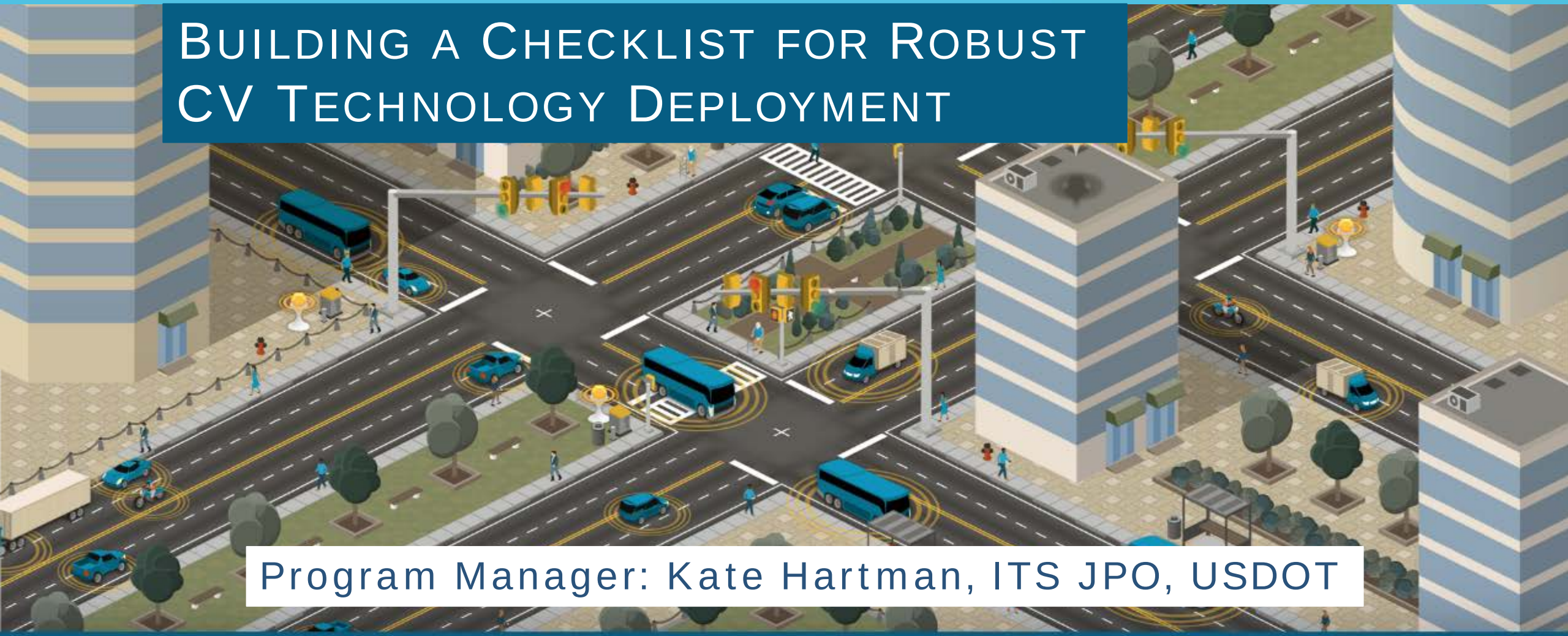
CONNECTED VEHICLE PILOT
Deployment Program

Building a Checklist for Robust CV Technology Deployment



Program Manager: Kate Hartman, ITS JPO, USDOT

SESSION AGENDA

- 8:00 – 8:35 AM: Connected Vehicle Pilot Deployment Program Overview
  - Program Overview - *Kate Hartman, Chief, Research/Evaluation/Management, ITS JPO, USDOT*
  - New York City Pilot Project – *Bob Rausch, Vice President, Transcore*
  - Tampa (THEA) Pilot Project – *Bob Frey, Planning Director, Tampa Hillsborough Expressway (THEA)*
  - Wyoming DOT Pilot Project – *Deepak Gopalakrishna, Principal, ICF*

- 8:35 – 8:50 AM: Interoperability Test Summary
  - *Kate Hartman*

- 8:50 – 9:40 AM: Panel Discussion: Building a Checklist for Robust CV Technology Deployment
  - *Kate Hartman, Bob Rausch, Bob Frey, Deepak Gopalakrishna*

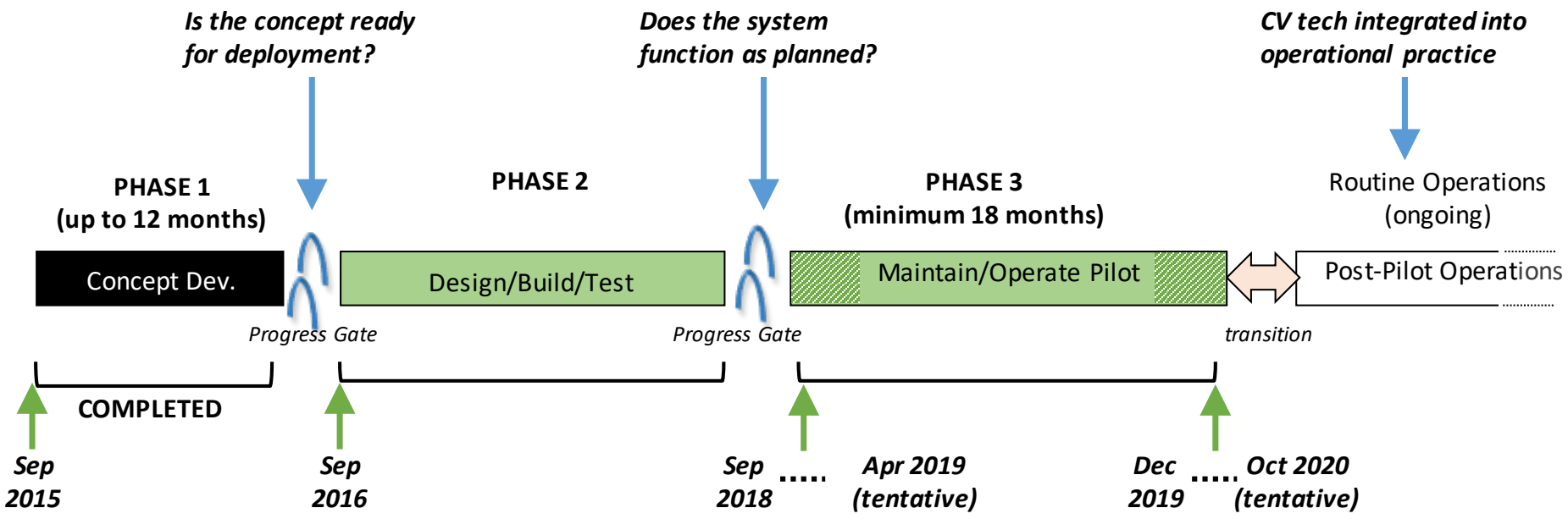
- 9:40 – 10:00 AM: Questions and Answers

CV Pilot Deployment Program Goals

Source: USDOT

U.S. Department of Transportation
Federal Highway Administration

CV Pilot Deployment Schedule



- **Phase 1: Concept Development (COMPLETE)**
  - Creates the foundational plan to enable further design and deployment.
- **Phase 2: Design/Deploy/Test**
  - Detailed design and deployment followed by testing to ensure deployment functions as intended (both technically and institutionally).
- **Phase 3: Maintain/Operate**
  - Focus is on assessing the performance of the deployed system.
- Post Pilot Operations (CV tech integrated into operational practice).

Last updated: August 2, 2018

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Federal Highway Administration

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.

