CONNECTED VEHICLE PILOT
Deployment Program

Program Manager: Kate Hartman

Status, Next Steps, Challenges, and Benefits

What to Expect in this Session

- Summarize progress-to-date in the Connected Vehicle Pilot Deployment Program
- Describe the deployment status of each of the three pilot sites
- Share technical challenges and lessons learned by the deployers’ first-hand experience and USDOT perspective
- Preview critical milestones and next steps in preparation for an operational phase starting in 2018

NYCDOT | Tampa (THEA) | WYDOT | USDOT

Session Agenda

- 1:30 – 1:40 PM Introduction and CV Pilots Overview
  Brian Cronin, Director, Office of Operations R&D, FHWA, USDOT
- 1:40 – 2:00 PM New York City DOT Pilot Deployment
  Mohamad Talas, Deputy Director, ITS, NYCDOT
- 2:00 – 2:20 PM Wyoming DOT Pilot Deployment
  Deepak Gopalakrishna, Principal, ICF
- 2:20 – 2:40 PM Tampa (THEA) Pilot Deployment
  Bob Frey, Planning Director, Tampa Hillsborough Expressway Authority (THEA)
- 2:40 – 3:00 PM Lessons Learned from USDOT Perspective
  Jonathan Walker, Program Manager, Research and Demonstration, ITS JPO, USDOT
- 3:00 – 3:15 PM Q&A

CV Pilot Deployment Program Goals

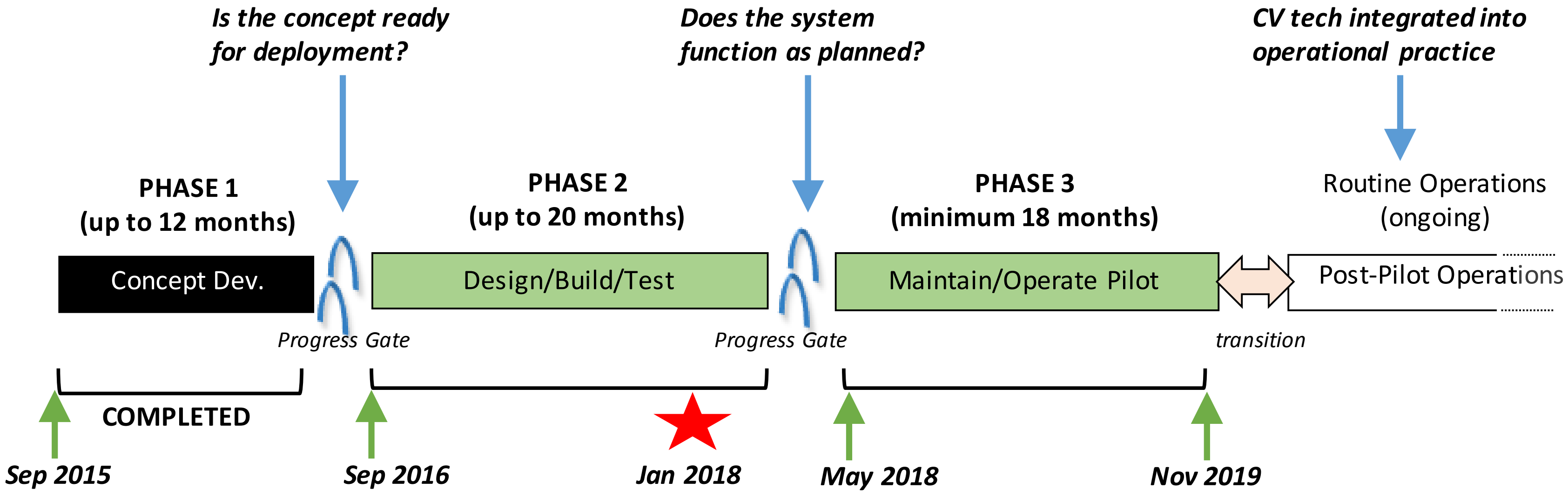
THE THREE PILOT SITES

- 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.

CV PILOT DEPLOYMENT SCHEDULE



Starting from May 2018, these deployments are scheduled to enter an operational phase.

NYCDOT Pilot Deployment

Presented by

Bob Rausch, TransCore

for

Mohamad Talas

Project Manager

Project Overview

Project Goals

New York City is aggressively pursuing "Vision Zero"

"Traffic Death and Injury on City streets is not acceptable"

Vision Zero Goal : to eliminate traffic deaths by 2024

NYC CV Pilot will evaluate

- ***Safety benefits of CV technology***
- ***Address CV deployment challenges***
  - ***With a Large number of vehicles & types***
  - ***Issues associated with the dense urban environment***

Vehicle-to-Vehicle (V2V) Safety Applications

- Vehicle Turning Right in Front of Bus Warning
- Forward Collision Warning
- Emergency Electronic Brake Light
- Blind Spot Warning
- Lane Change Warning/Assist
- Intersection Movement Assist

*Vehicles Broadcast **BSM***
*Receive **BSMs** from surrounding vehicles*
Assess Threat potential
Alert driver of "real" threats

V2V applications based on existing demonstrations and prior developments and documentation

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

Tailored for New York City - Modified from the generic versions

Use infrastructure information and vehicle "status" (loc. Heading, speed) Alert driver based on application.

- Emergency Communications and Evacuation Information *(Traveler information)*

V2I applications based on existing demonstrations and/or modifications to prior developments and documentation

Additional Applications

Pedestrian

- Mobile [Visually Impaired] Ped Signal System – *navigation assistance*
- Pedestrian in Signalized Intersection Warning – *to vehicles*

Traffic Management

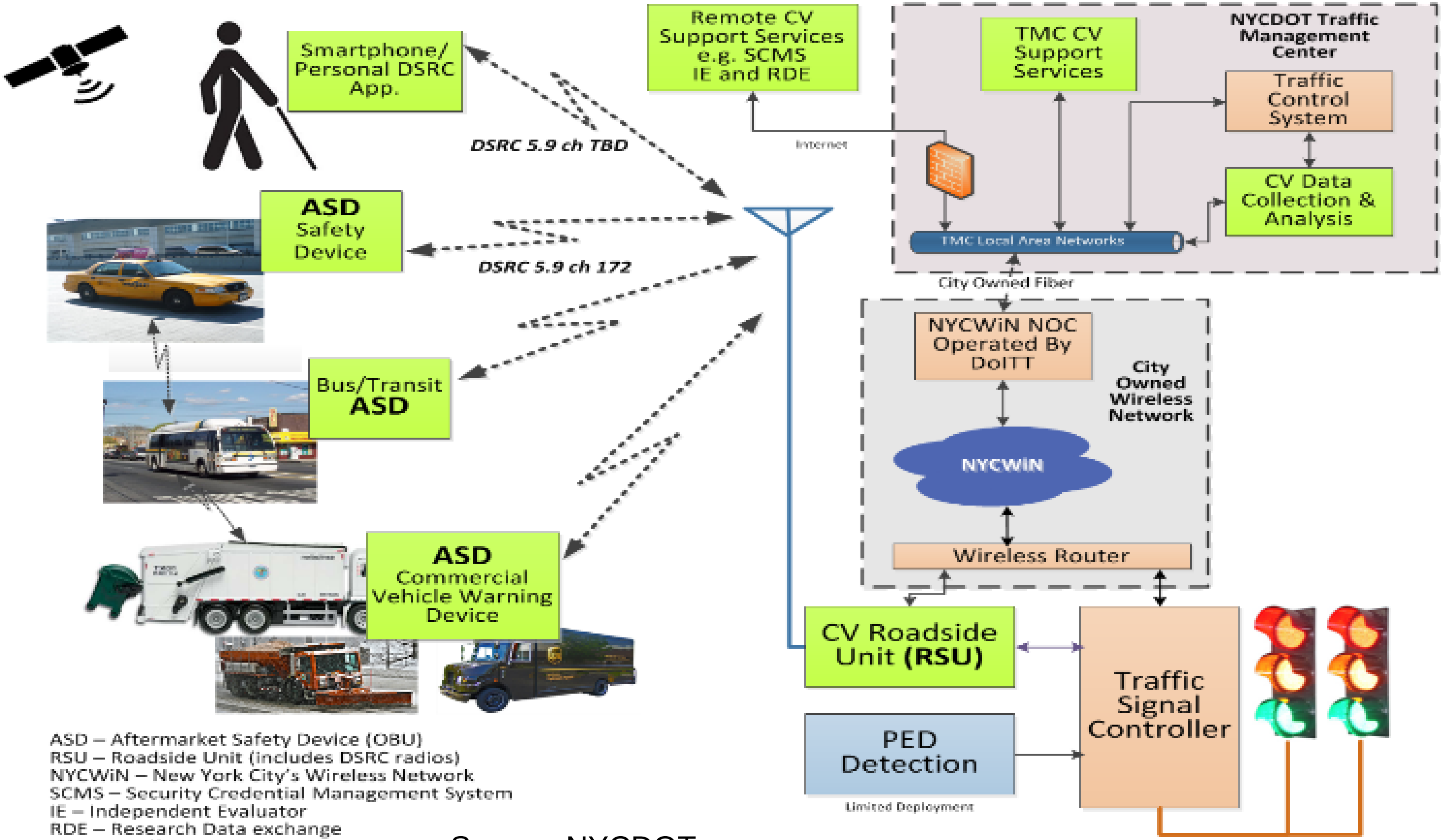
- CV Data for Intelligent Traffic Signal System ***Roadway segment travel times***

Operations, Maintenance, and Performance Analysis

- RF Monitoring
- OTA Firmware Update
- Parameter Up/Down Loading
- Traffic data collection
- *Event History Recording*
- *Event History Up Load*

To Evaluate the benefits

Overall Project Concept



ASD – Aftermarket Safety Device (OBU)
RSU – Roadside Unit (includes DSRC radios)
NYCWiN – New York City's Wireless Network
SCMS – Security Credential Management System
IE – Independent Evaluator
RDE – Research Data exchange
TMC – Traffic Management Center

Source: NYCDOT

CV STAKEHOLDER/USER DEPLOYMENT

Vehicles

- **Up to 8,000 fleet vehicles with Aftermarket Safety Devices (ASDs):**
  - ~5,800 Taxis (Yellow Cabs)
  - ~ 700 MTA Buses
  - ~ 1,050 Sanitation & DOT vehicles
  - ~ 400 UPS vehicles

Revenue Vehicles

Operating Statistics:
*Vehicles are in motion or active ~**14 hours per day!***
Average taxi drives 197 miles per day
Fleet total Vehicle Miles Traveled:
>1.3 Million Miles per day
~40 Million Miles per month

Pedestrians

- Pedestrian **PIDs**
  - Visually Impaired
  - 100 Subjects – PID
- PED in Crosswalk
  - 10 Fully Instrumented Int.

NEW YORK CITY DOT

CV INFRASTRUCTURE DEPLOYMENT

- Roadside Units (**RSU**) at ~350 Locations
  - ~200 Manhattan Ave
  - ~ 80 Manhattan Cross
  - ~ 30 on Flatbush Ave
  - ~ 8 on FDR *"freeway and restricted route"*
  - ~ 36 Support locations (airports, river crossings, terminal facilities)

Will Include Intersection I2V SPaT, MAP, RTCM, TIM (applies to the Manhattan Ave, Manhattan Cross and Flatbush Ave items)



LOCATIONS (MANHATTAN, BROOKLYN)

V2I applications work where **infrastructure is installed** (along highlighted streets).

V2V applications work **wherever** equipped vehicles encounter one another.

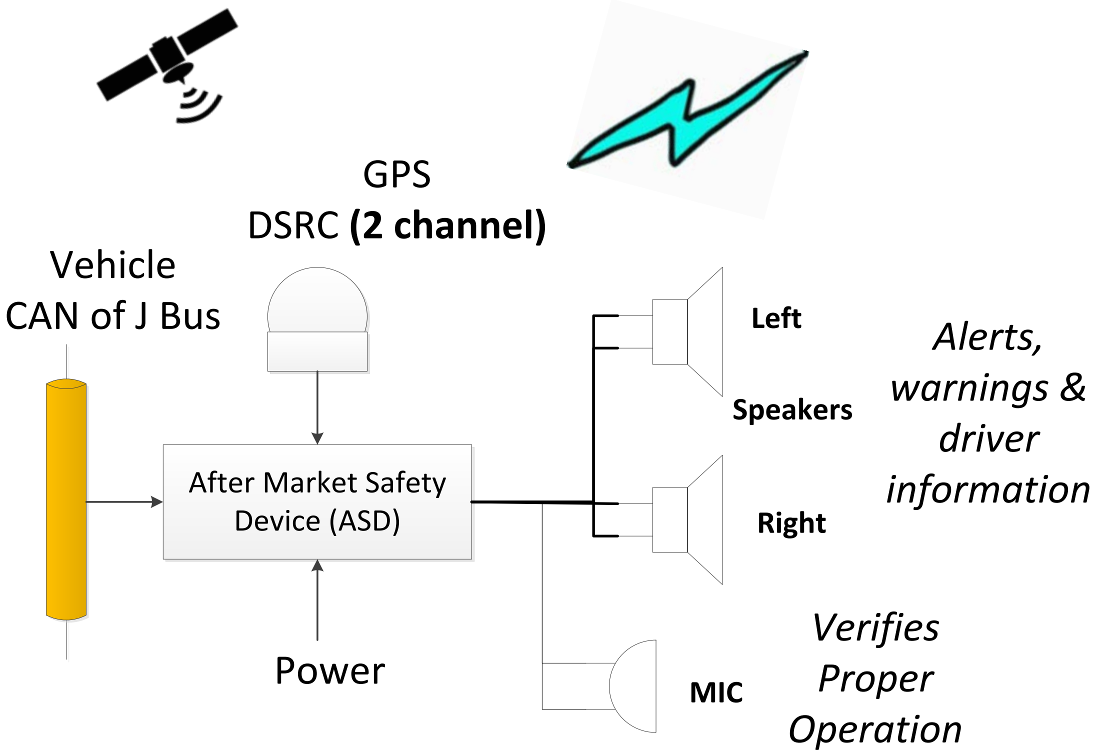
The CV project leverages the City's transportation investments

AFTERMARKET SAFETY DEVICE FOR NYC

- Audio output only
  - Tones based on threat
  - Words based on situation

- ASD includes
  - Inertial Navigation
  - GNSS Navigation
  - Connection to Vehicle data Bus
  - **Triangulation from RSU signals**

  - Multi Channel DSRC support
    - 2 Radios + GPS



Source: NYCDOT

WHY AUDIO ONLY HMI ?

- Typical Taxi "cockpit"
  - Note the current level of distraction;
  - Stakeholders did not want another display!

