance**
  - Prohibited Facilities (Parkways)
  - Over Height
- Emergency Communications and Evacuation Information
  *Using the traveler information features*

**RLVW**
**SPD-COMP**
**CSPD-COM**
**SPDCOMPWZ**
**OVC**
**EVACINFO**

V2I applications based on existing demonstrations and/or modifications to prior developments and documentation
CV APPLICATIONS - 3

Other Applications

- Mobile [Visually Impaired] Ped Signal System: PED-SIG
- Pedestrian in Signalized Intersection Warning: PEDINXWALK
- CV Data for Intelligent Traffic Signal System: I-SIGCVDAT

Operations, Maintenance, and Performance Analysis

- RF Monitoring: RFMON
- OTA Firmware Update: FRMWUPD
- Parameter Up/Down Loading: PARMLD
- Traffic data collection: TDC
- Event History Recording: EVTRECORD
- Event History Up Load: EVTCOLLECT

To Meet USDOT Requirements for Benefit Analysis
Performance Metrics & Evaluation Methods
While preserving privacy

Safety Needs (ConOps) → Safety applications → Developed Questions for Evaluation → Performance Measurement Metrics

Reduce Veh-Veh Crashes

- V2V & V2I Safety Applications for Crash Avoidance
  - Does number of crashes decrease?
  - Does number and severity of red light violations decrease?
  - Does number of bus / right turn vehicle crashes decrease?

Data collection:
Everything that “occurred” immediately before and after the alert

- Fatality crash counts
- Injury crash counts
- Property damage only crash counts
- Time to Collision
- Red light violation counts
- Red light violation crash counts
-Driver actions and/or impact of actions when they receive alerts
- Bus & right turn related crash counts
- Number of warnings generated
- Right-turning related conflicts

~47
EXAMPLE OF LOGGING

- **EvtRcd Parameter**
- **Control Parameter**
- **SpdThreshold**
- **StartUp**
- **CVAppX (Safety App)**
  - **BSM_{HV}**
  - **BSM_{TV}**
  - **BSM_{RVn}**
  - **SPaT** Closest RSU
  - **MAP** Closest RSU

**EvtRcdApp**

- HV – Host Vehicle
- TV – Target Vehicle
- RV – Remote Vehicle
- n – Vehicle 1-n

All of the data collected during T_x is transferred to the event record, and after the trigger the data is collected and added to the record until T_x expires.

<table>
<thead>
<tr>
<th>Time Before</th>
<th>Time After</th>
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<tbody>
<tr>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
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</table>
Obfuscation of Logs for Privacy

- Obfuscation process to scrub precise time and location data
  - Relative details retained
  - Non-obfuscated data will be destroyed following the obfuscation process
**Deployment Approach**

- **Turn-key ASD and RSU equipment procurement**
  - Multiple stage delivery
    - Award to 2 ASD Bidders (~1/2 each) and 1 RSU Bidder
    - Prototypes install/test Hardware/Software/DSRC
    - Prototypes are verified in the field
    - Production units delivered

- **City field installation (RSU)**
- **Project team developing back-office software**
- **Vehicle installation**
  - City personal – City Fleets
  - CMT and Verifone
  - UPS – handles their own vehicles

- **Concept: Verify the hardware & software platform early**
  - Use OTA updates (firmware, parameters) to tune and expand the applications

*The limiting factor – Installation time for 8000 vehicles!*
Phase 1 Completed October 2016

- Deliverables:
  - Concept of Operations
  - Security Management Operating Concept
  - Safety Management Plan
  - Performance Measurement Plan
  - System Requirements
  - Application Deployment Plan
  - Human Use Approval Summary
  - Training and Education Plan
  - Partnership Status Summary
  - Outreach Plan
  - Comprehensive Deployment Plan
  - Deployment Readiness Summary

Twelve Major Deliverables, multiple webinars, MANY meetings and reports

Published on USDOT CV Website: http://www.its.dot.gov/pilots/index.htm
Phase 2 – Ends ~ 4/30/2018
- Completed procurement specifications for devices
- Vendors demos of NYC CV Applications for evaluation
- Final bids received
- Completing negotiations and the contracting process
- Purchased and are learning and testing samples/prototypes
- Detailed Design is in process with reviews
- Developing installation plans
- Back office software is under development
- Test plans and testing program is under development
- Continue to work cooperatively with the other sites in support of interoperability
NYC CV PILOT NEXT STEPS 1

- Phase 2 Tasks:
  - Completing the deployment
  - Tuning the applications for NYC
  - Validating the performance measures
  - Updating Phase 1 design documents
  - Validating the data collection and Maintenance operations

- Phase 2 Performance Measures Related:
  - Evaluating the obfuscation time and location binning protocols
  - Develop the data warehouse and data handling protocols
NYC CV PILOT NEXT STEPS 2

- Phase 3 O&M
  - Collection of performance data to measure benefits
  - Collection of confounding data (for analysis)
  - Silent period operation (Before)
  - Active operation with alerts
  - Reliability evaluation
  - Ongoing operation and maintenance activities
    - Dealing with fleet turnover during operation period
    - Ongoing equipment maintenance and support
Tony English
Trihydro Corporation