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New York City DOT Pilot Overview

Bob Rausch
Vice President, Transcore

CV Deployment Equipment

- Up to 8,000 **fleet** vehicles with Aftermarket Safety Devices (ASDs):
  - Taxis (Yellow Cabs)
  - MTA Buses
  - Sanitation & DOT vehicles
  - DCAS vehicles
- Pedestrian PIDs ~100 units
  - Visually Impaired Navigation
- Roadside Units (RSU) at

  ~353 Locations+
  - ~202 Manhattan Ave
  - ~ 79 Manhattan Cross
  - ~ 28 on Flatbush Ave
  - ~ 8 on FDR
  - ~ 36 Support locations (airports, river crossings, terminal facilities)

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

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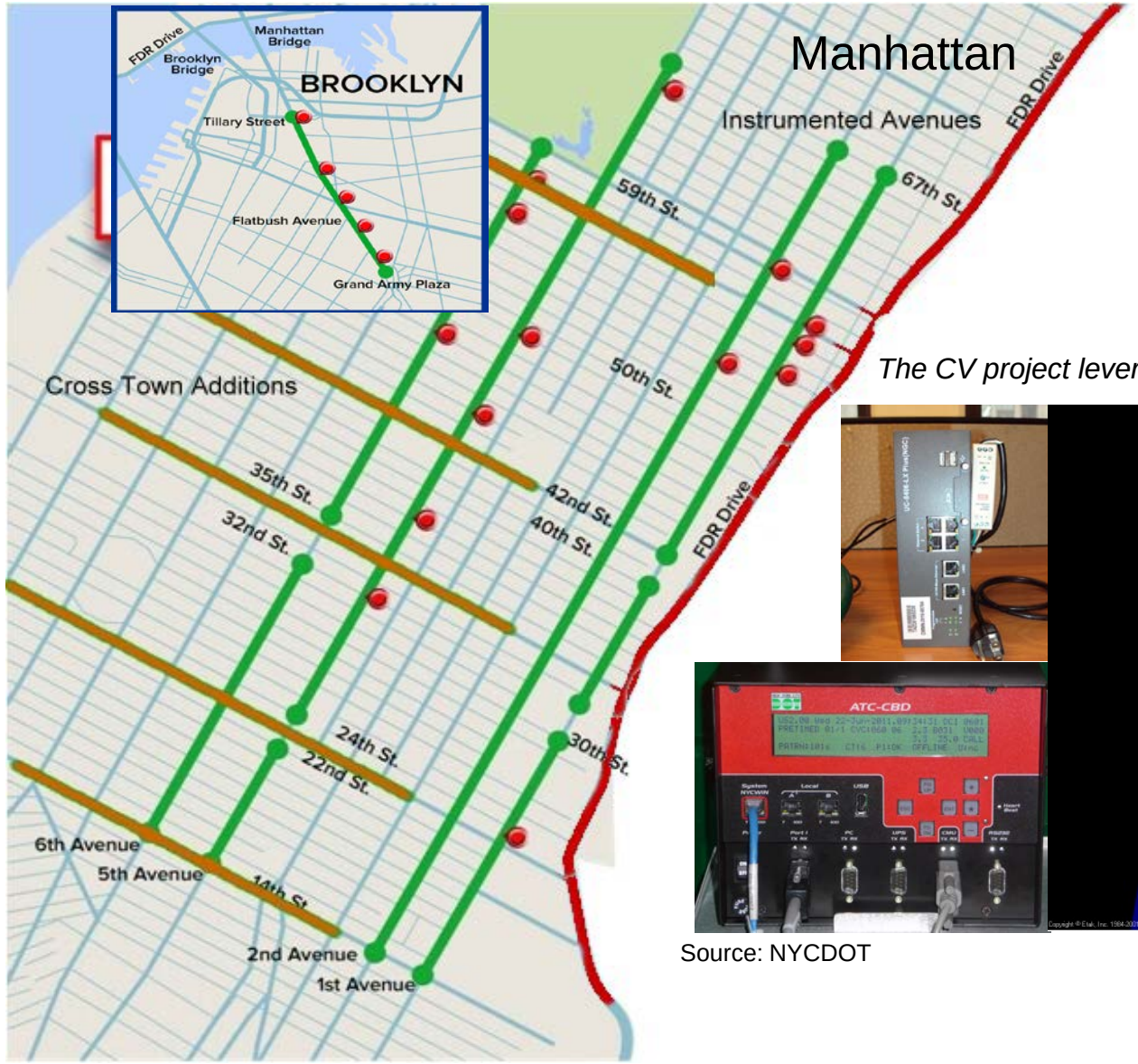
LOCATIONS (MANHATTAN, BROOKLYN)



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

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

The CV project leverages the City's transportation investments

Source: NYCDOT

CV Safety Applications

Vehicle-to-Vehicle

- 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

Pedestrian Applications

- Pedestrian in Crosswalk
- Visually Impaired Crossing

Vehicle-to-Infrastructure

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

Other Applications

- OTA Firmware Update
- Parameter Modifications (Tuning)

CV SUPPORT Applications

Other Applications

- OTA Uploading of Data Collected
- Application Parameter Modifications (Tuning)

Data Collection: Operations, Maintenance, and Performance Analysis

- CV Data for Intelligent Traffic Signal System
- RF Monitoring
- Traffic data collection
- *Event History Recording*
- *Event History Up Load*

To Meet USDOT Requirements for Benefit Analysis

Data Collection Issues

What to collect

- What could we collect?
  - What is the raw data available
- What do we need?
  - What is the intended use of the data?
- What should we collect?
  - To Justify the costs!

This is not an R&D project!

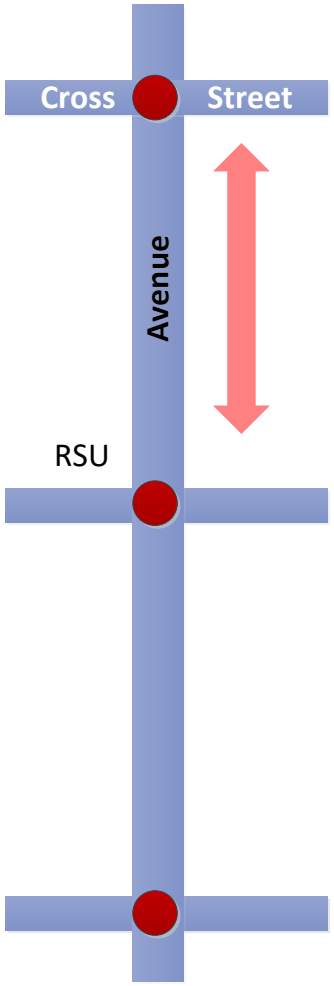
What are the costs

- Backhaul communications
- Storage
- Processing
- Supporting FOIA requests
- Supporting Subpoenas

Privacy Issues

- Prohibition of keeping PII
- Combination with other src.
- Data Ownership

EXAMPLE – TRAVEL TIME



- Block Spacing ~70M Feet (230')
- 20 MPH – 30 feet per second
- DSRC Range ~300M (1000')
- BSMs Xmit @ 10 Hz
- Time between blocks ~8 seconds
- BSMs transmitted 80
- BSMs needed 2 (3%) **a 97% reduction**
- Edge computing @ RSU
  - RSU looks for vehicle entry to Intersection
  - Transmits one BSM to TMC per vehicle
  - TMC matches BSM – Vehicle ID
  - TMC computes travel time
  - Or TMC data times out - -

Optimized Intersection Control

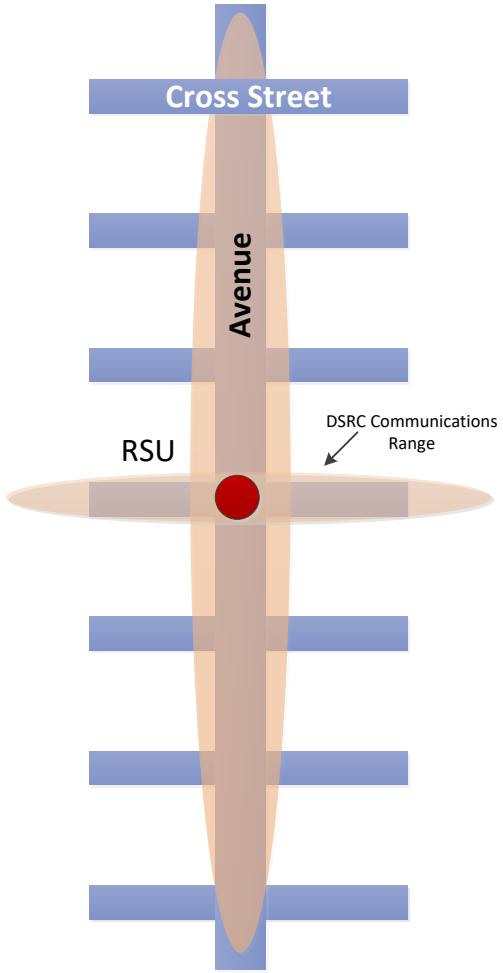
- Edge computing @ traffic controller
  - Queue length - Stopped Vehicles
  - Vehicle speeds – Reported in local BSM
  - Priority and preemption – With local communications
  - Incident detection – deviation around obstacle
  - Pedestrian presence

- Send to TMC only what needs to be used
  - Platoon management (Freight priority)
  - Alternate route management/diversion
  - Incident detection
  - Travel times (Average link speed)

Remember: without 100% penetration of CV technology:

- ***Volume***
- ***Occupancy***

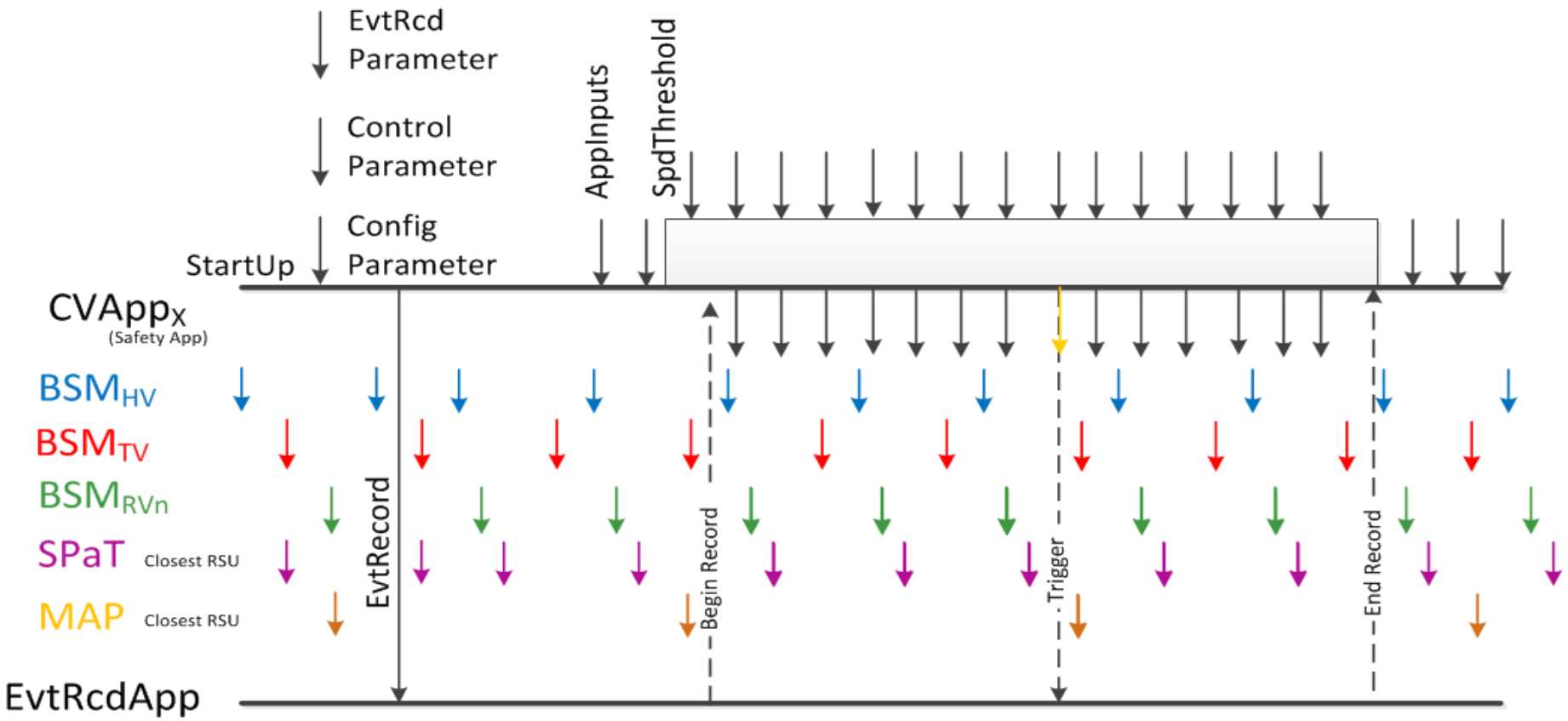
PRACTICAL DATA COLLECTION - INCIDENTS



- 1.2 M vehicles in NYC broadcast **83 TB/day**
- 13,000 intersections in NYC broadcast **3 TB/Day SPaT & MAP**
- 8,000 vehicles collect ***2 TB of BSM data/day***
- Data ***needed*** for benefits analysis:
  - How many crashes per day did we prevent
  - How many crashes per day did we mitigate
- Edge computing – Onboard Unit (OBU)
  - OBU monitors vehicle operation (S, Yaw, etc.)
  - OBU monitors surrounding vehicles' operation
  - OBU assesses threats
  - OBU alerts driver to mitigate threat
  - OBU records what the caused alert and driver actions

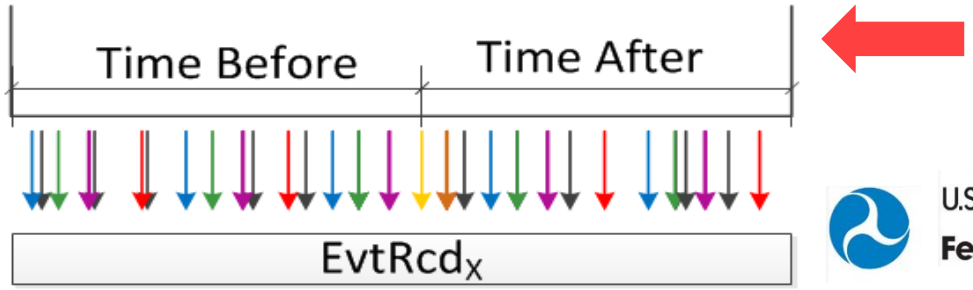
SOLUTION "INCIDENT DATA"

INTERMITTENT LOGGING



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

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



"Alert" triggers and event record

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More Efficient Data Collection
Real Privacy Concerns

Efficiency

- Instead of 2 TB – only 116 GB per day
  - 17 times less – and more useful detail
  - Includes SPaT and MAP information - 4 events per hour /vehicle
  - Expected data and incidents – 1/hour @ 14 hours/Vehicle/Day = 29 GB per day 67x less!

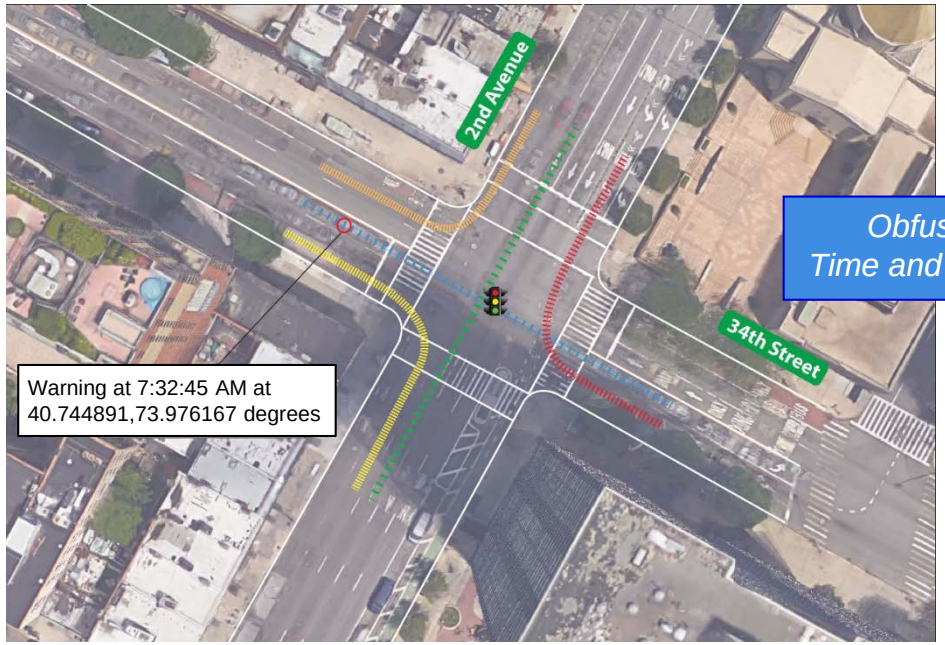
Privacy

- If BSM data were to be collected - -
  - Provides vehicle locations at 0.1 second intervals
  - Time-of-day Stamped to 0.1 second accuracy
  - Police Records indicate “final position” of vehicles and time of day
  - CV data could be used to recreate the accident scene

- Even though CV vehicle ID is randomly changed – the raw data can be tracked to an individual vehicle