NEW YORK CITY DOT

The NYC Approach

- Focus on "proven" **Safety Applications from Prior R&D**
  - Pilot Deployment will evaluate the benefits on a much larger scale – dense urban situation
- **Leverage "existing" safety applications** (demonstrated)
  - Manage *(Tune)* the CV applications for NYC
  - Adjust operation for the congested traffic environment of NYC
- **Modify several existing applications** to encourage speed **compliance**
  - NYC City has a 25 MPH speed limit
- **Leverage existing** standards, infrastructure, and knowledge base
- Advance the state of the art **(O&M and Data Collection)**:
  - Develop operations and maintenance applications
  - Develop scaleable data collection applications [for benefits analysis]

Data Collection and Performance Measurement

Performance Measures
First - Identified Use Cases – Benefits from CV

1. Manage Speeds
2. Reduce Vehicle to Vehicle Crashes
3. Reduce Vehicle to Pedestrian Crashes
4. Reduce Vehicle to Infrastructure Crashes
5. Inform Drivers of Serious Incidents
6. Provide Mobility Information
7. Manage System Operations

Drove Selection of Applications

Performance Metrics & Evaluation Methods

Safety Needs (ConOps)

Safety applications

Developed Questions for Evaluation

Performance Measurement Metrics

~47

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?

- 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

Data collection:

Everything that "occurred" immediately before and after the alert

Challenges For Data Collection

- Privacy
  - Real-time BSM data – combined with other sources
    - Fear of subpoena and FOIA requests
    - Police crash records
  - Data is Encrypted, Normalized, Obfuscated and Aggregated
  - Data ages off the ASD within 48 hours if not collected
- Scalability of the collection scheme
  - Fleet Vehicles Transmit 4B **BSM**s/day = 322 GB per day
  - With 36 Data Collection Stations - ~9GB/Day/Site
  - Add SPaT, MAP, TIM and everything everyone receives . . . .

Not enough "connection time" to upload this amount of data!

Data Collection Approach

Incident Tracking – Safety Benefits

- Cause for any alerts – triggers, type of event
- Before & after vehicle status/operation @ appropriate rate (1Hz, 2Hz, 10 Hz …)
- ASD log data generally collected daily or shift change at “portal”

Are “things” working properly?

- ASDs record RF levels of first and last SPaT, MAP, TIM message
- RSUs record RF levels of first and last BSM *(periodically uploaded)*

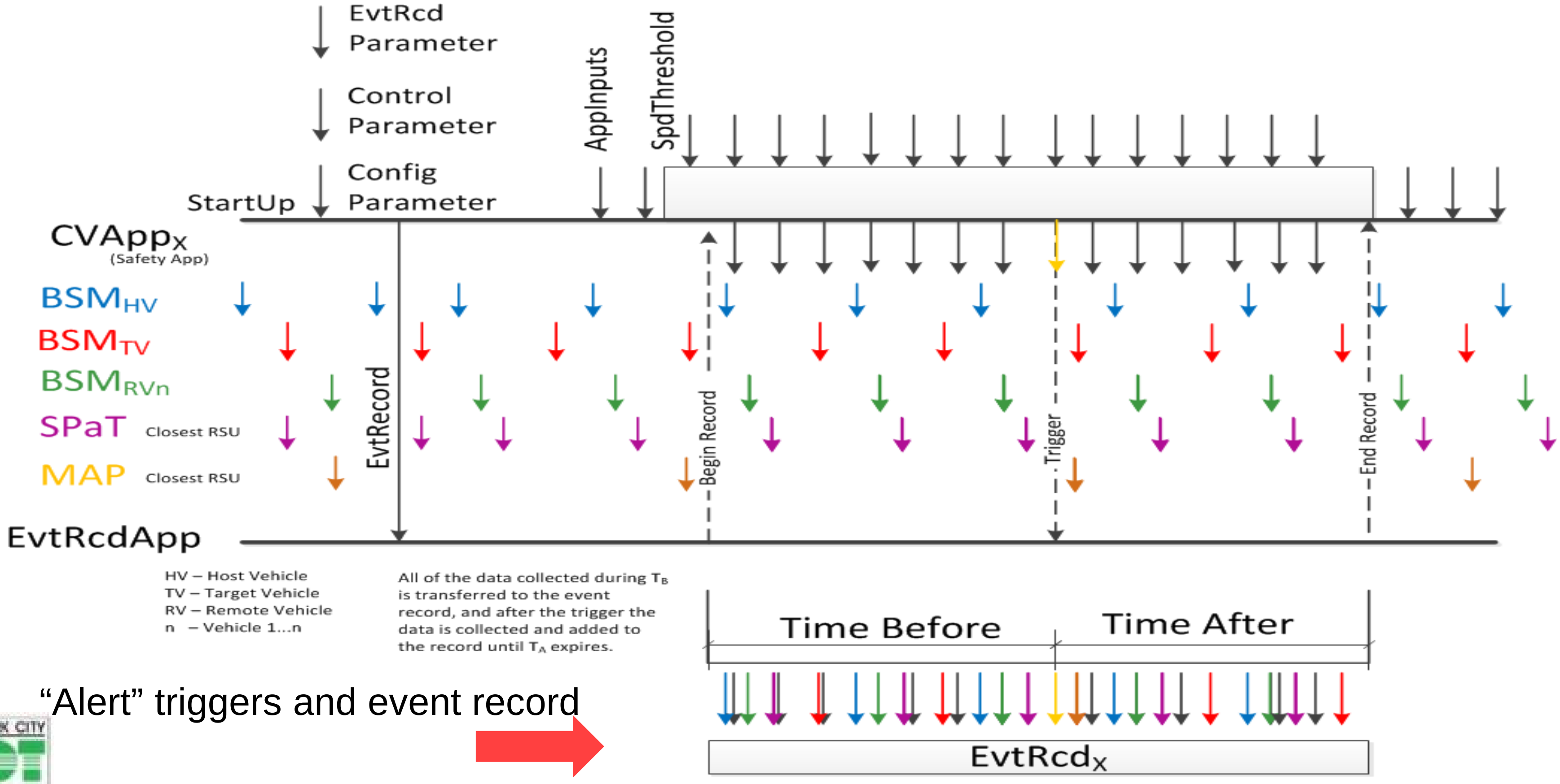
Measure travel times

- RSUs record BSM (1 per vehicle) at preset location in intersection
- Send to TMC in *real time* for link travel time calculations

Frequency of “encounters”

- ASDs log closest BSM it hears from other ASDs –
  - “Guess who I saw” – where and when - all over the City

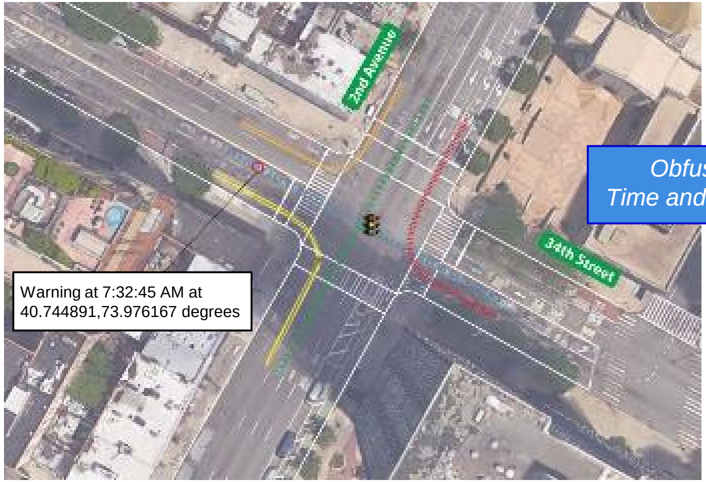
Example "Incident Data" – Intermittent Logging

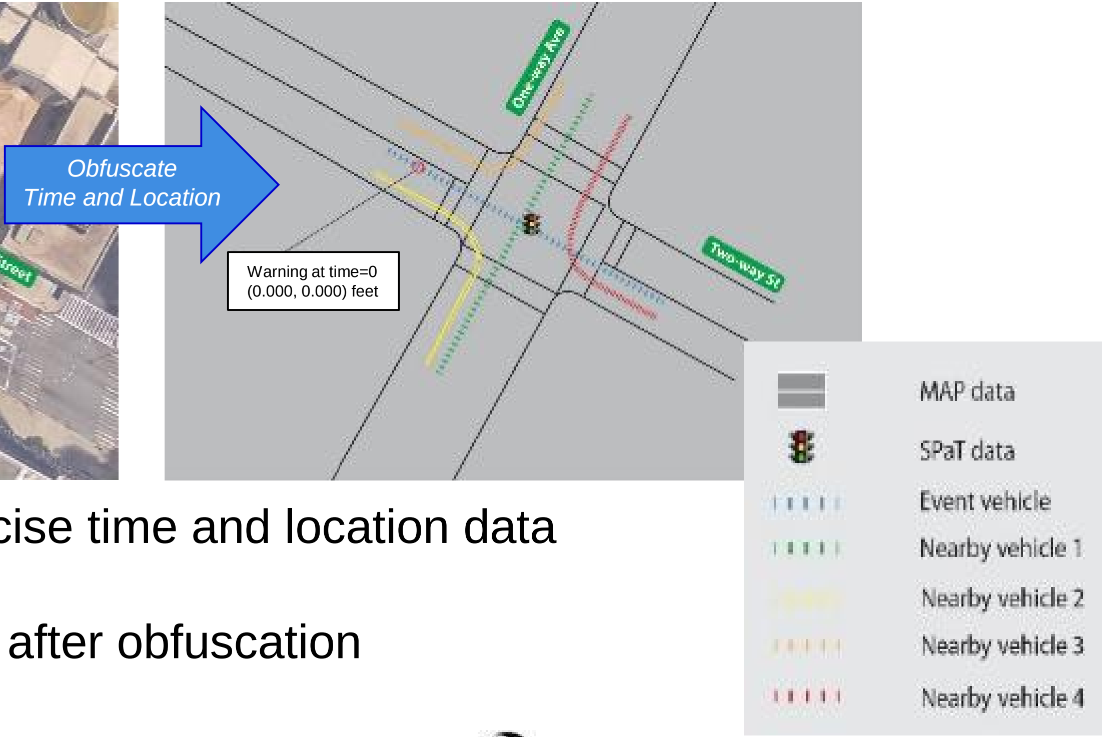


"Alert" triggers and event record

Obfuscation of Logs to Protect Privacy

Raw ASD Action Log Data | **Obfuscated ASD Action Log Data**





- Obfuscation process to scrub precise time and location data
  - Relative details retained
- Non-obfuscated data – destroyed after obfuscation

Analysis Methods

	Safety Impacts	Non-Safety Impacts
Empirical	***Before & After Analysis of Crash Records*** • *Actual Records* • *Confounding Factors* • *Statistical Significance?*	***'Breadcrumb' Speed/Travel Time Records from ASD*** • *Actual probe data samples* • *Confounding Factors* • *Sample Size?*
Simulated	***Safety Surrogate Measures (SSM) Simulations*** • *Calibration to ASD Action Log Data* • *No Confounding Factors* • *Risk Based Analysis of Safety*	***Mobility & Reliability Simulations*** • *Systemwide Impact Assessments* • *No Confounding Factors* • *Estimate Crash Costs on User Delay* • *Estimate Emissions Impacts*

Current Status

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

WHERE ARE WE NOW ?

Phase 2 –Design & Deployment

- Developing TMC software to support CV
- **Working with 2 ASD vendors**
- Updating **Controller software and TCS security**
  - To provide SPaT data to RSU
  - Using NTCIP 1202v3 and DTLS 1.2 Security
- **Adding Hardware Security Module to TMC**
- Developing evaluation software
- Working with a PED application developer – **non DSRC**
- **Preparing for interoperability testing**
- Developing test procedures to verify elements and system

The Project Teams are sharing ideas, challenges, workshops, and the NY team is aggressively participating in the standards development program!

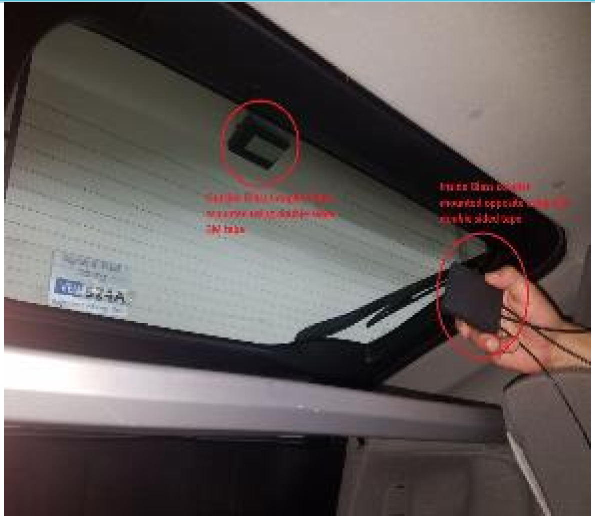
Installation Planning and Testing

- Developing MAP message Content (USDOT)
- Planning RSU installation sites
  - Establishing Installation "partners"
- Developing vehicle installation kit designs
  - Working with vendors
  - Working with Fleet owners
  - Running samples – awaiting prototypes

INSTALLATION PLANNING - 2

- **Develop installation procedures**
  - Location and orientation of in-vehicle “box”
  - Location and routing of Antenna cables (3 = 2 DSRC + GPS)
  - Interface to vehicle data bus (J bus, CAN bus)
  - Speaker location (or entertainment system connection – muting and levels)
  - Developing testing and alignment procedures
  - Verify non-interference with existing instrumentation and vehicle operation
- **Procedures to Configure ASD at time of installation** - -
  - Vehicle dimensions or characteristics
  - Center of vehicle – antenna offsets etc.
  - RF adjustments
  - RF sensitivity verification
  - Location calibration and accuracy