Wyoming DOT Pilot Deployment Overview
Wyoming’s I-80 Corridor

Heavy Freight Traffic
• Major E/W freight corridor
• Freight = over half of annual traffic

Severe Weather Conditions
• Elev. Over 6000 ft
• Heavy winds, heavy snow and fog
• Severe blowing snow and low visibility

Adverse Impacts on Trucks
• Higher than normal incident rates
• Multi-vehicle crashes
• Fatalities

Source: WYDOT (Dec 17, 2015)
Scope of the problem

700 incidents involving commercial vehicles occurred on I-80 since project kick-off

1,600+ crashes
1,923 vehicles
$865.3M Societal Impact
I-80 Users Need Actionable Road Weather Information

The need for actionable information is growing

Estimated Firms Subscribed to WYDOT’s CVOP

- Sept 2015: 150
- Aug 2016: 800

Downloads of WYDOT 511 App*

- Sept 2015: 0
- Aug 2016: 26,443

*Downloads since Feb 2016 when app was released

WYDOT’s Commercial Vehicle Operator Portal (CVOP)
# Pilot Objectives

## Road Weather Condition Input
1. Improve road weather condition reports received into the TMC

## TMC Information Dissemination
1. Improve ability of the TMC to generate wide area alerts and advisories
2. Efficiently manage closures, restrictions and speed limits
3. Effectively disseminate and receive messages from TMC to en-route vehicles
4. Improve information to commercial vehicle fleet managers

## Vehicle/Roadside Alerts & Advisories
1. Effectively transmit and receive V2V messages to reduce incidents and their severity
2. Enhance emergency notifications of a crash

## Outcomes
1. Improve speed adherence and reduce speed variation
2. Reduce vehicle crashes
Pilot Elements

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

**V2V Applications**
- Forward Collision Warning
- Distress Notification

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

**WYDOT’s CV Pilot System**

**Vehicle System**

**Wyoming CV System**
- Roadside Infrastructure
- Back office system

**External Interfaces**
Vehicle System

All vehicles that are part of the vehicle system will have:

- Ability to share information via DSRC with connected devices (vehicles and RSUs)
- Ability to broadcast Basic Safety Message Part I
- Ability to receive Traveler Information Messages (TIM)
- Human-Machine Interface (HMI) to communicate alerts and advisories to driver

Vehicle Sub-Systems

1. WYDOT Fleets
2. Integrated Trucks
3. Retrofit Vehicles
4. Basic Vehicles

On-board Vehicle Technologies

- OBU with DSRC only
- OBU with DSRC and Satellite Receiver
- Human Machine Interface
- CAN Bus Integration (selected vehicles)
- Environmental Sensors (selected vehicles)
System Overview – Wyoming CV System

Ingests and processes CV data

Generates alerts and advisories

Brokers data between internal and external systems

Generates and distributes TIMs

Stores data for performance management

Wyoming CV Pilot System

External Interfaces
- US DOT Interfaces (e.g. SCMS)
- WYDOT Interfaces (e.g. ATMS and ATIS Systems at the TMC)
- Weather

CV Subsystems
- Roadside Units
- Operational Data Environment
- Pikalert® System
- WYDOT Data Broker
- WYDOT Data Warehouse
CV Applications

**On-Board Applications**
- Applications available to equipped vehicles

**TMC Operations Applications**
- Support for WYDOT Traveler Information and Traffic Management
The pilot will develop five on-board applications that will provide key information to the drivers of equipped vehicles.

- **Forward Collision Warning (FCW)**
- **Infrastructure-to-Vehicle (I2V) Situational Awareness (SA)**
- **Work Zone Warning (WZW)**
- **Spot Weather Impact Warning (SWIW)**
- **Distress Notification (DN)**
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.

- Support Variable Speed Limit, Closures, Restriction Management
- Support Wyoming Traveler Information (WTI) Updates
- Support Commercial Vehicle Operators Portal Updates
- Support Third-Party Interface
Road Weather Condition Input
Improve road weather condition reports received into the TMC

TMC Information Dissemination
- Improve ability of the TMC to generate alerts and advisories
- Efficiently disseminate broad area traveler information
- Effectively disseminate and receive I2V or V2I alert/advisory messages from TMC
- Improve information to commercial vehicle fleet managers

Vehicle/Roadside Alerts & Advisories
- Effectively transmit and receive V2V messages
- Automate emergency notifications of a crash

Outcomes
- Improve speed adherence and reduce speed variation
- Reduce vehicle crashes
21 Specific Performance Measures

- Hypotheses
- Data needed
- Evaluation Design

Collect, Process, and Store Data

- ODE
- WY Data Warehouse
- RDE
- CV-PEP

Evaluation and Analysis

- Before-After
- With-Without
- System Performance
- Behavior Assessment
- Qualitative Assessment