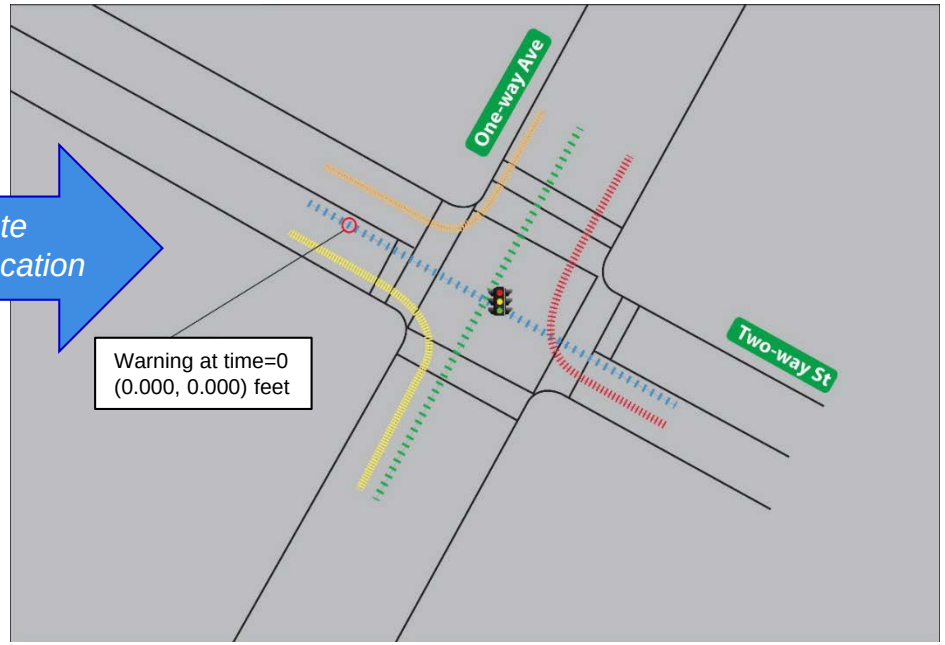
Obfuscation of OBU Action Logs

Raw ASD Action Log Data



Obfuscate
Time and Location

Obfuscated ASD Action Log Data



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

Other examples – Operations Data

- RF Data – Proactive Analysis
  - Records first and Last BSM heard from each OBU
  - Time-out to find dropouts
  - At 1000 ft. vehicle “hears” RSU for 50 seconds
  - Actual BSMs from that vehicle – 500
  - Edge computing RSU – monitor OBU keep first/last
  - Same for OBU – 98% bandwidth reduction!
  - Only 8 BSMs actually captured!

- Guess who I saw
  - Track other OBUs seen throughout the City
  - Record 2 bytes per encounter - - BUT some parallel change

Data Collection Summary

- The CV technology could make “mountains of data” available – but there is a cost
  - DSRC Channel time
  - Cellular media monthly limitations and costs
  - Processing and storage – as well as retrieval (FOIA)
- NYC pilot deployment project
  - Tailored data collection to meet needs
  - Concept is to distribute processing to the edge
  - Added RSU locations to collect data
- **NYC System – DSRC only V2I**

Where Are We Today

- City Processes have delayed procurement contracts
  - RSUs now on order – prototypes received – Siemens
    - RSUs software under development
      - Data collection
      - OTA uploading logs
      - OTA downloading software & Application Parameters
      - ATC interface security (DTLS x.509 Certs)
  - ASD procurement contracts - final review & approvals 2 vendors (DanLaw, Savari)
    - ASD software still in design and development – Vendor 1
      - Data logging
      - OTA downloading of firmware & application parameters
      - OTA uploading of log files
      - Minor hardware changes for audio control and RTC Quiescent Current

Where Are We Today

- ASD software still in design and development – Vendor 2
  - Data logging
  - OTA downloading of firmware & application parameters
  - OTA uploading of log files
- Location Accuracy – project requiring 1.5 M open sky – testing underway
- Urban Canyons create problems! Required map matching, inertial navigation, dead reckoning, triangulation in addition to GNSS!
- Testing RSU triangulation now – with 10 prototype RSU
- Will be testing another proposed solution in a few weeks
- Repeated location accuracy testing at TFRC – found error in Ublox chips – vendor fixed and traces repeated and clearly show lane distinguishing.
- Vendors seeking certification from Omniair – based on version 1
- Have performed end-to-end testing for interoperability WITH security!
- Prototype evaluation and development phase starts with the delivery of the actual units

Where Are We Today

- Installation procedure development – ASD/OBU
  - Establishing contracts with professional installation firms
  - Have installed 68 OBUs in a wide variety of vehicles
    - Evaluated installation procedures and materials and end result
    - Developing video instructions for installers
    - Developing cost estimates for the contracts
    - Establishing the “rules” for installation on each vehicle type
    - OBUs attach to the CAN bus !
  - Installation procedure development – RSU
    - Location – mast arm ; survey all intersections for available space
    - Testing wireless ethernet extension to reach remote RSU
    - Installation technique
    - Wiring to ATC cabinet
    - IP addressing and network configuration
    - Security Provisions and maintenance procedures

Where Are We Today

- ATC software update is nearly complete
  - NTCIP 1202v3 interface with modifications
  - Supports Adaptive and Interval based operation with TSP
  - Simulation configuration operational
  - Integration with RSU is underway
  - Integration with TMC is underway
  - Protecting NTCIP within a DTLS secured connection
- Pedestrian Information Device (PID) for the visually impaired
  - Demonstrations well received
  - Debugging interface with NYU servers – to protect data
  - Communications design completed
  - Awaiting final design review and evaluation of HMI
  - Demonstrated location augmentation

More Recent Lessons Learned

- Setup of all devices is too complicated for field personnel
  - Scripts supported by TMC
  - MAP will be prepared and loaded by TMC
  - Developing plug-n-plan field installation – simple maintenance
- Developing “secure” and “trusted” maintenance procedures requires accountability!
- We still have IPv4 and IPv6 issues for SCMS services
- Stakeholders prefer through-the-glass antenna mount
- RF Monitoring – (GPS Jamming, other in-band testing)

Thank you → ***Bob Frey and the THEA pilot***

Tampa (THEA) Pilot Overview

Bob Frey

Planning Director, Tampa Hillsborough Expressway (THEA)

Focused Deployment Area

PARTICIPANTS

PHOTO: THEA

PHOTO: NPR

PHOTO: THEA

PHOTO: THEA

1,600

Privately Owned Vehicles

500+

Pedestrian Smartphones (Android devices only)

10

TECO Line Streetcar Trolleys

10

Hillsborough Area Regional Transit (HART) buses

EQUIPMENT

PHOTO: THEA

PHOTO: SIEMENS

20

On-Board Transit Units (OBUs)

Tablet display for transit vehicles

40

Road Side Units (RSUs)

Mounted on existing structures throughout the deployment area

On Board Units (OBUs)