Vehicle Installation

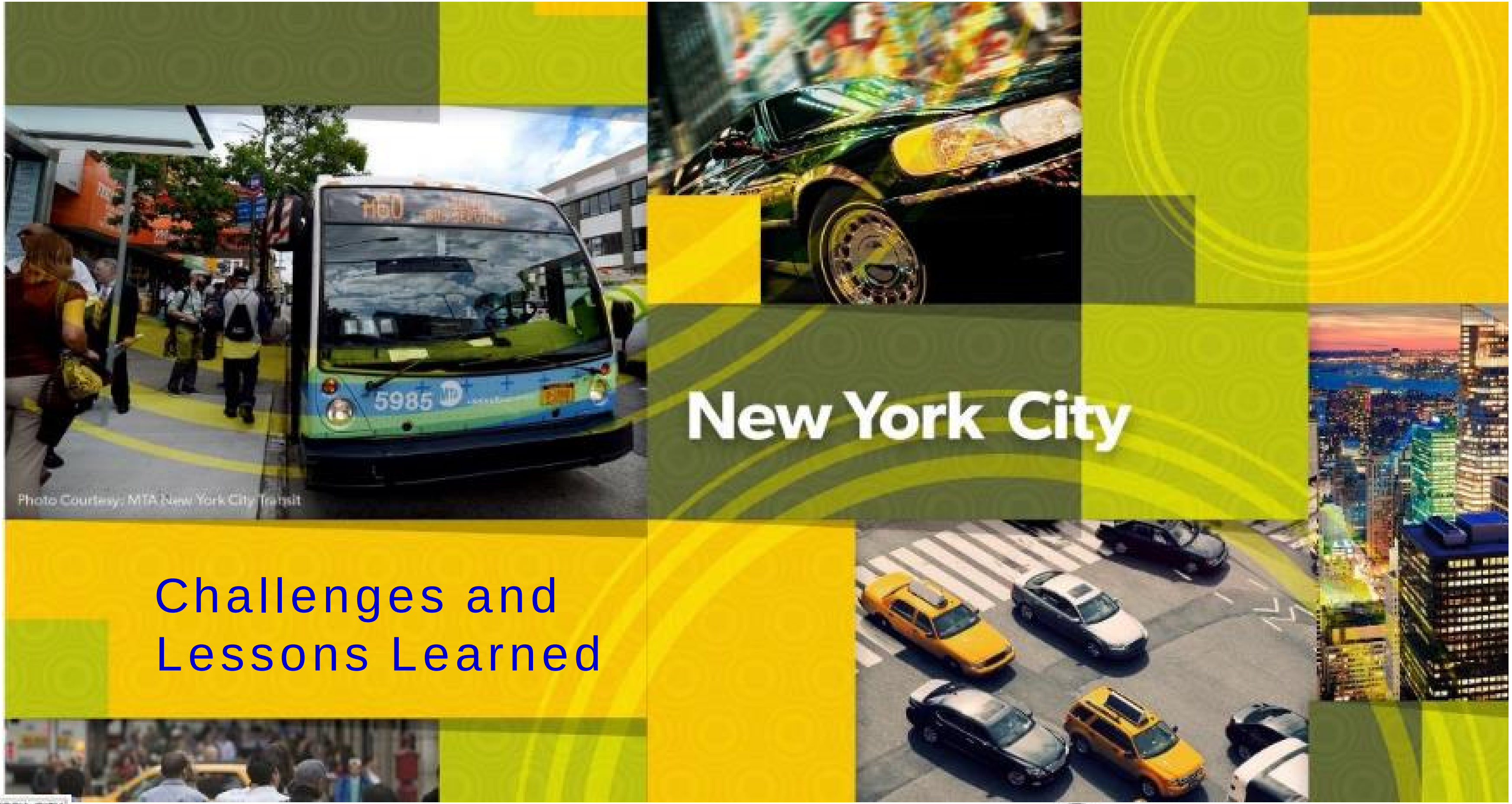

- Samples are for Fleet installation
- Testing through the glass and drilled mountings
- Working with various different vehicle types

RSU Location Determination

NEW YORK CITY DOT

NYC CV Pilot Next Phase

- 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



Challenges and Lessons Learned

CYBERSECURITY IS FUNDAMENTAL TO CV DEPLOYMENT

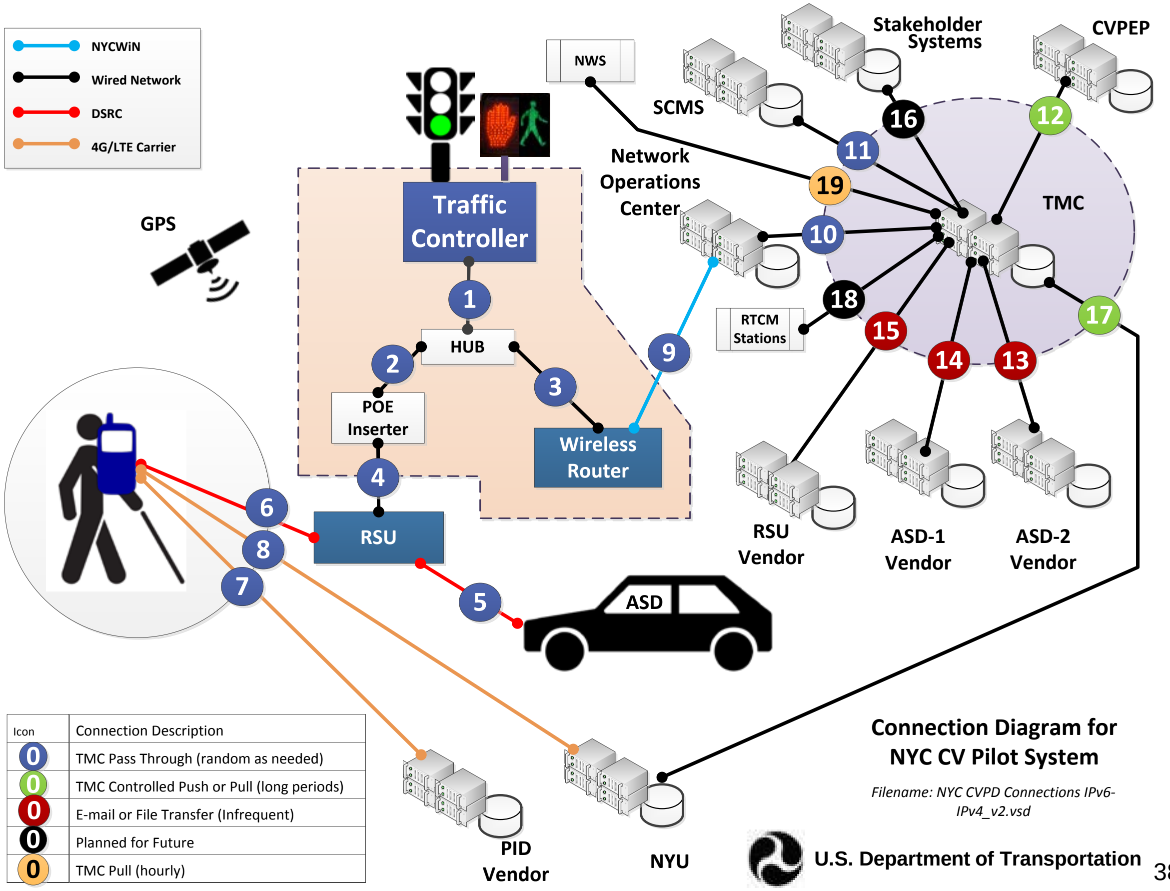
CV depends on a "trusted" environment - vehicles & infrastructure

- Message authentication (BSM, SPaT, MAP, TIM, etc.…)
- Data encryption of (To preserve privacy)
- Requires Equipment Certification
  - RF technology (IEEE 802.11p, IEEE1609.x)
  - Message content – SAE J2735
  - BSM Performance – SAE J2945/1
  - Applications (& data accuracy)
- **Organizational IT security**
  - Physical security of the TMC systems
  - Login and security practices
- Protection for all connections and data exchanges
- CV Hardware Impact
  - **Hardware Security Module (HSM) for the TMC** system
  - **HSM inside the ASD/OBU** and RSU

System Architecture: Security Everywhere

- Security is a major Issue
  - Each link is a secure connection
  - Each media has different issues

- Security System design addresses all of the links!



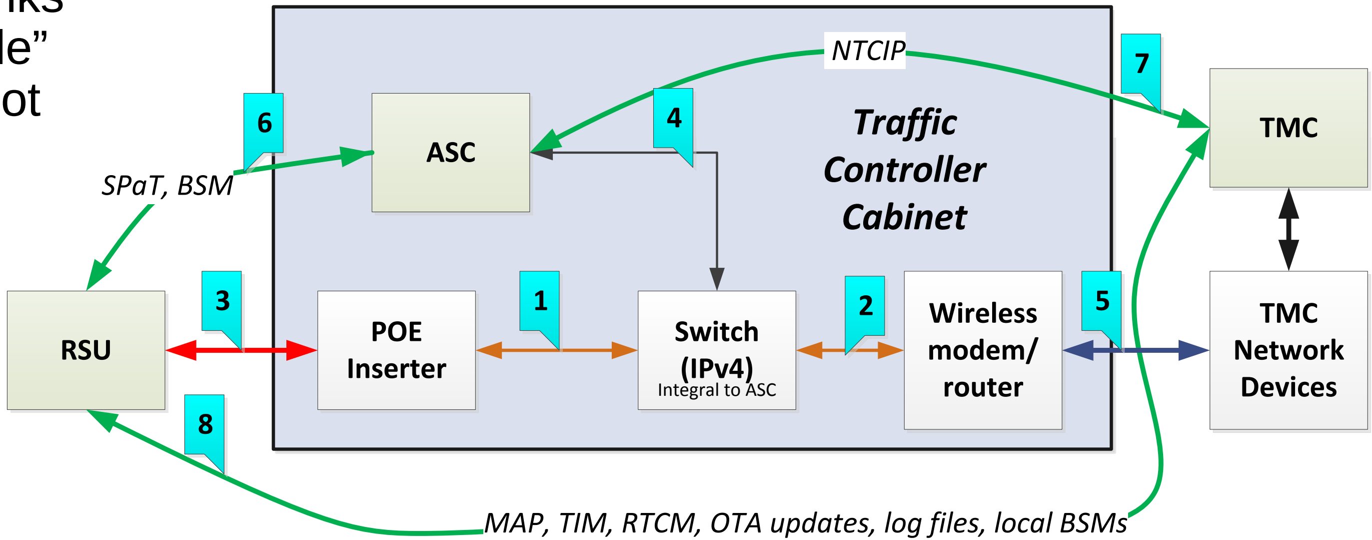
Icon	Connection Description
0	TMC Pass Through (random as needed)
0	TMC Controlled Push or Pull (long periods)
0	E-mail or File Transfer (Infrequent)
0	Planned for Future
0	TMC Pull (hourly)

Connection Diagram for NYC CV Pilot System

Filename: NYC CVPD Connections IPv6-IPv4_v2.vsd

Typical of The Security Risks

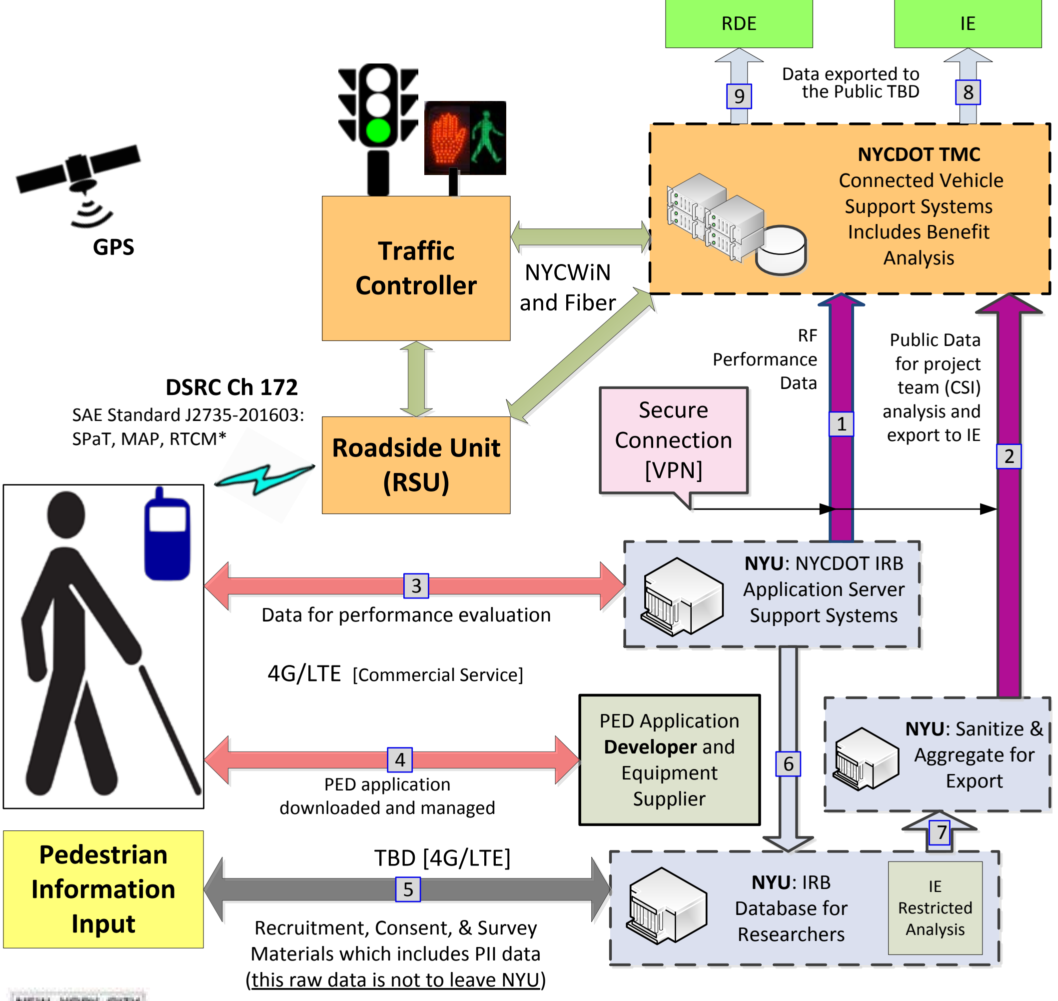
- Protect the exposed links from "man in the middle" corruption; NTCIP is not secure!



- Approach
  - DTLS 1.2 per RFC 6347
  - TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA

Security Context for Traffic Controller Infrastructure

PED APPLICATION ARCHITECTURE



Visually Challenged Pedestrian Application Context Diagram

VisioDocument

- Each link must be protected from intrusion/corruption
- Each link with Personal Information must be encrypted
- Databased must be protected and encrypted!

Challenge – Scalable OTA Data Exchanges

- Push (10 MB+) software updates to 8,000 vehicles efficiently over **DSRC**
  - **No WiFi and No LTE/4G**

- Developed Scheme to support broadcast updates
  - ASD's read WSA from Control Channel
  - Directed to Service Channel if RSU supports Updates
  - RSU **broadcasts** available updates
    - Some updates broadcast (continuous) some available by unicast
    - Vehicles initiate update using unicast or monitor broadcast streams
    - Using licensed software to manage the efficient breakdown and assembly

    - Efficient Channel Use
    - Privacy is maintained

Challenge – Location Accuracy

- **Location Accuracy –**
  - Urban Canyons pose issues *(both relative V2V and absolute V2I)*
    - Dropout at underpasses
    - Loss of GPS lock
  - **ASD vendor demonstrated RSU triangulation**
  - Established Compound ASD requirements:
    - Dead reckoning,
    - Triangulation with static DSRC locations,
    - Map matching,
    - Tethered to the vehicle - vehicle interface

- **Testing has been promising !**

INFRASTRUCTURE PREPARATION EXPERIENCE

- DSRC Licensing (FCC) – Almost Done!
  - Three applications per site to license the full channel range
  - 75 Km airport range (LGA, JFK, ENW, TEB)
  - Heliports / Seaplane (Four in Manhattan)
  - Working with USDOT/FCC to improve the process
  - Over 1,000 licenses required!