Report
Project Status
## Current Status

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td><strong>Final System Design</strong></td>
<td>In-progress; draft submitted to U.S. DOT</td>
</tr>
<tr>
<td><strong>Acquisition and Installation Planning</strong></td>
<td>Final Comprehensive Acquisition Plan submitted to U.S. DOT; Draft Comprehensive Installation Plan submitted to U.S. DOT</td>
</tr>
<tr>
<td><strong>Ongoing Equipment Bench Testing</strong></td>
<td>4 OBUs are up and running, 4 RSUs are running (52 more to install), Android HMI up and running. Targeting 92-95 snowplows and 50 with Weather Cloud sensors. Targeting 33 Lear Sharkfin on 33 Highway Patrol Vehicles</td>
</tr>
<tr>
<td><strong>Integration of CV Pilot Elements with TMC</strong></td>
<td>Progress on TMDD Interface, participant tracking application, 511 app updates, location for the 75 RSUs identified, Pikalert® instance activate</td>
</tr>
<tr>
<td><strong>Operational Readiness Demonstration</strong></td>
<td>November 15-16, 2016 in Cheyenne, WY</td>
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### Next Steps and Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
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<tr>
<td>Site Interoperability Demo</td>
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<tr>
<td>System Operations and Maintenance starting May 2018 for 18 months</td>
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<tr>
<td>Post-Pilot Transition Planning</td>
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<tr>
<td>Support for performance measurement and evaluation (throughout)</td>
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<td>Standards support (throughout)</td>
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<td>Stakeholder outreach (throughout)</td>
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Bob Frey
Tampa Hillsborough Expressway Authority

Tampa (THEA) Pilot Deployment Overview
Tampa (THEA) Pilot Deployment Overview
Tampa (THEA) Pilot Deployment Overview
Participants

1,600

500+

10

10
Morning Backup

Forward Collision Warning (FCW)
Emergency Electronic Brake Light (EEBL)
End of Ramp Deceleration Warning (ERDW)
Intelligent Signal Systems (I-SIG)
Wrong-Way Drivers

- Wrong-way Entry
- Intersection Movement Assist (IMA)
- MAP
- Signal Phasing and Timing (SPaT)
Pedestrian Safety

Pedestrian in a Signalize Crosswalk Warning (Ped-X)

Pedestrian Collision Warning (PCW)
Transit Signal Priority

I-SIG
Transit Signal Priority (TSP)

IMA
Pedestrian Transit Movement Warning (PTMW)
Streetcar Conflicts

Vehicle Turning Right in Front of Transit Vehicle (VTRFTV)

PTMW
Traffic Progression

Probe Data Enabled Traffic Monitoring (PDETM)
Pedestrian Mobility (PED-SIG)
I-SIG
IMA
City of Tampa Traffic Management Center provides info

Safety message sent

Traffic info

Vehicle/ pedestrian info sent to RSU

Safety message displayed to commuter

THEA
Volpe Institute
THEA
THEA
THEA
THEA

Siemens
RSU Photos

Source: Siemens
Mirror display uses sticker to depict location and concept of warning. Actual image is still in development

Source: Brand Motion and Global 5
Benefits
Status

Level 6: Needs & Feasibility
- Project Stakeholders
- Operate & Maintain

Level 5: Concept of Operations
- Phase 1
- System Validation
- System Validation LTP

Level 4: Requirements
- Phase 2C
- System Verification LTP

Level 3: High Level Design
- Subsystem LTP
- Sub Systems

Level 2: Detailed Design
- Unit/Device LTP
- Units / Devices

Level 1: Existing Software & Hardware (Available From)
- Phase 2B
- From Other Projects

Phase 3: P3 Deliverable
- Measure the Effect
- Install & Test 40 Locations
- Install & Test in 1500 Cars

Integrate & Test
- 6 Use Cases
- Integrate & Test Apps into RSU
- Integrate & Test Apps into Phones
- Integrate & Test Apps into OBU

Security & Test
- Infrastructure HW
- V2I Apps (OSADP, CAMP)
- Android Phone
- Vehicle HW (Brand Motion)

SOURCE: HNTB
Kate Hartman
ITS Joint Program Office, USDOT

Questions and Answers
Stay with Us to Learn More about Technical and Evaluation Aspects

- 1:45 – 3:15 PM
  - Session 2 - Technical Challenges and Proposed Solutions
- 3:30 – 5:00 PM
  - Session 3 - Evaluating Performance and Long-Term Sustainment

Visit USDOT Exhibition Booth
- USDOT Booth #1301
- Talk to the Pilot Site Representatives
  - October 31, 2017, 2:00 PM – 5:00 PM
  - November 1, 2017, 9:00 AM – 12:00 PM

Contact for CV Pilots Program/Site AORs:
- Kate Hartman, Program Manager, Wyoming DOT Site AOR; Kate.hartman@dot.gov
- Jonathan Walker, NYCDOT Site AOR Jonathan.b.Walker@dot.gov
- Govind Vadakpat, THEA Site AOR G.Vadakpat@dot.gov

Visit CV Pilot and Pilot Site Websites for more Information:
- CV Pilots Program: http://www.its.dot.gov/pilots
- NYCDOT Pilot: https://www.cvp.nyc/
- Tampa (THEA): https://www.tampacvpilot.com/
- Wyoming DOT: https://wydotcvp.wyroad.info/