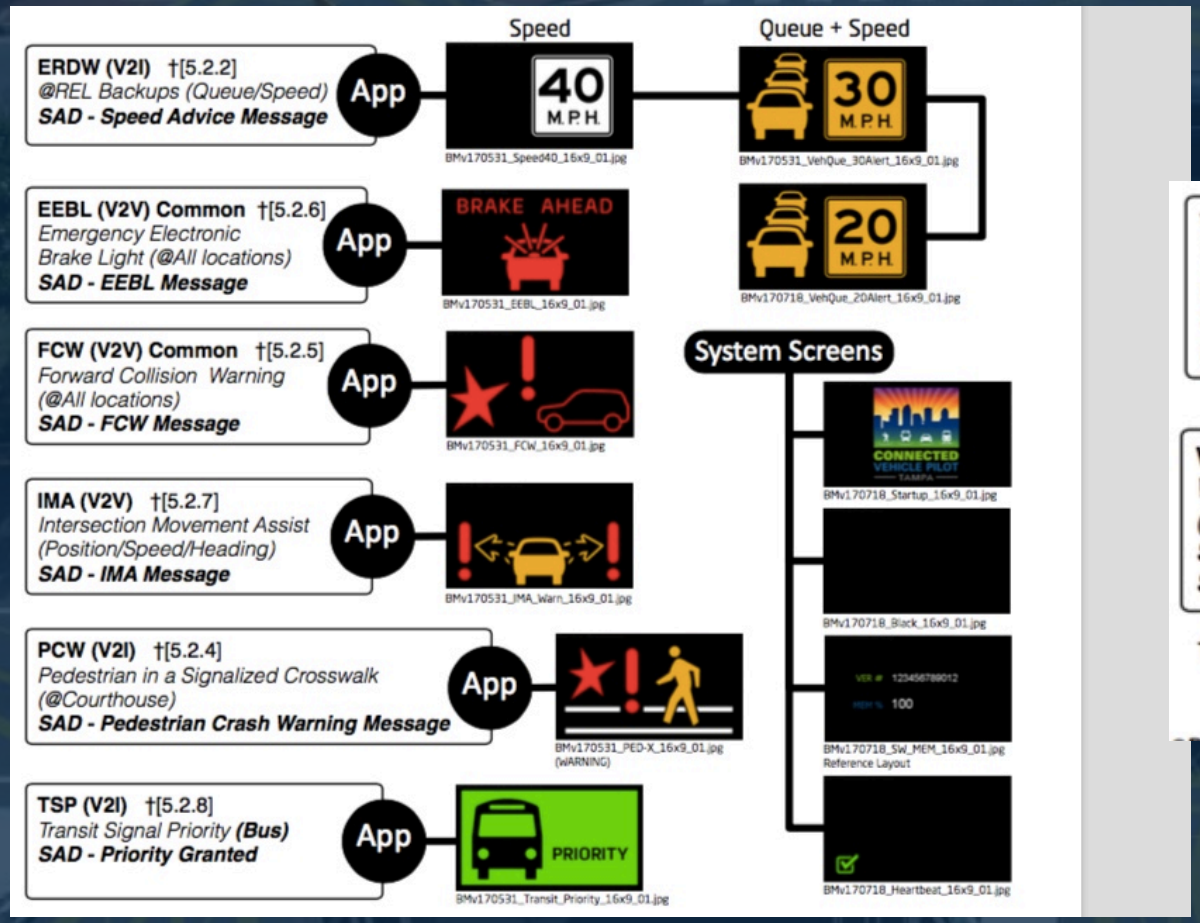
1,600

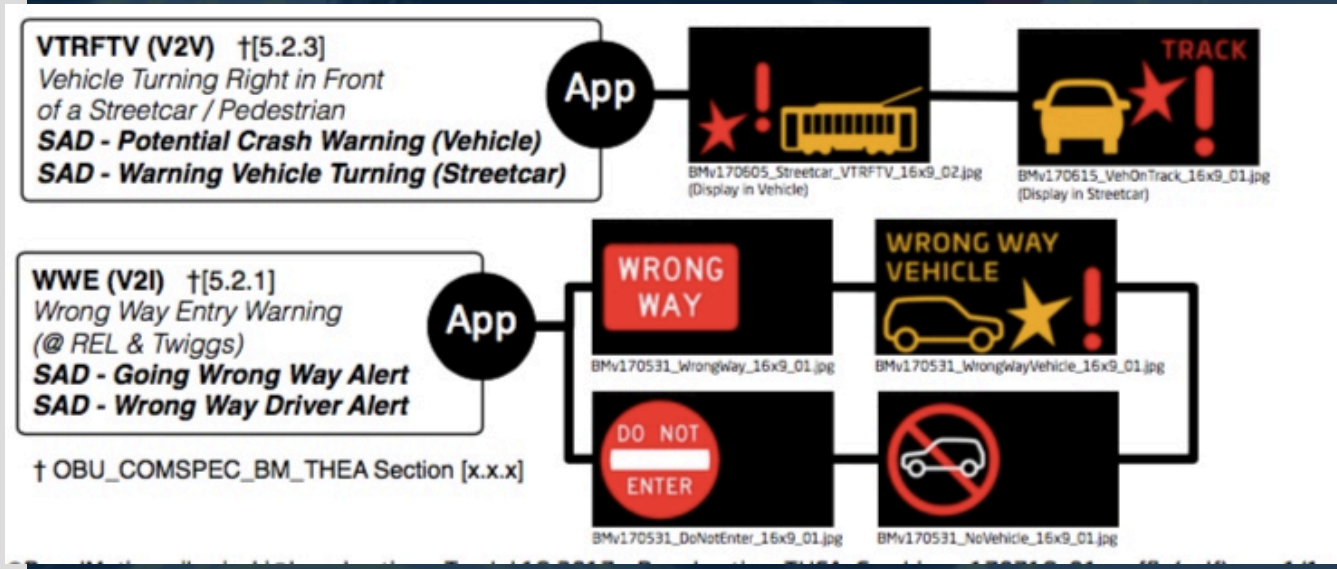
On-Board Units (OBUs)

A rear view mirror for passenger vehicles

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

In Vehicle System – App Warning Graphics





Source: Brand Motion

In Vehicle User Interface

Safety warnings integrated into the rear-view mirror, visual (with auditory alert) examples shown below.

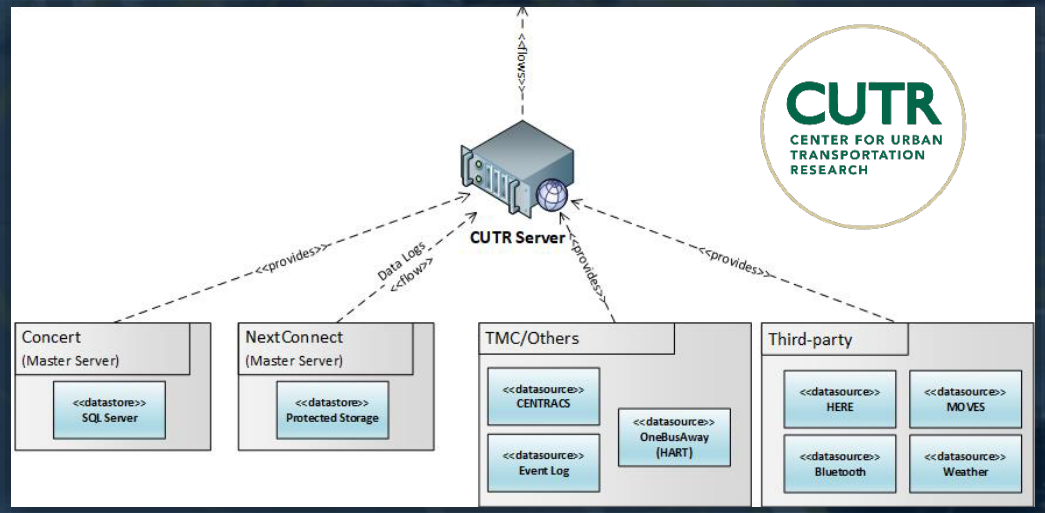
Electronic Brake Light Warning

Exit Ramp Deceleration Warning

Source: Brand Motion and Global 5

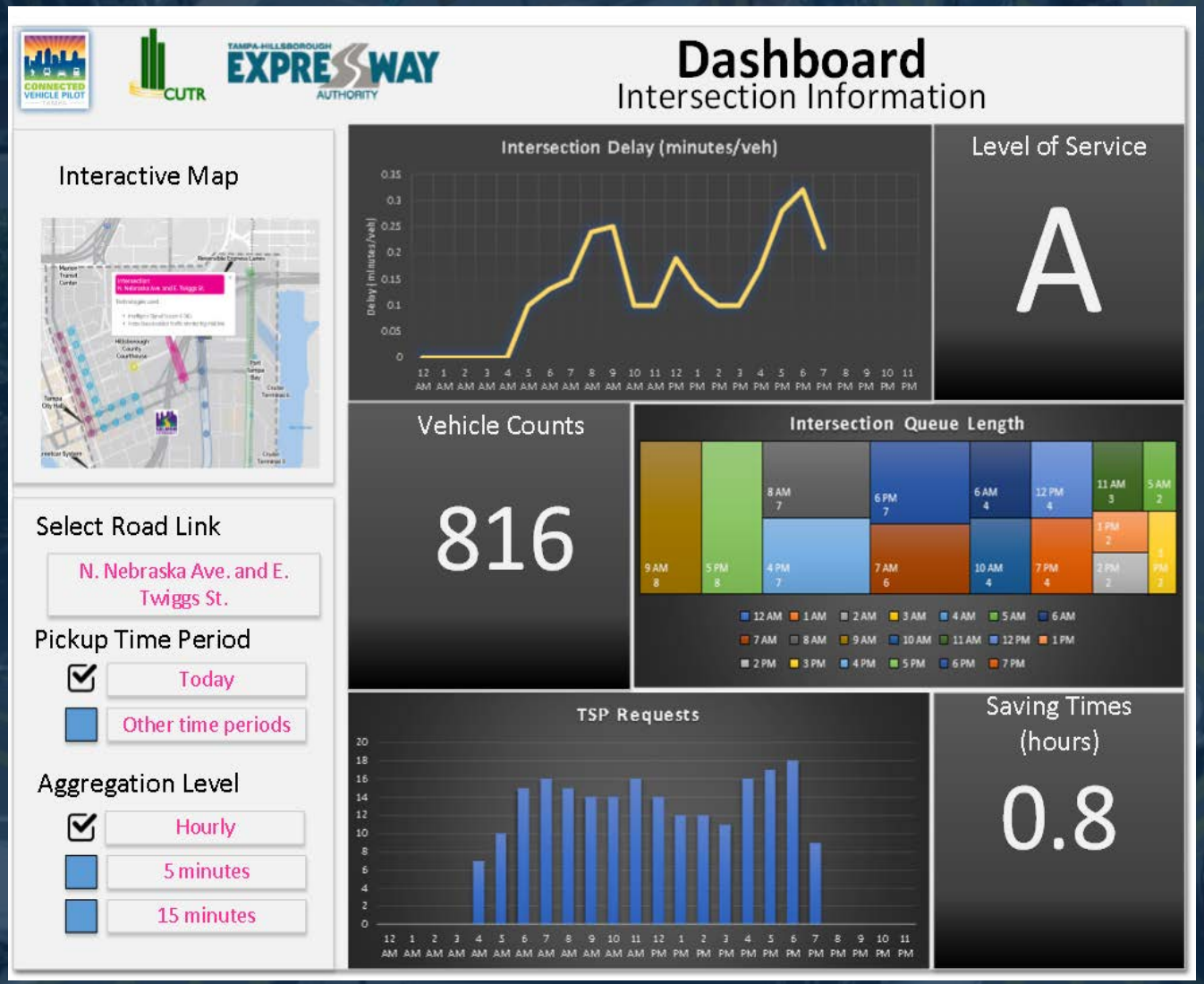
Measuring Performance

- Impact on travelers will be measured in terms of:
- Mobility
  - Travel time
  - Travel time reliability
  - Travel and vehicle delay
- Safety
  - Changes in type and severity of crashes/crash rate
  - Changes in type and severity of conflicts/near misses
- Environment
  - Impact on tailpipe emissions



- **Comparison of performance metrics against baseline conditions**
- Baseline conditions come from two sources:
  - Pre-deployment data collected during traffic studies
  - Stage 1 deployment data (data is collected from equipped vehicles without the participating drivers seeing warnings/alerts) for a period of 90 days

Tracking Results



- CV deployment impact on travel will be reported on a Performance Evaluation Dashboard
  - Linked to Tampa CV Pilot website
  - Customizable reporting frequency (daily, weekday, monthly)
  - Downloadable custom queries
  - Performance measures algorithms, analysis tools available to select stakeholders
- Pre-post implementation participant surveys:
  - Overall effectiveness of the CV Pilot
  - Feedback on applications

WHAT DOES THIS MEAN TO THE US?