Completed except for final FAA approval at a few locations!

- **MAP message generation** – Intersection geometrics
  - Each intersection map must stand-alone
  - Maps don’t link together (egress become next intersection’s ingress)
  - Conventions (parking lanes, far-side transit stops)
  - Crosswalk identification for PED applications!
  - **Working with USDOT to improve the tool**

Other Technical Challenges

- Adjusting the applications for 25 MPH and Freeway speeds
- CAN/J (vehicle) Bus Interface –
  - Vendor resistance to providing necessary engineering information
  - ***Purchasing a gateway device***
- Many different vehicle types and model years
  - Varied installation kits
  - The Good part – they are fleets – we drill holes!
- Verifying "platform" stability under all situations

SUMMARY

Phase 2 has Required significant CV engineering and development

- **Applications not "mature" – production ready**
  - Lack of application test procedures
  - Support for O&M not deployed
  - Data collection not scaleable
- CV RF technology is changing rapidly (3 month life cycle)
  - Vendors constantly updating products
- Changes to the credentialing requirements seem to be ongoing
  - Security support software still in development
  - Vendors updating to keep up
- **Coordination among the sites has been valuable**
  - Common interpretation of standards
  - Mutual support for application development and testing
- **Previous R&D efforts did not address scaleable deployment**

Deepak Gopalakrishna

Wyoming DOT Pilot Deployment

I-80 Users Need Actionable Road Weather Information

The need for actionable information is growing

November 2017

800

91,267*

Estimated Firms Subscribed to WYDOT's CVOP

Downloads of WYDOT 511 App*

150

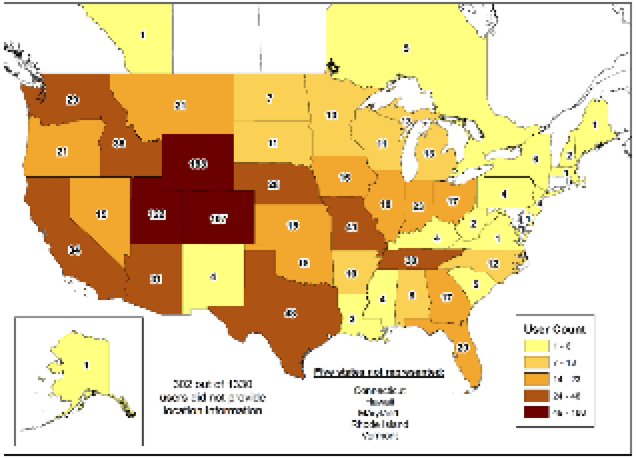
0

Sept 2015

*Downloads since Feb 2016 when app was released

WYDOT's Commercial Vehicle Operator Portal (CVOP

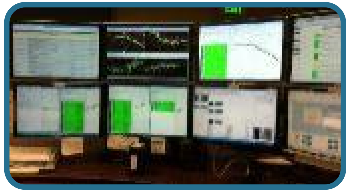
CVOP Users by Location



Pilot Objectives

Road Weather Condition Input

1. Improve road weather condition reports received into the TMC

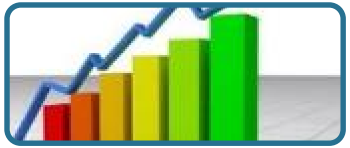


TMC Information Dissemination

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

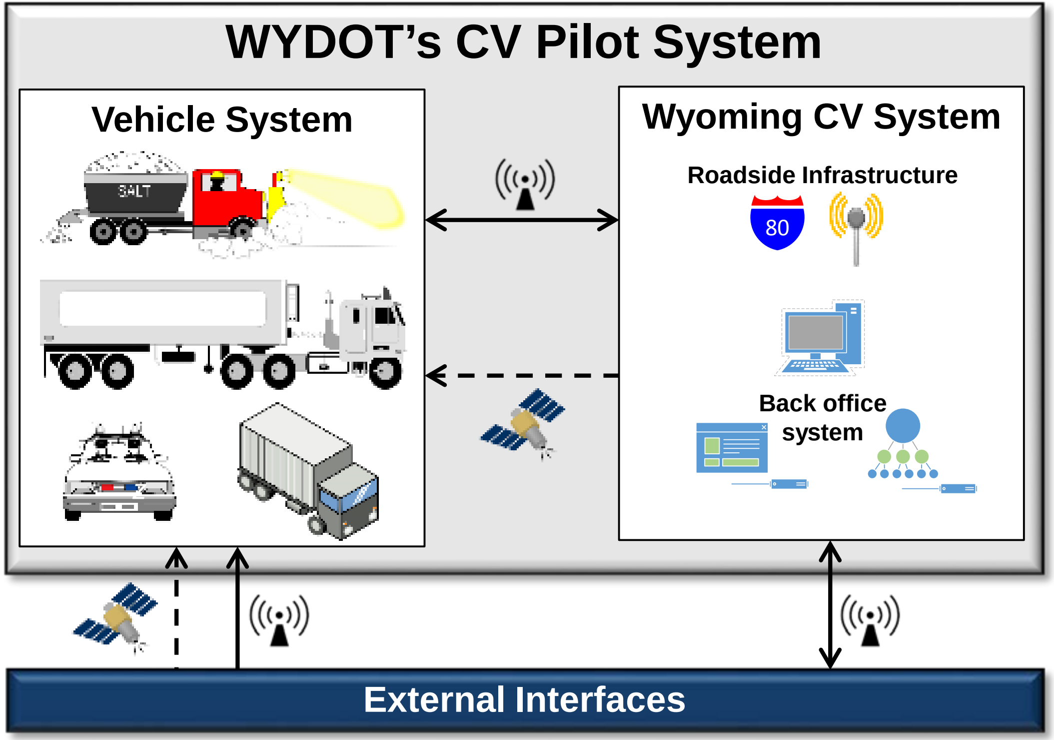
Distress Notification

V2I Applications

Situational Awareness

Spot Weather

Work Zone Warning



CV Applications

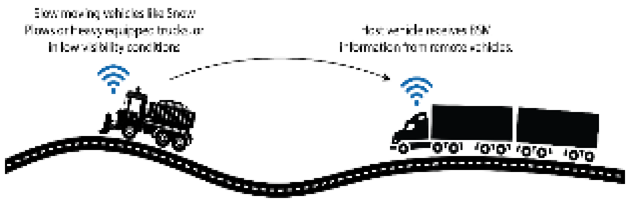
On-Board Applications

- Applications available to equipped vehicles

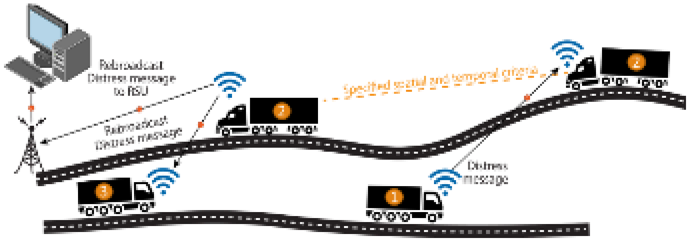
TMC Operations Applications

- Support for WYDOT Traveler Information and Traffic Management

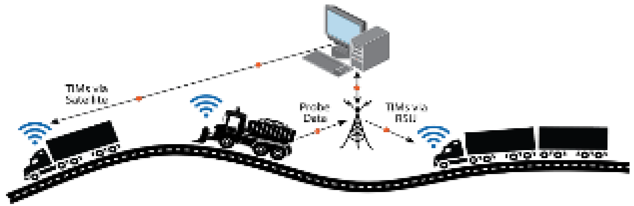
Onboard Applications



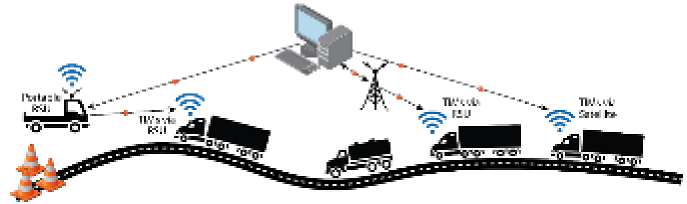
Forward Collision Warning (FCW)



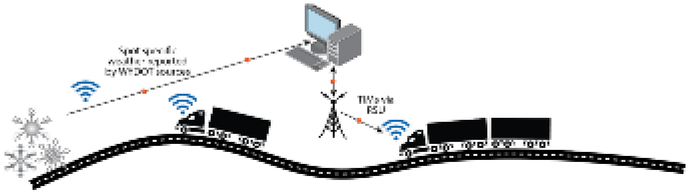
Distress Notification (DN)



I2V Situational Awareness



Work Zone Warning (WZW)



Spot Weather Impact Warning (SWIW)

Onboard HMI

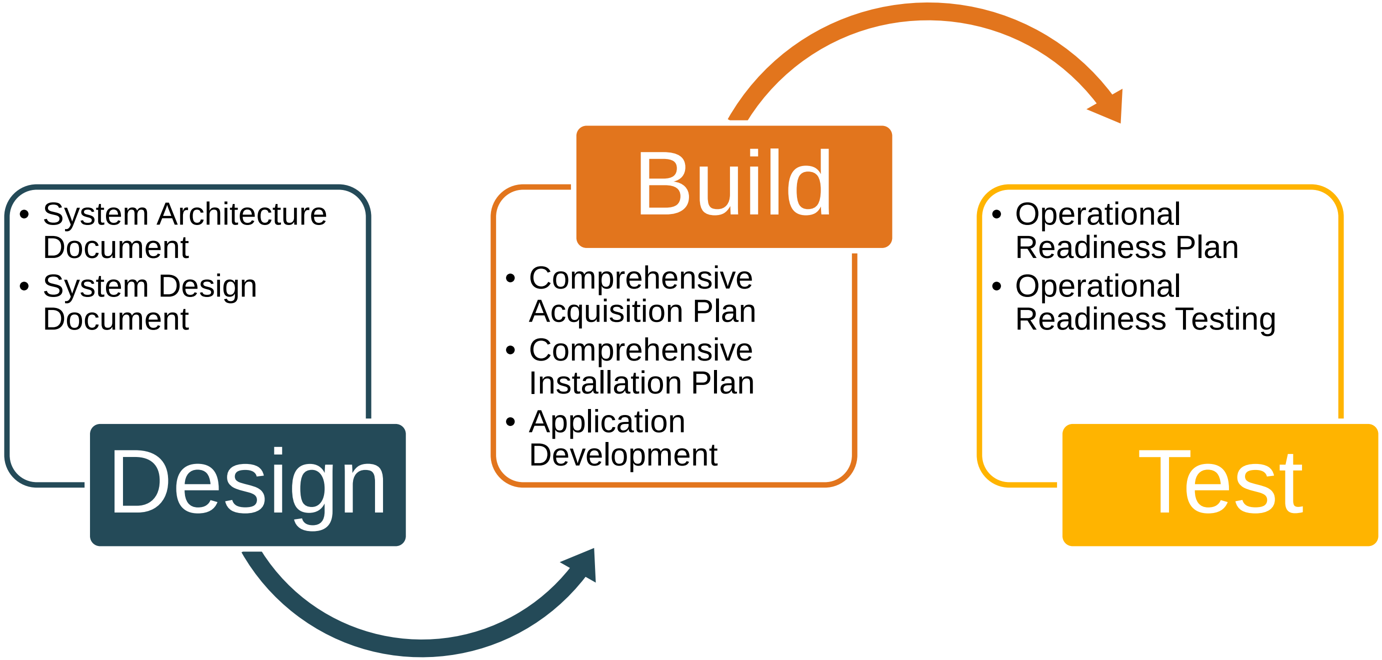
In-Cab Display Unit Layout

TMC Operations 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

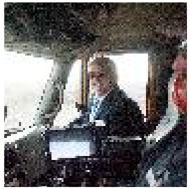
- ***Support Variable Speed Limit, Closures, Restriction Management***
- ***Support Wyoming Traveler Information (WTI) Updates***
- ***Support Commercial Vehicle Operators Portal Updates***
- ***Support Third-Party Interface***

Phase 2 Activities



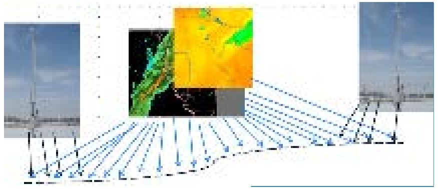
Operational Readiness Demo Setup

Operational Readiness Demo



End-to-end testing of on-board applications

Training Module demonstrations



Environmental Sensor demonstrations

Attended by over 50 Stakeholders from Wyoming, neighboring states and USDOT

November 15-16
Archer Complex,
Cheyenne, WY

Performance Goals

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 Evaluation

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

Data Collection

System Data - Vehicle -

- Basic Safety Messages
  - Part 1 & 2
- Mobile Weather Observations
- Vehicle Interactions
  - V2V, V2I

System Data - CV System -

- Pikalert
  - Road conditions
  - Advisories, warnings
- Traveler information messages
- WYDOT TMC logs

Non-System Data

- Road weather reports
- Individual vehicle speeds
- Road Weather Information
- Variable speed limits
- Dynamic message signs
- Road closures
- Crashes

Survey and Interview Data

- Commercial Vehicle Operator
- Drivers
- WYDOT staff
- Other stakeholders

Modeling and Simulation Data

- Modifications to VISSIM Model Of I-80 Section

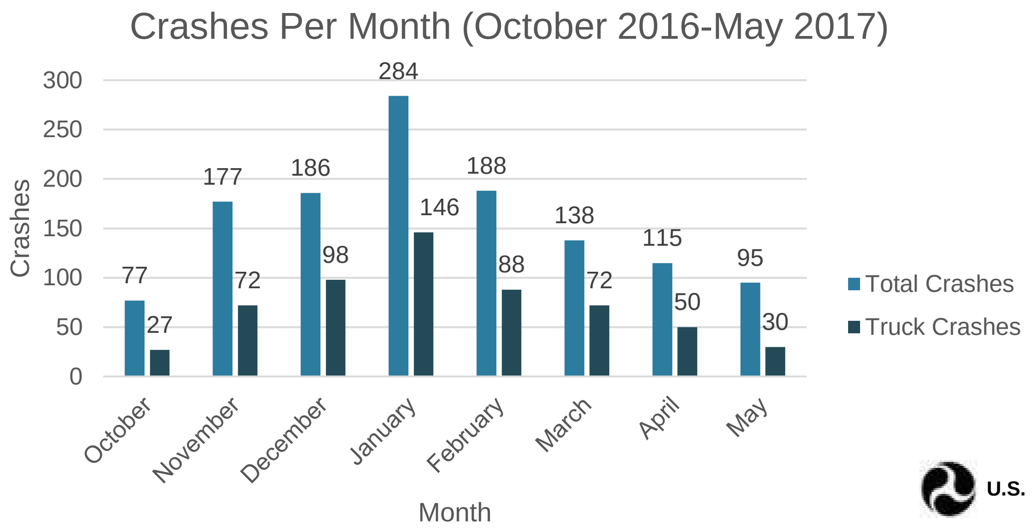
Pre-Deployment Data Collection and Analysis

- Collected Pre-Deployment data to establish baseline conditions
  - October 2016 through January 2018
- Phase 2 System Performance Report (Baseline)
  - Initial – 12/11/2017 (completed)
  - Final – 4/30/2018 (under development)

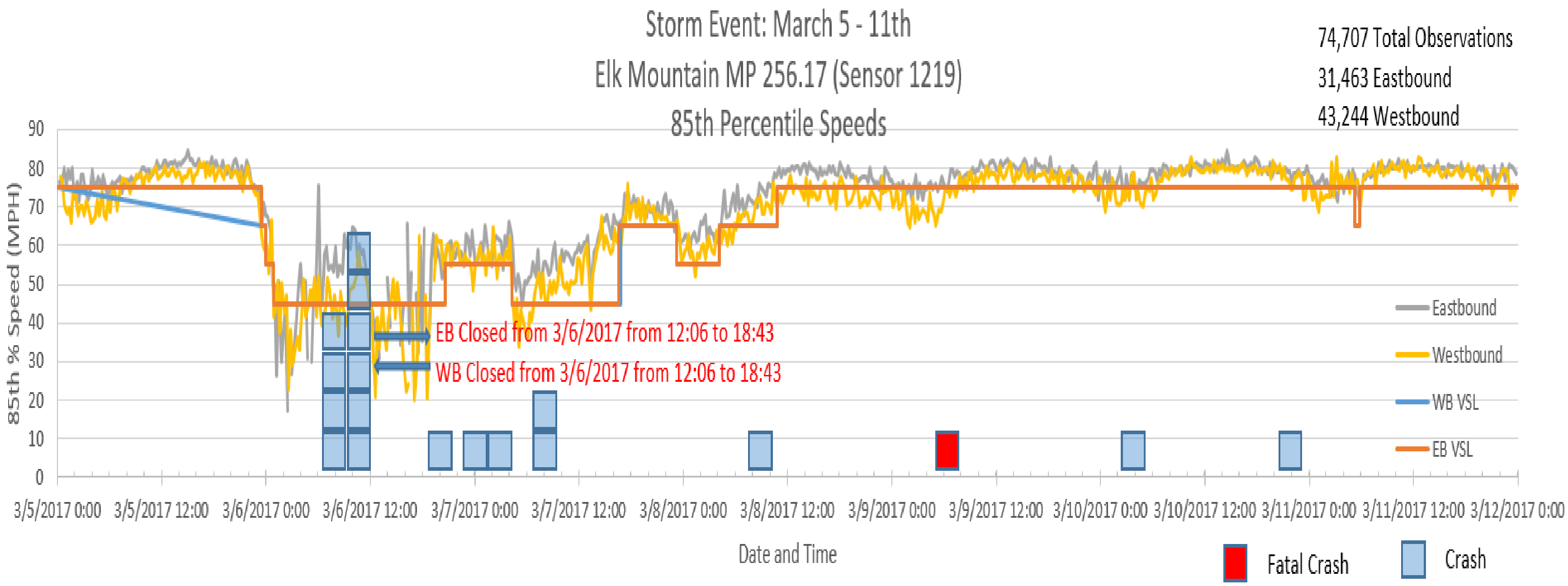
Non-System Data

Survey and Interview Data

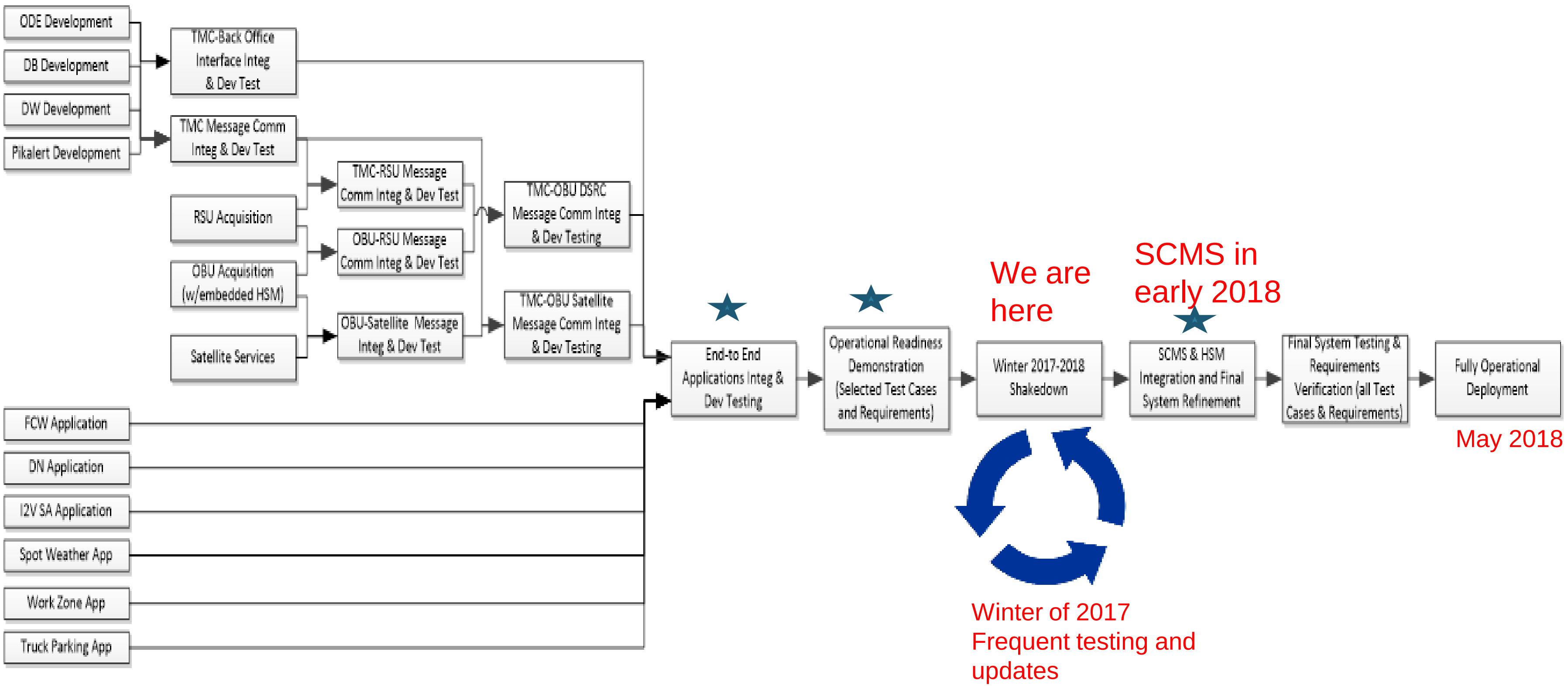
Modeling and Simulation Data



Speed Data Analysis Example



Phase 2 to Phase 3 Roadmap



Deployment Status

Final System Design	In-progress; draft submitted to U.S. DOT
Acquisition and Installation Planning	Final Comprehensive Acquisition Plan submitted to U.S. DOT; Draft Comprehensive Installation Plan submitted to U.S. DOT
Ongoing Equipment Bench Testing	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.
Integration of CV Pilot Elements with TMC	TMDD Interface Ready, participant tracking application, 511 app update complete, installation for the 75 RSUs ongoing, Pikalert® instance activated
Operational Readiness Demonstration	Completed November 15-16, 2017 in Cheyenne, WY

Next Steps and Activities

- Site Interoperability Demo
- System Operations and Maintenance starting May 2018 for 18 months
- Post-Pilot Transition Planning
- Support for performance measurement and evaluation (throughout)
- Standards support (throughout)
- Stakeholder outreach (throughout)

Lessons Learned

Lessons Learned	Description
Developing a robust and scalable data design for CVs is a challenge	Different requirements add significant data needs for storage and throughput which may or may not be possible technically in the real-world.
Approaches to manage for security are still in development	Evolving SCMS integration plan and outside cred management require flexibility in development of associated interfaces.
Utilize existing standards as a part of the system architecture and design process.	The use of standards helped create a solid deployment effort in Phase 2, simplified technical documentation, and assisted with interoperability.
Reserve an appropriate amount of time in the schedule to account for testing, both test planning and test execution.	Detailed test planning is dependent on many other factors including equipment availability, so the development of detailed test plans can be a lengthy process while uncertainties are nailed down.
Detailed testing is required for OBU and RSU software.	Much of the software is not yet created or not created completely.

Technical Issues Faced

- DSRC Antenna Positioning on Trucks
- Basic Safety Message for Trucks
- Application Algorithms for Trucks
- Stability of Bluetooth/WiFi linkage in-vehicle
- Weather sensor quality and robustness
- Event logging
- Integration with Security Credentialing Management System (SCMS)
- Traveler Information Message (TIM) formats
- Back-office Transportation Management Center integration
- Over The Air (OTA) updates

Institutional Issues

- Currently Being Resolved
  - Memorandums of Understanding (MoUs) with fleet partners
  - Independent evaluation needs
  - Operations & Maintenance procedures
  - Training
  - Human subjects/privacy

- Already Resolved
  - IRB initial approval
  - Initial procurements
  - Procurement & installation plans

Bob Frey

Tampa (THEA) Pilot Deployment

Tampa (THEA) Pilot Deployment Overview

Expanded Stakeholder Impact Area

CV Applications to be Deployed

Application	Description	Use Case
Curve Speed Warning	Alerts driver approaching curve with speed safety warning	1
Emergency Electronic Brake Light (EEBL)	Enables broadcast to surrounding vehicles of severe braking	1
Forward Collision Warning (FCW)	Warns driver of impending collision ahead in same lane	1,3
Intersection Movement Assist (IMA)	Indicates unsafe (i.e., wrong way) entry into an intersection	2
Pedestrian in a Signalized Crosswalk (PED-X)	Alerts vehicle to the presence of pedestrian in a crosswalk	2,4,6
Pedestrian Mobility (PED-SIG)	Gives pedestrians priority with signal phase and timing (PED-SIG)	2,4,6
Intelligent Traffic Signal System (I-SIG)	Adjusts signal timing for optimal flow along with PED-SIG and TSP	1,2,6
Vehicle Data for Traffic Operations (VDTO)	Uses vehicles as probes to detect potential incidents, (also called Probe-enabled Data Monitoring or PeDM)	6
Transit Signal Priority (TSP)	Allows transit vehicle to request and receive priority at a traffic signal	4
Vehicle Turning Right in Front of a Transit Vehicle (VTRFTV)	Alerts transit vehicle driver that a car is attempting to turn right in front of the transit vehicle	5
Red Light Violation Warning (RLVW)	Warns driver of potential of red light violation	2

Source HNTB

Focused Deployment Area

Participants

1,600

500+

10

10

Morning Backups

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

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

Wrong-Way Drivers

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

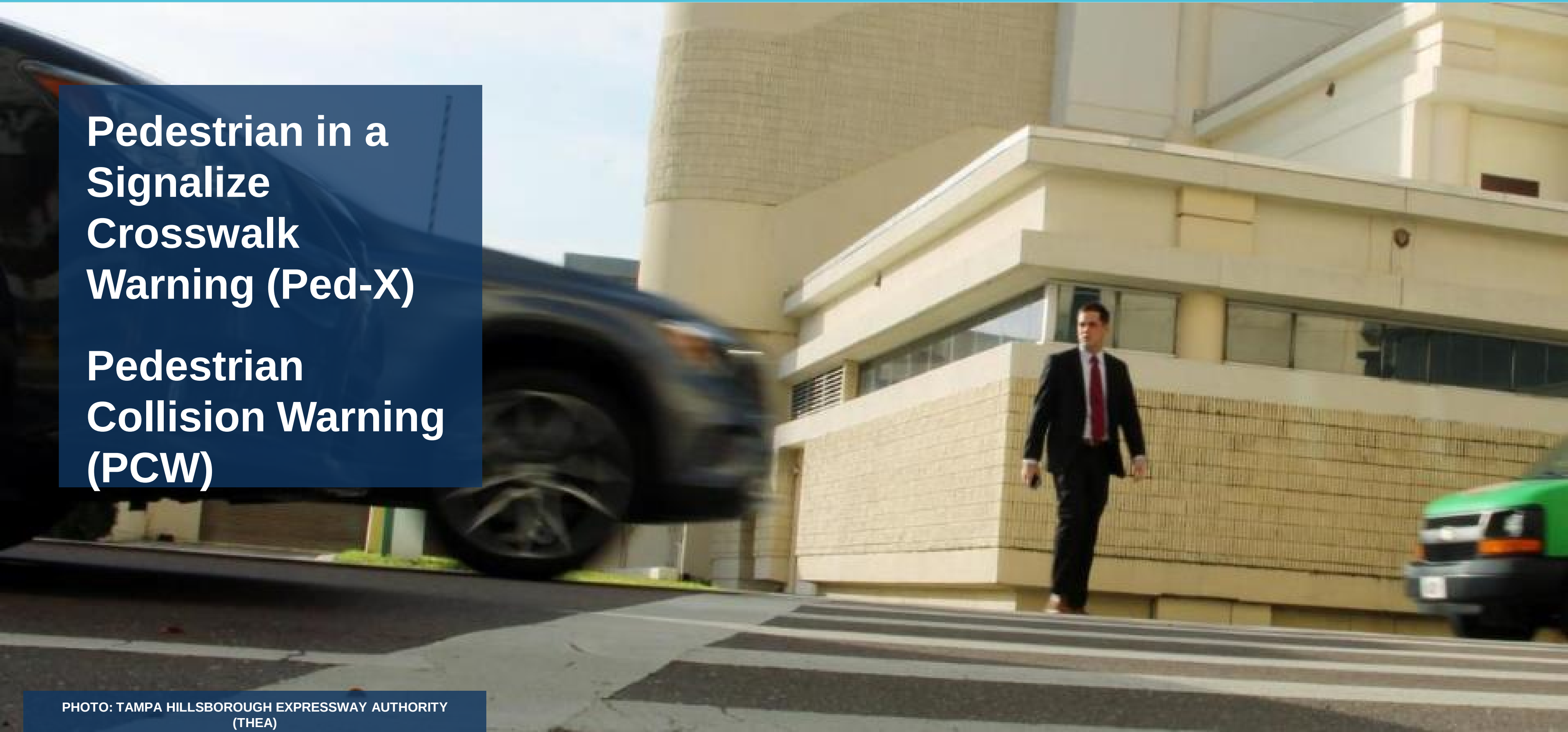
Wrong-way Entry

Intersection Movement Assist (IMA)