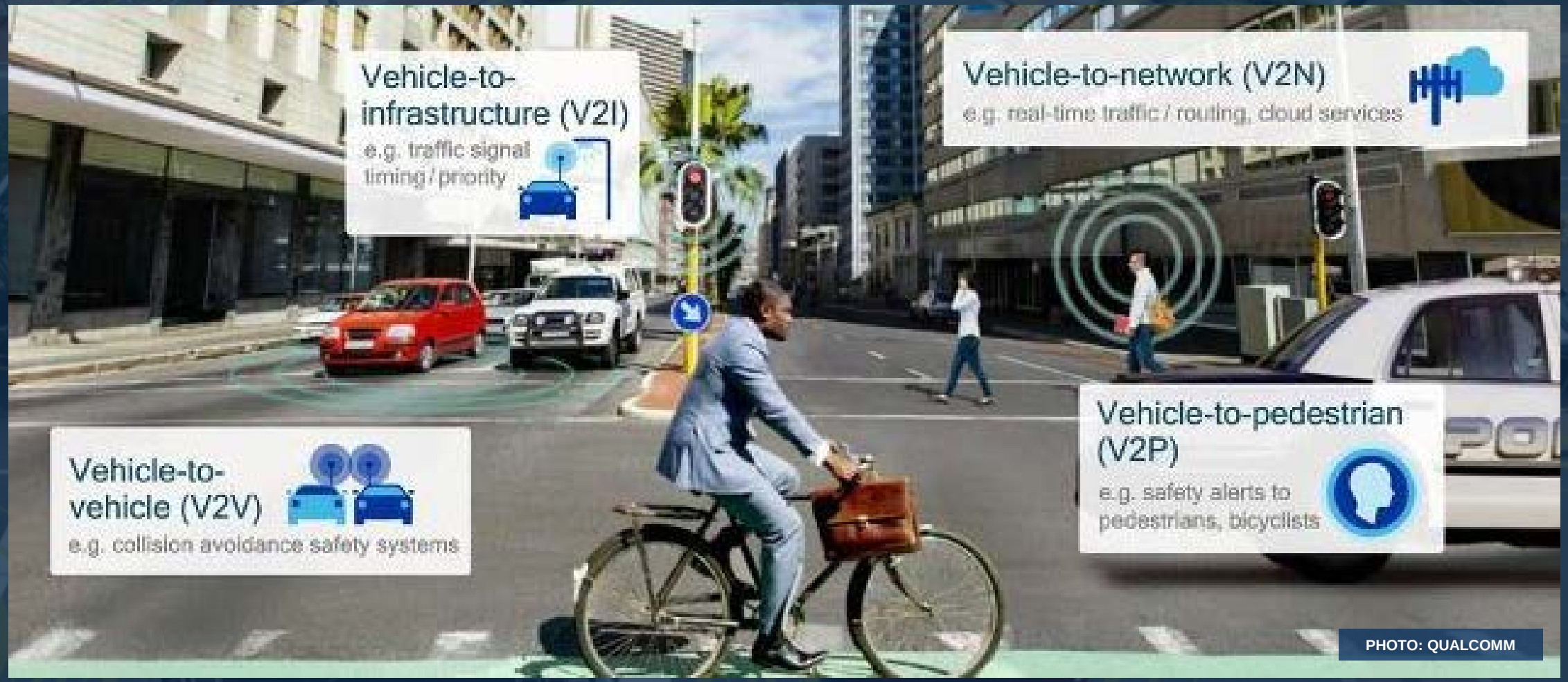


PHOTO: QUALCOMM

How can CV fit into Smart Cities?

What are Smart Cities, Why Should we Pay Attention?

A **Smart City** utilizes **innovative and emerging technologies and concepts** to collect, analyze, and utilize data from many sources to enhance the city's livability.

- Mobility
  - Mobility as a Service
  - Automated/ Connected Vehicles
  - Public Transit
- Transportation Infrastructure
  - Parking Monitoring
  - ITS & Incident Management
  - Arterial Operations

Smart Cities are about Connectivity

Connectivity and Smart City Components of Tomorrow

CONNECTIVITY PRECURSOR to EFFECTIVE:

	Vehicle & Infrastructure Based Data	Local/Regional Communications Network	Data Management	Data Integration & Distribution	Data Analytics	Actionable Information	Informed Decision
Description	• Connected Vehicles (DSRC) • Cell data • Community input (ie. Waze, Uber)	• Radio towers • Fiber network (100-Gig) • Cell network (5G)	• Big Data systems • Financial Data for MBUF and Tolling	• No silos • Traffic, weather, asset and other data integrated • Raw data freely available to the world	• Fully transportation integration. • Integration with non-transportation systems (smart grid, trash, etc.)	• Predictive travel time info • Active AV Route guidance • Enhance emergency vehicle dispatch • First/Last Mile	• Real-time system-wide information • Crash avoidance • Congestion avoidance & rerouting

Vehicle Driven Design Considerations

- **Vehicle Staging for Event Pick-Up and Drop-Off**
  - Safe and secure staging area
  - Pick-Up and Drop-Off at venues requires passenger queuing and organization to avoid chaos
  - TNC/bus staging and pick-up locations
  - Better means to ID passengers and vehicles

- **Developer Owned and Operated Fleet of AVs**
  - Secure vehicle storage, maintenance and charging facility
  - Staging/parking area for small, shared use vehicles
  - Operational considerations
    - Vehicles scheduling and headways
    - Maintenance of vehicles
    - Electrification facilities for charging

- **Revenue Production**
  - Vehicle branding opportunities
  - Mobility on Demand

City Street Design Considerations

- **Parking Considerations**
  - Include electric vehicle charging facilities (plug-in, wireless induction)
  - Automated valet services for self-parking vehicles
  - Reduction in parking spaces with shared mobility (likely requires zoning and regulatory exceptions)

- **Mobility Hub for the Development**
  - Transit stop (for traditional and automated transit vehicles; ADA compliant)
  - Shared mobility services (shared use personal vehicles, bikes)
  - Integrated mobility service information and payment (kiosks, mobile app, wayfinders)
  - Shelter for users, integrated with development design and streetscape

- **Vehicle Pull-Outs and Pick-Ups**
  - ADA compliant
  - Wheelchair accessibility

If we could do it over again, We Would…

- Identify Vendor to Manage and Perform Professional Privately Owned Vehicle Installations
- Solidified Standards Earlier
- Obtain a Better Understanding of “Available” Applications’ Maturity
- Obtain a Better Understanding of “Available RSU and OBU Hardware
- Obtain a Better Understanding of Vendors’ Depth and Resources
- Obtain a Better Understanding of Legacy Equipment
- Like More Transparency in the Device Certification Process From Vendors
- Complete Integration Testing Before Private Vehicle Installs Begin
- Have Shifted the Focus Much Sooner to a Commercial Security Credential Management System
- Identify the Need to Use Traditional ITS Devices as Part of Solution Earlier

Lessons Learned - Infrastructure

- Standards & Certification:
  - Design using standards published on Jan 1, 2017. Do not rely on unpublished standards in progress
  - If a USA standard does not exist, design using international standards (Yeah, that went well…)
  - If no standard exists, refer to USDOT V2I Hub publication
  - Certification process lagged the design process
  - Mitigated by Conformance statement to self-certify missing link
- Interoperability:
  - Pursuit of interoperability among the pilots
  - Identify common requirements that affect interoperability, such as crosswalk, before the design started.
- Existing Infrastructure:
  - Know what you have in the field before you start
  - Identify the Need to Use Traditional ITS Devices as Part of Solution Earlier
  - Deployment in an area undergoing significant redevelopment will likely complicate project dealing with confounding factors
- Pedestrian Detection:
  - Telecommunications (i.e. cell phones) not precise enough for public safety applications.
  - Physical installation, not a given in urban environment

Lessons Learned – In-Vehicle

- Vendors
  - Choose Multiple Vendors when Developing new Technology
  - Early Sourcing of Suppliers to Create a Collaborative Environment
  - Ensure Vendors can Support – We Had a Distributed Team Across the Country and in Europe
  - Recognizing the need for a complete and experience project team - systems, infrastructure, vehicle systems, performance measurement, etc.