MAP

Signal Phasing and Timing (SPaT)

Pedestrian Safety



Pedestrian in a Signalize Crosswalk Warning (Ped-X)

Pedestrian Collision Warning (PCW)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

Transit Signal Priority

- I-SIG
- Transit Signal Priority (TSP)
- IMA
- Pedestrian Transit Movement Warning (PTMW)

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

STREETCAR CONFLICTS

Vehicle Turning Right in Front of Transit Vehicle (VTRFTV)

PTMW

PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

TRAFFIC PROGRESSION

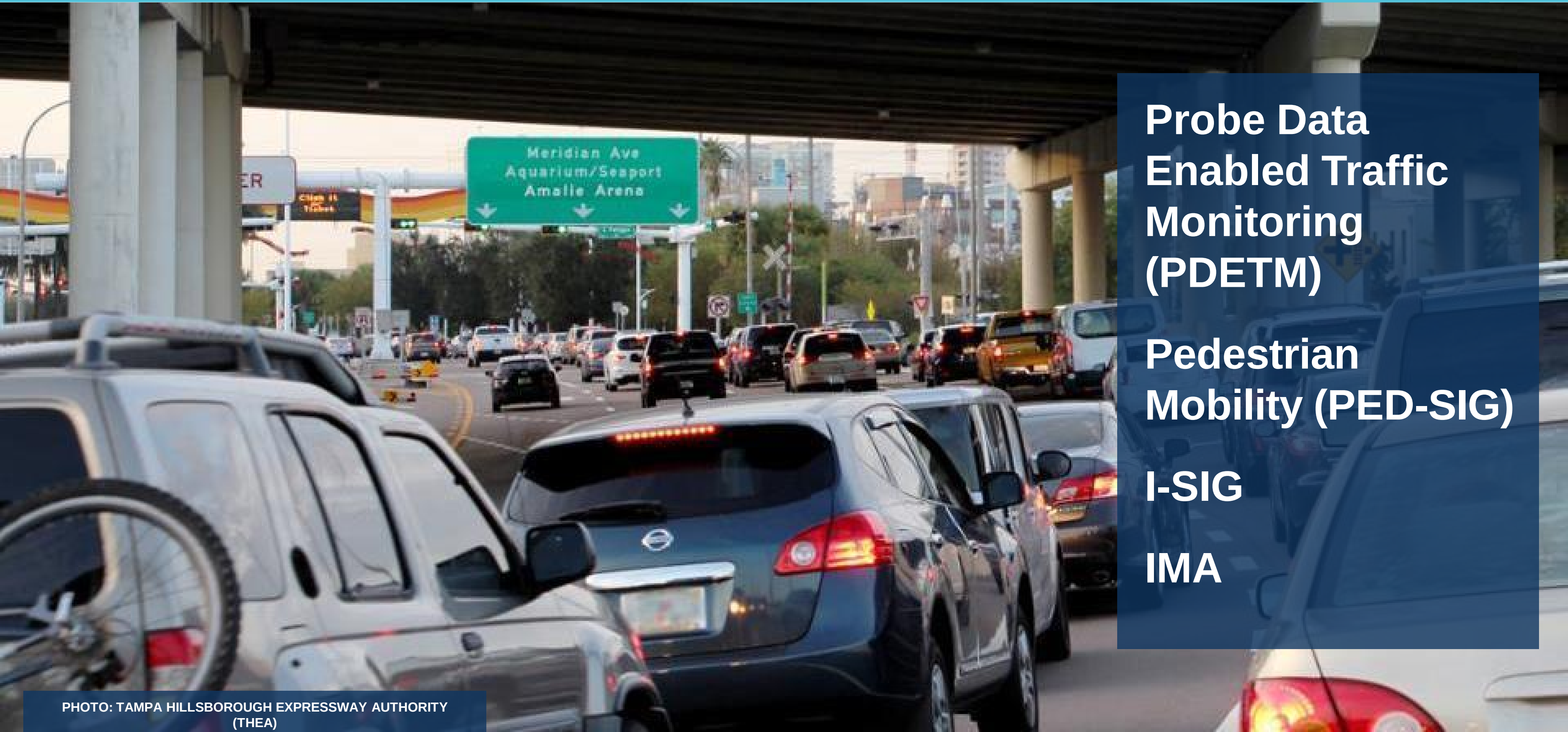
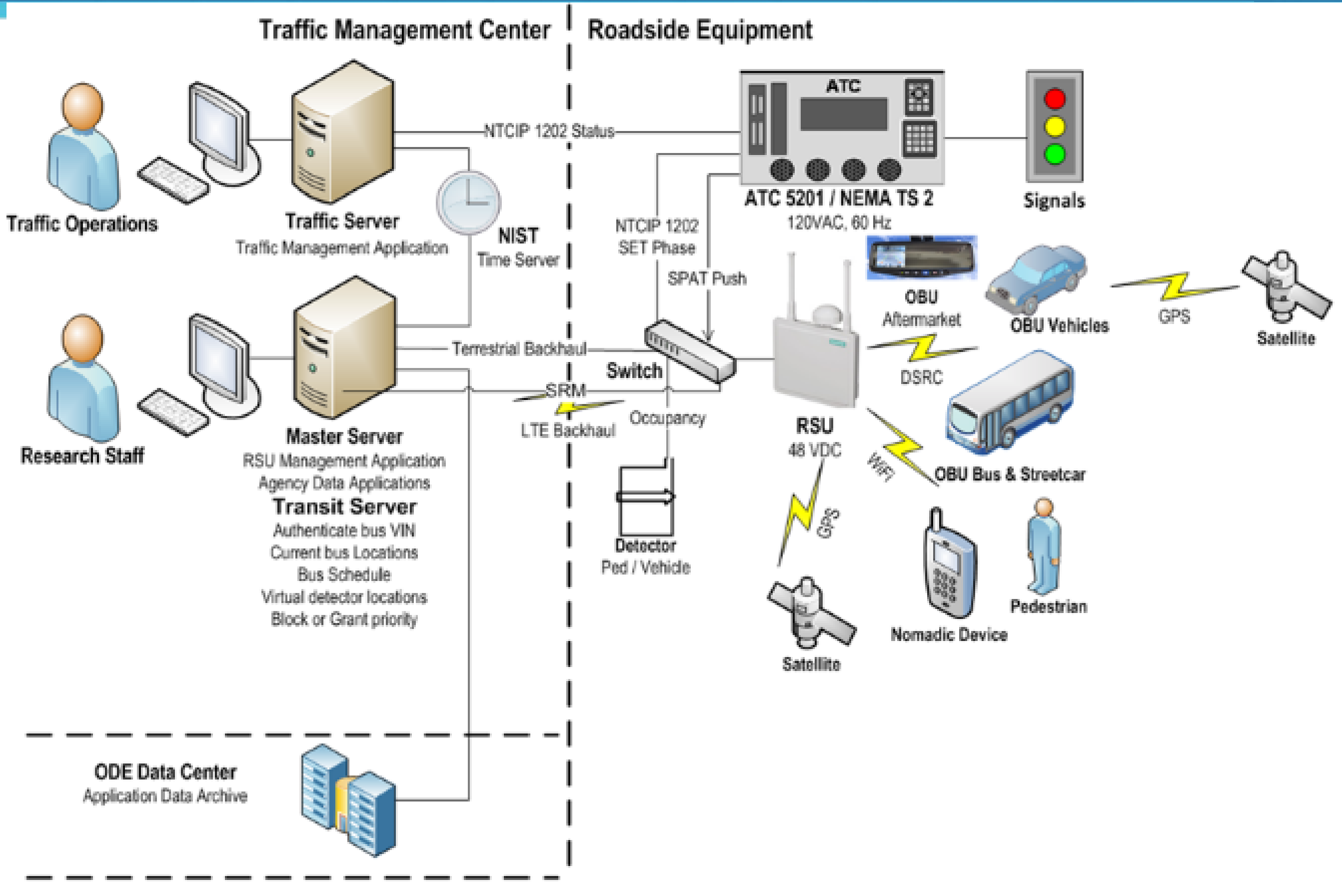


PHOTO: TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY (THEA)

- **Probe Data Enabled Traffic Monitoring (PDETM)**
- **Pedestrian Mobility (PED-SIG)**
- **I-SIG**
- **IMA**

DEPLOYMENT CONCEPT



RSU PHOTOS

Source: Siemens

HMI Photos

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

Source: Brand Motion and Global 5

METRICS IDENTIFIED PMESP

Performance Pillars	*Performance Measures*	*UC1 Morning Peak Hour Queues*	*UC2 Wrong Way Entries*	*UC3 Pedestrian Safety*	*UC4 BRT Signal Priority*	*UC5 Trolley Conflicts*	*UC6 Enhanced Signal Coordination Progression*
Mobility	Travel time	✓	✓	✓			✓
	Travel time reliability	✓		✓			✓
	Queue length	✓		✓			✓
	Vehicle delay	✓	✓	✓			✓
	Throughput	✓		✓			✓
	Percent (%) arrival on green	✓			✓		✓
	Bus travel time				✓		
	Bus route travel time reliability				✓		
	Percent (%) arrival on schedule				✓		
	Signal priority: - Number of times priority is requested and granted - Number of times priority is requested and denied - Number of times priority is requested, granted and then denied due to a higher priority (i.e. EMS vehicle)				✓		
Environmental	Emissions reductions in idle	✓	✓	✓	✓		✓
	Emissions reductions in running	✓	✓	✓	✓		✓

- 6 Use Cases
- 11 CV Apps
- 40 RSUs
- 4 Evaluation “Pillars”
  - Mobility
  - Environmental
  - Safety
  - Agency Efficiency
- 3 Experimental Designs
- 22 Potential Measures

Metrics Identified PMESP (continued)

Performance Pillars	*Performance Measures*	*UC1 Morning Peak Hour Queues*	*UC2 Wrong Way Entries*	*UC3 Pedestrian Safety*	*UC4 BRT Signal Priority*	*UC5 Trolley Conflicts*	*UC6 Enhanced Signal Coordination Progression*
Safety	Crash reduction	✓	✓	✓		✓	✓
	Crash rate	✓	✓	✓		✓	✓
	Type of conflicts / near misses	✓	✓	✓		✓	✓
	Severity of conflicts / near misses	✓		✓		✓	✓
	Percent (%) red light violation/running		✓				
	Approaching vehicle speed	✓	✓	✓			✓
	Number of wrong way entries and frequency		✓				
Agency Efficiency	Mobility improvements through the mobility pillar analysis	✓	✓	✓	✓		✓
	Safety improvements through the safety pillar analysis	✓	✓	✓		✓	✓
	Customer satisfaction through opinion survey and/or CV app feedback	✓	✓	✓	✓	✓	✓

- 6 Use Cases
- 11 CV Apps
- 40 RSUs
- 4 Evaluation “Pillars”
  - Mobility
  - Environmental
  - Safety
  - Agency Efficiency
- 3 Experimental Designs
- 22 Potential Measures

Evaluation Approaches

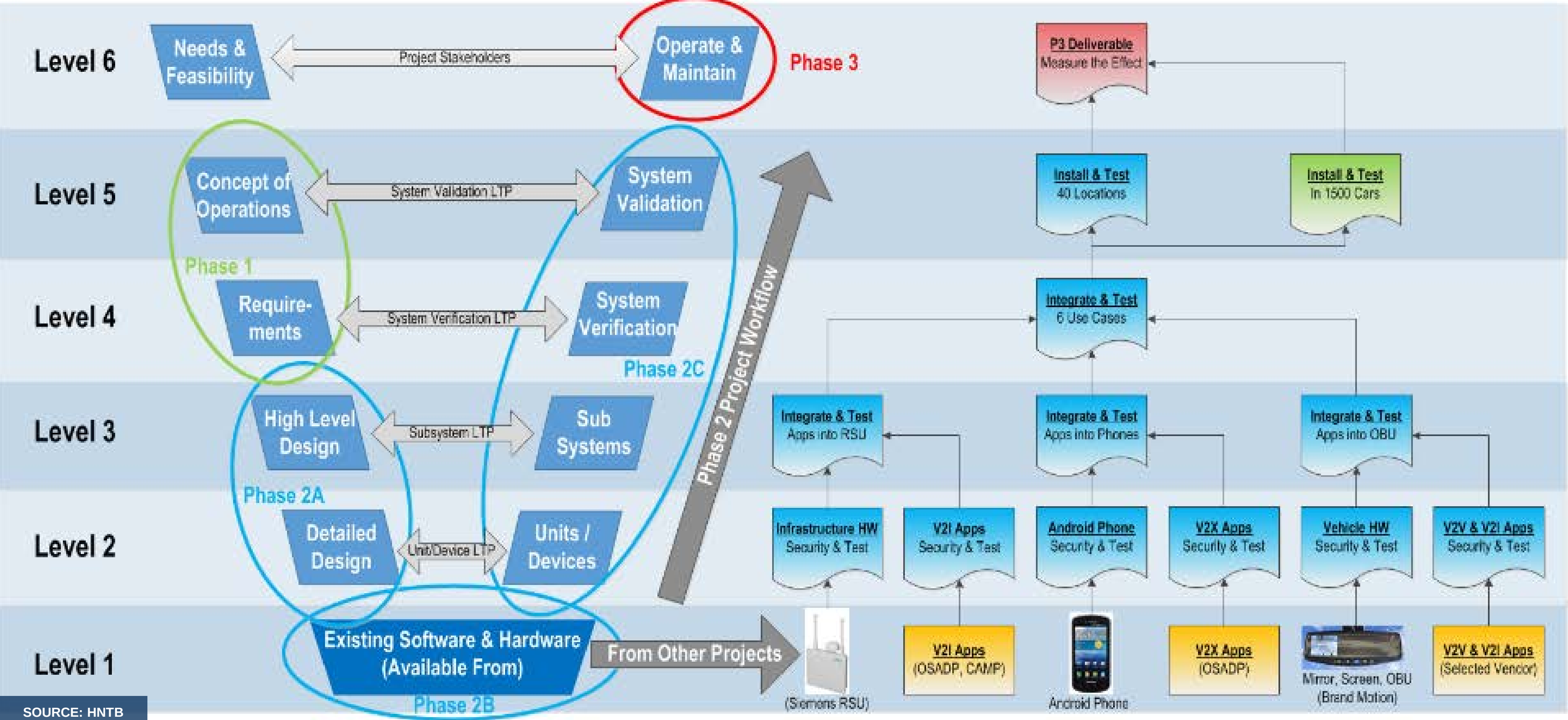
Experimental Design	UC1 Morning Peak Hour Queues	UC2 Wrong Way Entries	UC3 Pedestrian Conflicts at Courthouse	UC4 Bus Rapid Transit Signal Priority Optimization Trip Times and Safety	UC5 TECO Line Streetcar Trolley Conflicts	UC6 Enhanced Signal Coordination and Traffic Progression
Before/ After	✓	✓	✓	✓	✓	✓
Quasi-Experiment	✓	✓	✓		✓	✓
Random Design	✓					✓

Random Design – Treatment and Control groups, random assignment, compare average treatment effect, desirable but always achievable

Quasi-Experimental – Used when random assignment not possible, selection bias reduced by using methods like propensity score matching, matching algorithm, difference in difference

Before/After – Time series analysis, no control and treatment groups, confounding factor identification, baseline data required

DEPLOYMENT STATUS AND NEXT STEPS



SOURCE: HNTB

Systems Engineering – Challenges / Lessons Learned

- Application maturity not as evolved as expected
- Evolving standards
- Concurrent planning documents development
- More direct interaction with other teams
- Use of non-CV technology as part of solution
- Security

Program Management – Challenges / Lessons Learned

- Challenges
  1. Distributed Team Locations – Logistics
  2. Aggressive Delivery Schedules
  3. Balancing High Energy, Super Talented Teams with Need to have Centralized PM
  4. HIGH Number of Stakeholders with Initially Low Level of Comprehension

- Lessons Learned
  1. Importance of face to face progress meetings followed by breakout sessions
  2. Critical documents have overlapping/redundant content.
     a) Each progressive document must be reconciled with prior documents
     b) QC/QA should include dedicated staff having no other project involvement
     c) Reconciliation document for tracking these connected changes
  3. Balance needed between empowering team leads to operate autonomously and maintaining centralized program management to keep all teams informed and connected
  4. Need to not only engage early but to educate early as to the “Benefits” of the program and why their participation is key to success.

Performance Measurement & Evaluation – Challenges/ Lessons Learned

- Challenges
  1. Deployment in an area undergoing significant redevelopment will likely complicate dealing with confounding factors
  2. Identification of performance targets more difficult than developing measures and methods.

- Lessons Learned
  1. Cross functional coordination is absolutely critical
  2. Early involvement in activities such as System Requirements helps facilitate meaningful measurement
  3. Early definition of needs and role of Independent Evaluator would be helpful

Jonathan Walker

Lessons Learned from USDOT Perspective

OBJECTIVES

- The Context and Definition of Lessons Learned
- The USDOT leveraged lessons learned from the **Safety Pilot Model Deployment (SPMD)** and applied in the Connected Vehicle Pilot Program
- Lessons Learned from the **Connected Vehicle Pilot Program (CV Pilots)**

Connected Vehicles

Connected Vehicle Pilot Deployment Program

THE CONTEXT FOR LESSONS LEARNED

- What is the definition of lessons learned?
  - “*A lesson learned is knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure...A lesson must be significant in that it has a real or assumed impact on operations; valid in that is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result.*” [1]

Source: Secchi, P. (Ed.) (1999). Proceedings of Alerts and Lessons Learned: An Effective way to prevent failures and problems (Technical Report WPP-167). Noordwijk, The Netherlands: ESTEC

USDOT's Goal In Regards To Lessons Learned

- Incorporate the knowledge gained from the Safety Pilot Model Deployment
- Address the shortcomings or limitations from various USDOT ITS projects
- While developing the scope-of-work, there was a need to analyze all stages of the CV Pilot Program including deliverables, acquisitions, planning, execution, and evaluation

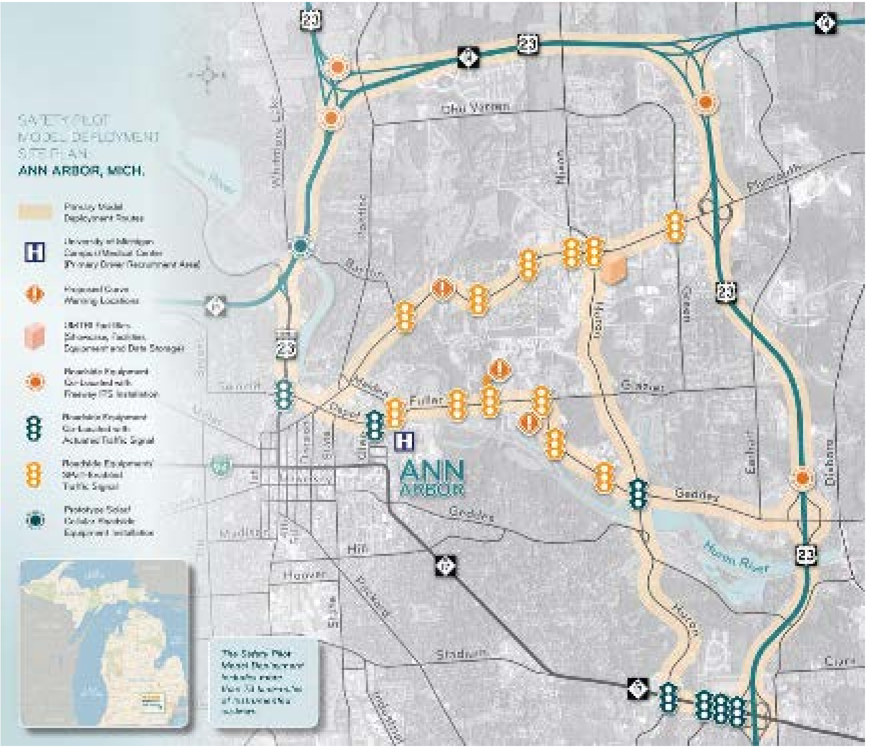
Overall Goals of the SPMD

- The overall goals of the Safety Pilot Model Deployment (SPMD) included, but not limited to:
  - Support NHTSA's decision to obtain empirical data on user acceptance and system effectiveness;
  - Demonstrate real-world connected vehicle applications in a data-rich environment;
  - Test the effectiveness of the connected vehicle crash avoidance systems
  - Establish a real-world operating environment for additional safety, mobility, and environmental applications development;
  - Archive data for additional research purposes.

Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 [Pg. 1] (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361

Overview of the SPMD

- In August 2012, the SPMD was launched in Ann Arbor (MI) and utilized connected vehicle technology in ~ 2,800 vehicles and at 29 infrastructure sites at a total cost of ~ $50 million.
- The SPMD involved numerous vehicle types such as passenger cars; light, medium, and heavy-duty trucks; and transit buses.



Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 [Pg. 1] (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361

Overview of the CV Pilots

- In September 2015, the USDOT awarded three (3) contracts to design the next generation connected vehicle system in a real-world environment under Phase 1 (12-months) of the Connected Vehicle Pilot Program: Wyoming, New York City (NYC), and Tampa.

- On September 1, 2016, the USDOT awarded three (3) cooperative agreements to the same CV Pilot sites for a collective worth of more than $45 million to initiate a Design/Build/Test (Phase 2 – 20 months).

Source:

- https://www.its.dot.gov/factsheets/pdf/JPO_CVPilot.pdf
- https://www.transportation.gov/briefing-room/us-department-transportation-announces-42-million-next-generation-connected-vehicle

NYCDOT

Tampa (THEA)

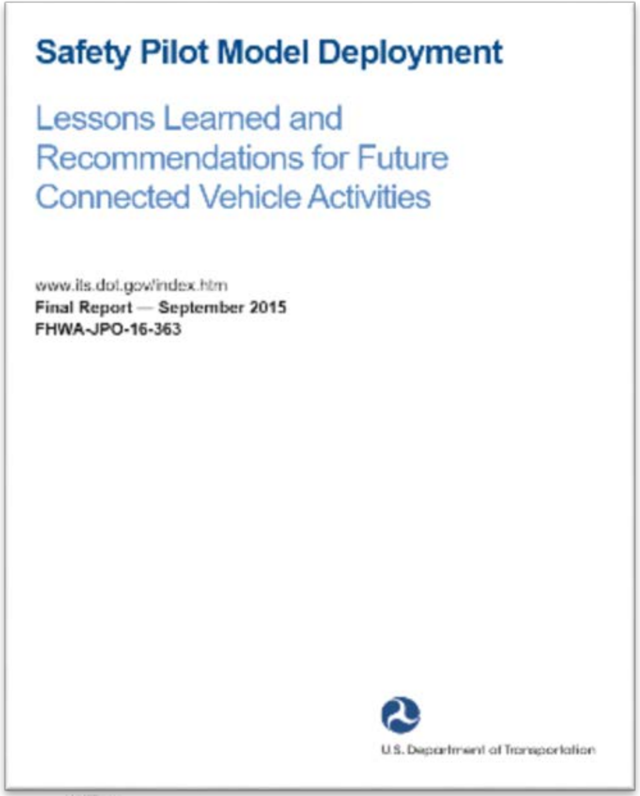
WYDOT

LESSONS LEARNED FROM THE SPMD

- Selecting a single, “ideal” Model Deployment site was highlighted as a significant challenge.

- A site optimized for a light vehicle demonstration may not be the best location for a heavy vehicle demonstration; or a site with many positive characteristics may be lacking a key aspect (e.g., a test track or closed facility for testing or demonstration).

Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 [Pg. 2] (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361


Safety Pilot Model Deployment

Lessons Learned and Recommendations for Future Connected Vehicle Activities

www.its.dot.gov/index.htm
Final Report — September 2015
FHWA-JPO-16-363

U.S. Department of Transportation

LESSONS LEARNED APPLIED TO THE CV PILOTS

Pilot Deployment Proposed CV Applications

Category	NYCDOT – CV Application
V2I/I2V Safety	Speed Compliance
	Curve Speed Compliance
	Speed Compliance/Work Zone
	Red Light Violation Warning
	Oversize Vehicle Compliance
	Emergency Communications and Evacuation Information
V2V Safety	Forward Crash Warning (FCW)
	Emergency Electronic Brake Lights (EEBL)
	Blind Spot Warning (BSW)
	Lane Change Warning/Assist (LCA)
	Intersection Movement Assist (IMA)
	Vehicle Turning Right in Front of Bus Warning
V2I/I2V Pedestrian	Pedestrian in Signalized Crosswalk
	Mobile Accessible Pedestrian Signal System (PED-SIG)
Mobility	Intelligent Traffic Signal System (I-SIGCVDATA)

** The applications have mobility/ efficiency as a secondary benefit.*

Category	WYDOT – CV Application
V2V Safety	Forward Collision Warning (FCW)
V2I/I2V Safety	I2V Situational Awareness*
	Work Zone Warnings (WZW)*
	Spot Weather Impact Warning (SWIW)*
V2I and V2V Safety	Distress Notification (DN)
Category	**Tampa (THEA) – CV Application**
V2I Safety	End of Ramp Deceleration Warning (ERDW)
	Wrong Way Entry (WWE)
	Pedestrian in Signalized Crosswalk Warning (PED-X)
	Pedestrian Collision Warning (PCW)
	Pedestrian Transit Movement Warning (PTMW)
V2V Safety	Emergency Electronic Brake Lights (EEBL)
	Forward Collision Warning (FCW)
	Intersection Movement Assist (IMA)
	Vehicle Turning Right in Front of a Transit Vehicle (VTRFTV)
Mobility	Mobile Accessible Pedestrian Signal System (PED-SIG)
	Intelligent Traffic Signal System (I-SIG)
	Transit Signal Priority (TSP)
Agency Data	Probe Date Enabled Traffic Monitoring (PDETM)

Stages of the SPMD

- The Safety Pilot Model Deployment consisted of the following four (4) major stages:
  - **Stage 1: Device Development (July 2010 – October 2012)**
    - The first stage included the development of devices that would be used throughout the SPMD.
    - The USDOT created a research Qualified Product Lists (rQPLs) and purchased devices under three categories: Vehicle Awareness Devices (VAD); Aftermarket Safety Devices (ASD); and Roadside Units (RSU).

Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361

LESSONS LEARNED APPLIED TO THE CV PILOTS

- **Device Interoperability:** It is essential to clearly outline the device's specifications and the devices must conform to relevant industry standards.

- **USDOT's DSRC Roadside Unit (RSU) Specifications Document v4.1**
  - This document set the requirements for roadside units (RSU) capable of acting as a network edge device for 5.9GHz DSRC infrastructure by establishing the base functionality as the infrastructure first point-of-contact for vehicles/mobile devices.

- **USDOT's Revision to Dedicated Short Range Communication Roadside Equipment Specification – RSU 4.1 Bench Test Plan**
  - This document describes the overall process for evaluating DSRC RSUs against the USDOT RSU Specification 4.1. The Test Cases will only evaluate basic RSU functionality because the document is intended to provide guidance to the vendors.

Source: https://ntl.bts.gov/lib/61000/61700/61794/FHWA-JPO-17-589.pdf
https://ntl.bts.gov/lib/62000/62100/62162/FHWA-JPO-17-591.pdf

Lessons Learned Applied to the CV Pilots

WYDOT – Devices	Estimated Number
Roadside Unit (RSU)	75
WYDOT Fleet Subsystem On-Board Unit (OBU)	100
Integrated Commercial Truck Subsystem OBU	150
Retrofit Vehicle Subsystem OBU	20-30
Basic Vehicle Subsystem OBU	100-150
Total Equipped Vehicles	*400*

Tampa (THEA) – Devices	Estimated Number
Roadside Unit (RSU) at Intersection	40
Vehicle Equipped with On-Board Unit (OBU)	1,600
Pedestrian Equipped with App in Smartphone	500
HART Transit Bus Equipped with OBU	10
TECO Line Street Car Equipped with OBU	10
Total Equipped Vehicles	*1,620*

NYCDOT – Devices	Estimated Number
Roadside Unit (RSU) at Manhattan and Brooklyn Intersections and FDR Drive	353
Taxi Equipped with Aftermarket Safety Device (ASD)*	5,850
MTA Fleet Equipped with ASD*	1,250
UPS Truck Equipped with ASD*	400
NYCDOT Fleet Equipped with ASD*	250
DSNY Fleet Equipped with ASD*	250
Vulnerable Road User (Pedestrians/Bicyclists) Device	100
PED Detection System	10 + 1 spare
Total Equipped Vehicles	*8,000*

MTA: Metropolitan Transportation Authority; DSNY: City of New York Department of Sanitation

** In addition, 600 spare ASDs will be purchased.*

Stages of the SPMD

- **Stage 2: Pre-Model Deployment Planning and Testing (August 2011 – August 2012)**
  - The second stage was used to test, identify, and resolve all critical issues before proceeding to the Model Deployment Execution stage.
  - The Pre-Model Deployment Planning and Testing stage included the following three activities:
    - Planning for the Model Deployment Execution;
    - Preparing and installing the required infrastructure and in-vehicle devices;
    - Conducting interoperability and dry run tests.