- Project Development
  - Early real-life testing with infrastructure in place to verify end-to-end system/application performance
  - New development efforts - OTA and security - need to be piloted, i.e. tested early in the program
  - Multiple Technical Scans using RFPs (with on the road testing)

- Installation
  - Can you find someone to identify, schedule and respond to public participants? If so, DO IT!!
  - Adequate incentives with community/media support engage the driver/consumer community
  - Innovative ways to incentivize the public to participate helped

- Contracting
  - Integrator approach
  - Fixed Fee and “Experimental Sole Source” way to go

For more information…

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/TampaCVpilot

@Tampa_CV

@TampaCV

Wyoming DOT Pilot Overview

Deepak Gopalakrishna
Principal, ICF

U.S. Department of Transportation
Federal Highway Administration

THE PROBLEM

Heavy Freight Traffic

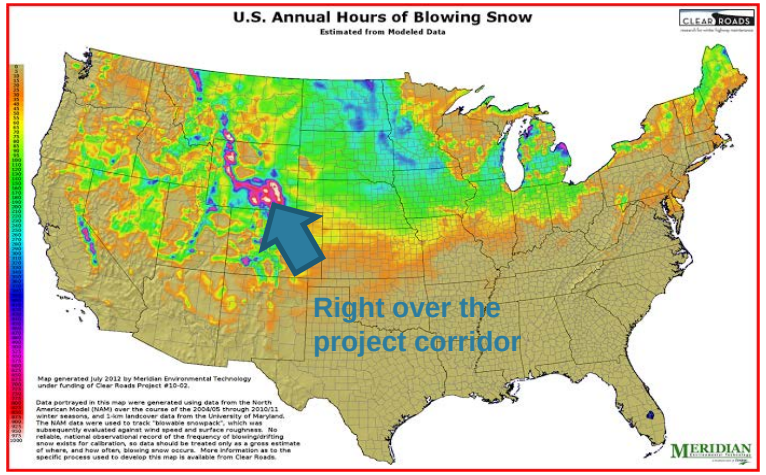
- Major E/W freight corridor
- Freight = over half of annual traffic

Severe Weather Conditions

- Roadway elevation
- 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**



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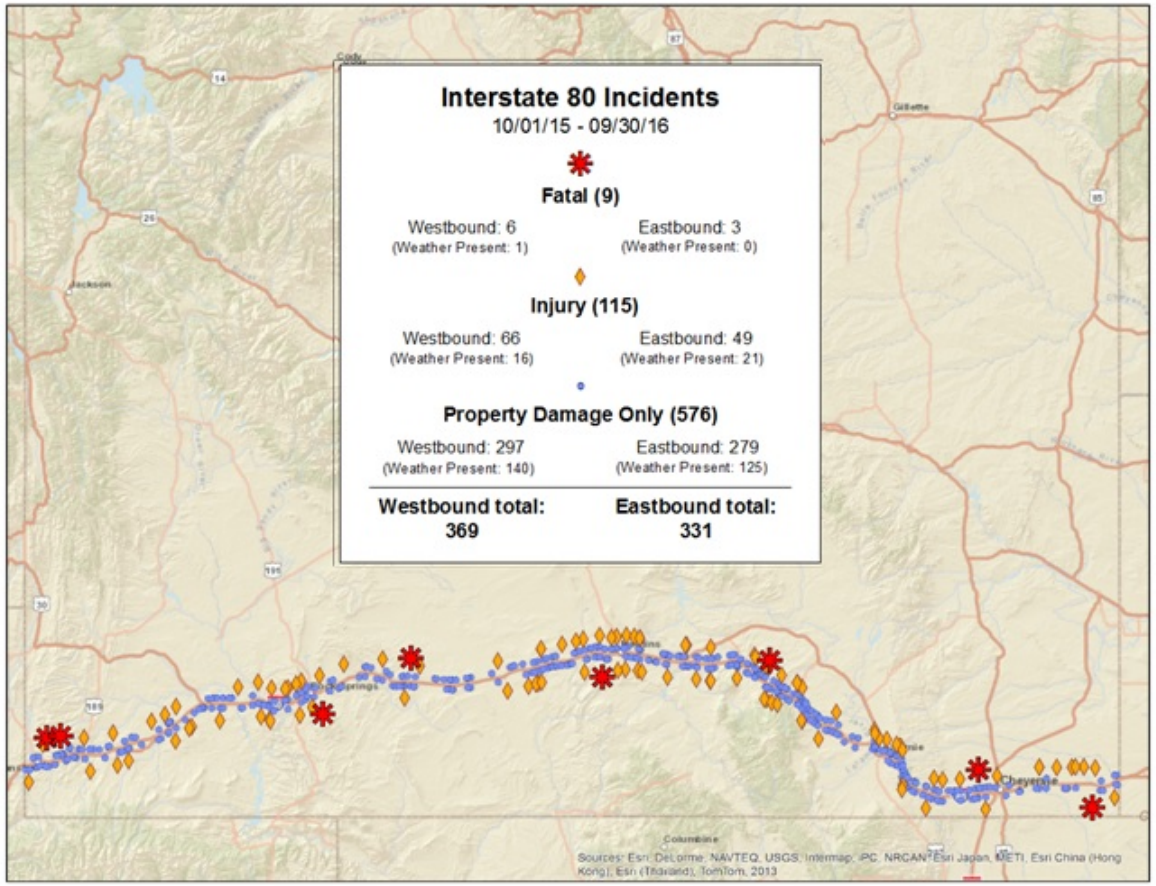
IMPACT TO FREIGHT



Year	Truck Crashes	% of Total
2010	563	33.9%
2011	642	33.6%
2012	569	40.0%
2013	632	36.5%
2014	690	35.4%
2015	555	40.0%
2016	714	34.3%
2017	408 (partial)	63.1% (partial)

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INTERSTATE 80 CORRIDOR

INTERSTATE 80 CORRIDOR

I-80 Corridor

One of the most heavily instrumented rural corridors in the United States

136 Variable Speed Limit Signs
supported by 94 traffic sensors

54 Electronic Message Signs

44 Weather Stations

52 Webcams

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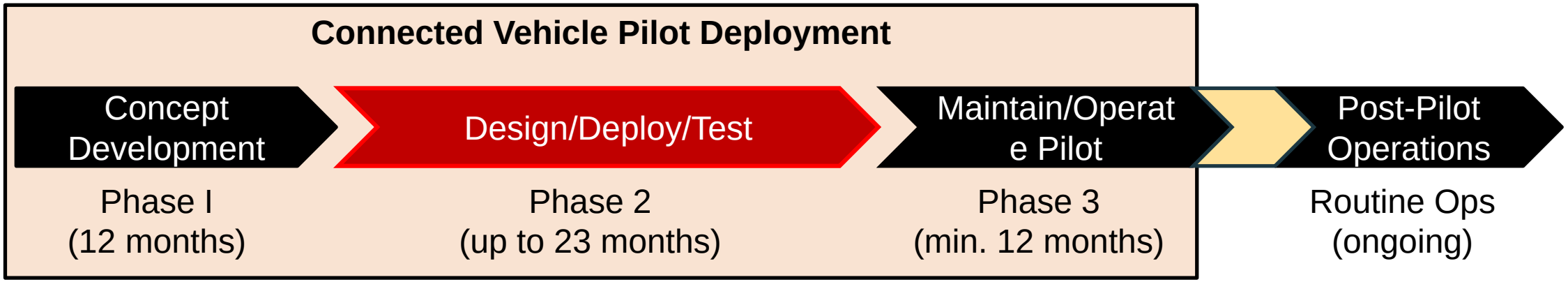
ACHIEVEMENTS-TO-DATE



Major Achievements

- ✓ End to end BSM data
- ✓ ODE development/integration
- ✓ Installation of IPv6 backhaul
- ✓ RSU installation
- ✓ Equipped 2 vehicles (3-7Km range)

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SYSTEMS OVERVIEW

78 RSUs equipped with DSRC connectivity

▪ Wyoming CV System

- Roadside Units (RSUs)
- Operational Data Environment (ODE)
- Pikalert System
- Data Broker (DB)
- Data Warehouse