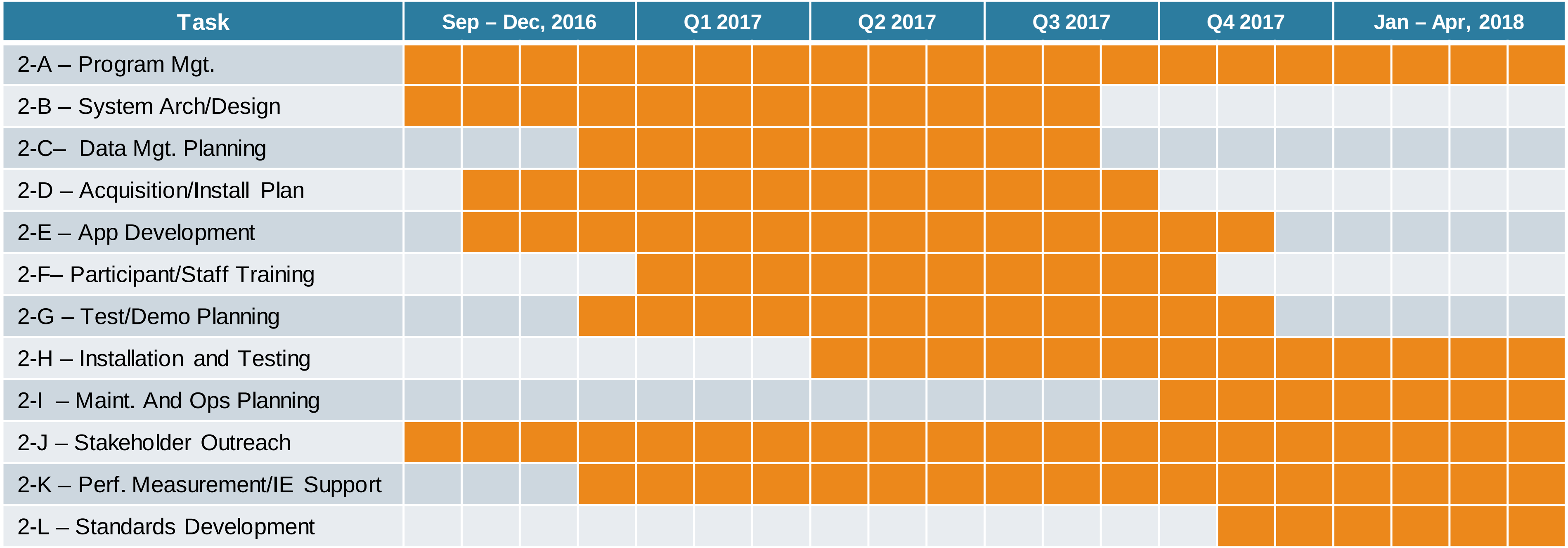
- **Stage 3: Model Deployment Execution (August 2012 – August 2013)**
  - The third stage of the SPMD focused on the deployment and maintenance of all equipped vehicles into the connected vehicle environment.
  - The maintenance of the devices included repairing or replacing non-functional units, updating device software and downloading data.

Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361

Lessons Learned Applied to the CV Pilots
Phase 1 Schedule

Task	Sep 2015	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016
Task 1 – Program Mgt.	■	■	■	■	■	■	■	■	■	■	■	■	■
Task 2 – Concept of Operations		■	■	■	■	■	■						
Task 3 – Security Concept			■	■	■	■	■	■					
Task 4 – Safety Plan				■	■	■	■	■					
Task 5 – Performance Measurement			■	■	■	■	■	■	■	■			
Task 6 – System Requirements					■	■	■	■	■	■	■	■	
Task 7 – App Planning				■	■	■	■	■	■	■	■	■	■
Task 8 – Human Use Approval					■	■	■	■	■	■	■		
Task 9 – Training Plan						■	■	■	■	■	■	■	
Task 10 – Partnership			■	■	■	■	■	■	■	■	■	■	
Task 11 – Outreach Plan							■	■	■	■			
Task 12 – Deployment Plan								■	■	■	■	■	
Task 13 – Readiness Summary											■	■	■

Lessons Learned Applied to the CV Pilots
Phase 2 Schedule



Note: This is a proposed schedule; not every Pilot site followed exactly the same schedule.

Lessons Learned Applied to the CV Pilots
Phase 3 Schedule

Task	Q2 2018	Q3 2018	Q4 2018	Q1 2019	Q2 2019	Jul – Oct 2019
3-A – Program Mgt.						
3-B – System Ops/Maint						
3-C– Stakeholder Outreach						
3-D – Perf. Meas./Evaluation Support						
3-E – Transition Planning						
3-F– Standards Development						

Note: This is a proposed schedule; not every Pilot site will follow exactly the same schedule.

Stages of the SPMD

- **Stage 4: Post-Model Deployment Evaluation (August 2013 – August 2014)**
  - This final stage of the SPMD involved analysis of the data collected during the Model Deployment Execution stage by the **Independent Evaluator**
  - The USDOT to determine the effectiveness of the connected vehicle systems.

Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361

Lessons Learned Applied to the CV Pilots
Multi-Tiered Evaluation

CV Pilot Site-Specific Evaluation	• Conduct cost-benefit SMEP (safety, mobility, environmental and public agency efficiency) analyses • Assess acceptance/satisfaction of pilots • Assess efficacy of deployed institutional/financial models • Document lessons learned
CV Pilot National-Level Evaluation	• Conduct national-level evaluation of CV Deployments
CV Pilot Program Evaluation	• Assess whether performance-management focus of pilot deployments was beneficial • Assess if the program achieved its vision cost-effectively

LESSONS LEARNED FROM THE SPMD

- **Technical Support**: In general, those affected by these additions indicated a preference for earlier engagement in subsequent pilot projects; indicating a need for efforts to predict potential expansions of scope early in the process in the future.
- **Technical Support**: While the effectiveness of many of the project management processes was strongly endorsed (e.g., the nature and frequency of meetings), other, more technically-focused processes and tools (e.g., development of a SEMP; configuration management; requirements generation; data types and formats specification) should be given greater emphasis in a future pilot project.
- **Data Access**: "… other opportunities were accommodated and pursued within the Model Deployment, including V2I application development and contextual data analysis."

Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 [Pg. 2 & 3] (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361

Lessons Learned Applied to the CV Pilots Technical Support

Title	Purpose	Frequency
All-site Monthly Meeting; Site Bi-weekly Meeting	• Tracking key issues as they arise and taking coordinated action	Monthly; Bi-weekly
Technical Roundtable	• Coordinating technical assistance activities between federal agencies and providing consistent messaging to the three CV Pilot deployments. • Providing a platform for the three deployment sites to exchange information/learn from each other • Allowing the CV Pilot deployments to give feedback to the USDOT, and make suggestions for future direction of activities.	• Virtual: bi-weekly • In-Person: quarterly
Performance Measurement and Evaluation Support Roundtable	• Highlighting challenges and issues, discussing potential solutions, and providing consistent advice and guidance to the three CV Pilot deployments and the Independent Evaluation Team on activities related to Performance Measurement; Support to Independent Evaluation; Independent Evaluation; and Human Use Approval	Bi-weekly
Outreach Roundtable	• Coordinating communication and outreach-related activities between federal agencies and the three pilot sites • Providing consistent messaging during the CV Pilots outreach activities.	Monthly
SCMS End Users Group	• Updating the SCMS Proof-of-Concept (PoC) development progress • Coordinating with the CV Pilot deployments	Periodically

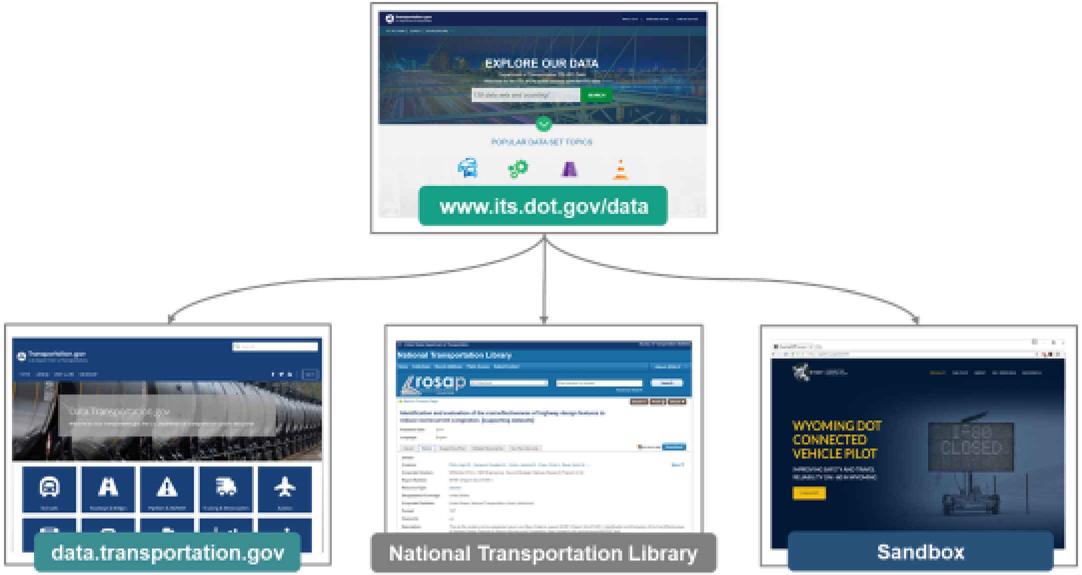
Lessons Learned from the SPMD Data Access

- **Observations:**
  - Data was collected for specific purposes by different organizations, with no overarching data management plan
  - Data access and retention policies were unclear
  - IRB terms of data use were defined narrowly

- **As a Result:**
  - Years later, no one group (including USDOT) has access to the full archive of data generated
  - This limits return on investment, and slows down pace of research

Lessons Learned Applied to the CV Pilots Data Access

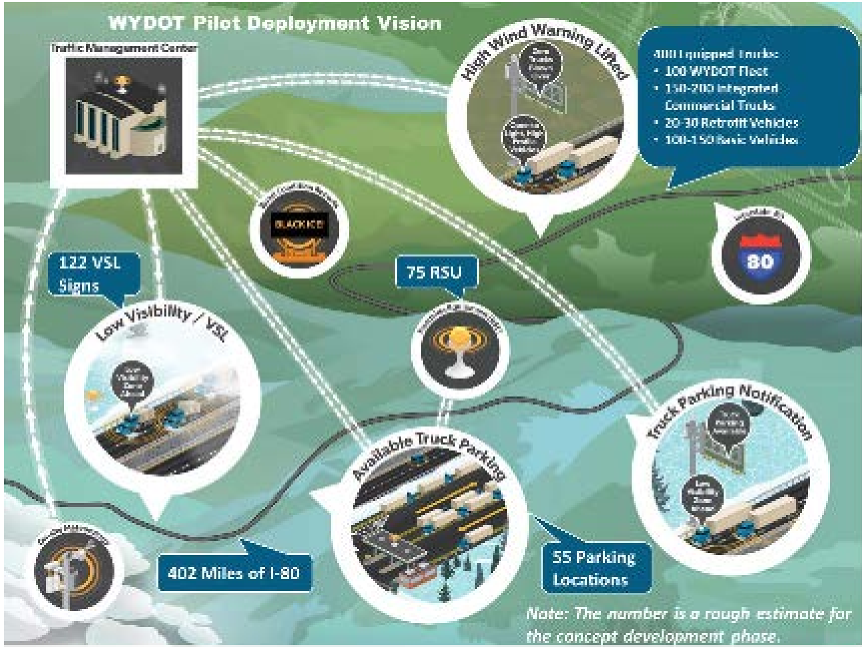
- ITS Research Data Access & Retention Program
  - No-wrong-door to discovery
  - Near-real-time delivery
  - Clear retention policies
  - Federated architecture
  - Robust governance and technical assistance program
  - Starting with public data
    - *But we are incubating a parallel structure for sensitive data, starting with CV Pilot evaluation data*



ITS research data hub: https: /www.its.dot.gov/data/

Lessons Learned Applied to the CV Pilots Data Access

- Available Now: Streaming Data from Wyoming Connected Vehicle Pilot
  - View and download data streams from early deployers like the CV Pilots
    - Full data set: https://github.com/usdot-its-jpo-data-portal/sandbox
    - Sample: https://data.transportation.gov/
  - Starting with filtered Basic Safety Messages (BSM) and Traveler Information Messages (TIM) from Wyoming



Lessons Learned from the SPMD

- It is important to ensure that future pilot projects can accommodate the planning and conduct of effective, rigorous testing activities needed for various devices, equipment, and systems.

- Provision should be made for sufficient time and resources for iterative testing that can commonly occur in programs of this nature.

Source: Safety Pilot Model Deployment Lessons Learned and Recommendations for Future Connected Vehicle Activities; September 2015 [Pg. 3] (FHWA-JPO-16-363). https://rosap.ntl.bts.gov/view/dot/4361

Lessons Learned Applied to the CV Pilots Field Demonstrations

- Tampa (THEA) hosted the first public demonstration of the technology it will deploy as part of the Tampa CV Pilot on November 13, 2017
- Wyoming and their partners demonstrated the new connected vehicle technology recently in Cheyenne on November 15, 2017
- NYCDOT tested mobile accessible pedestrian signal system application on November 27, 2017


Source: NYCDOT


Source: Wyoming DOT


Source: THEA

More Lessons Learned Under the CV Pilots

- The most common lessons learned reported by the federal team, pilot sites, and technical support include:
  - It is essential to conduct consistent internal team meetings with clearly communicated agendas and outreach plans to keep everyone in the loop and pace the performance of the project;
  - Be as frank as possible with the contractor regarding the agency's technical resources (or lack of support) during the design phase and before deployment (i.e., agency's IT support, FCC license application);
  - Leverage local stakeholders and leadership early (i.e., before the solicitation and during design) to develop an effective concept of operations and system architecture development;
  - Conduct several vendor demonstrations before the solicitation and during the design phase to evaluate the technological maturity of deployment-related systems and resources;
  - Connected Vehicle projects are not a end-all-be-all solution to ITS deployments;
  - Don't be afraid to say no.

Source: Connected Vehicle Pilot Deployment Program Phase 1 Lessons Learned Final Report — January 2017 (FHWA-JPO-17-504) https://ntl.bts.gov/lib/61000/61000/61019/FHWA-JPO-17-504.pdf

Q&A

NYCDOT

Tampa (THEA)

WYDOT

USDOT

Stay Connected

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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.wyoroad.info/

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