~400 vehicles equipped with OBU with DSRC connectivity

▪ Vehicle System

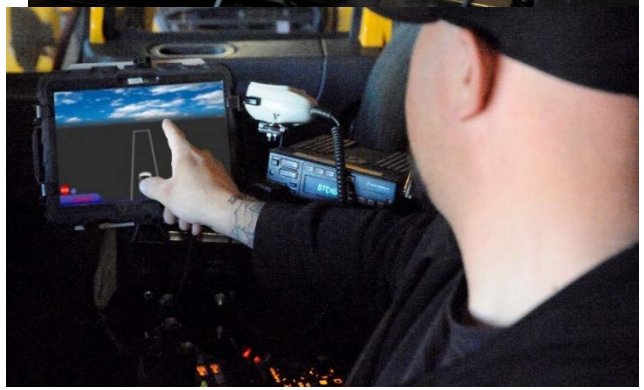
- WYDOT Maintenance Vehicles
- WYDOT Highway Patrol Vehicles
- Integrated Commercial Vehicles
- Retrofit Commercial Vehicles
- Basic Equipped Vehicles

66 snow plows

33 patrol vehicles

188 trucks

121 small trucks & vehicles



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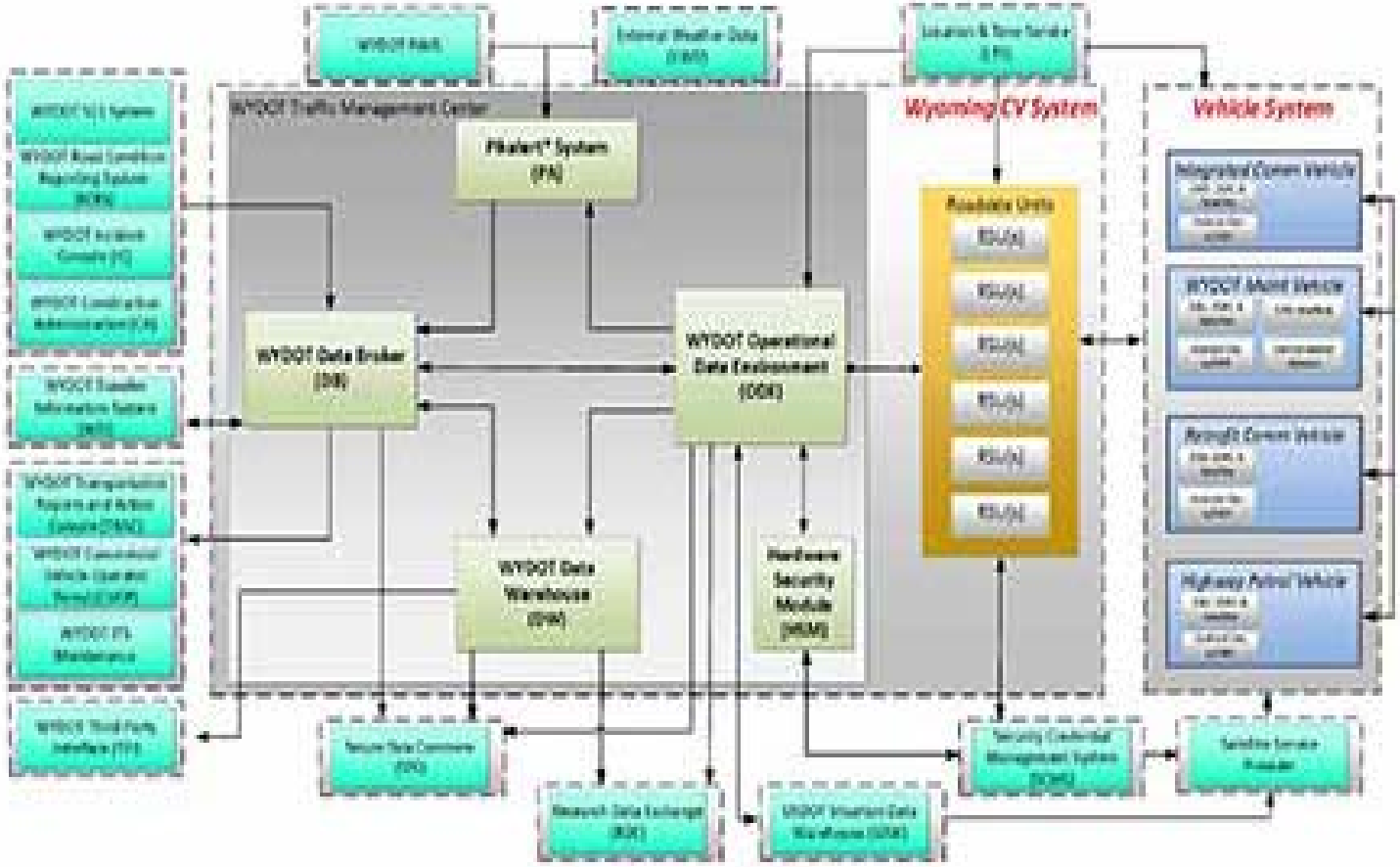
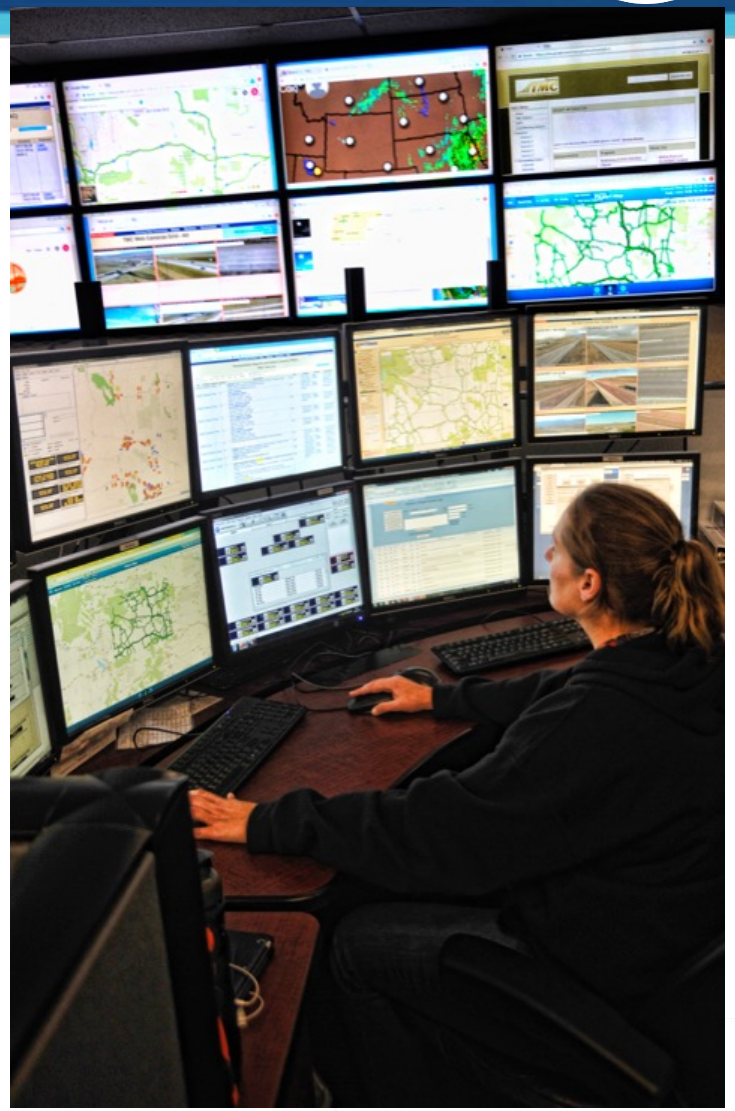
CONNECTED VEHICLE PILOT: INTEGRATION





Connected Vehicle Pilot: Next Steps

Phase 1	• Planning • (09/2015 – 09/2016)	Concept Development System Planning Deployment Plan
Phase 2	• Deployment • (10/2016 – September 2018)	System Design System Build System Testing and Acceptance
Phase 3	• Demonstration • (Fall 2018 – 10/2019)	Real-World Demonstration Evaluation Maintenance

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Interoperability Test Summary

Kate Hartman

Chief, Research, Evaluation, & Management, ITS JPO, USDOT

U.S. Department of Transportation
Federal Highway Administration

Overview of Interoperability Test

- Objectives:
  - Test interoperability among connected vehicle (CV) devices from the three sites as well as to identify potential interoperability issues that may require resolution prior to the sites advancing to an operational phase of the CV Pilot Deployment Program later in 2018.

- Interoperability Definition:
  - "*A vehicle with an onboard unit (OBU) from one of the three CV Pilot sites is able to interact with OBUs and roadside units (RSUs) from each of the other sites in accordance with the key connected vehicle interfaces and standards*."

NYCDOT

Tampa (THEA)

WYDOT

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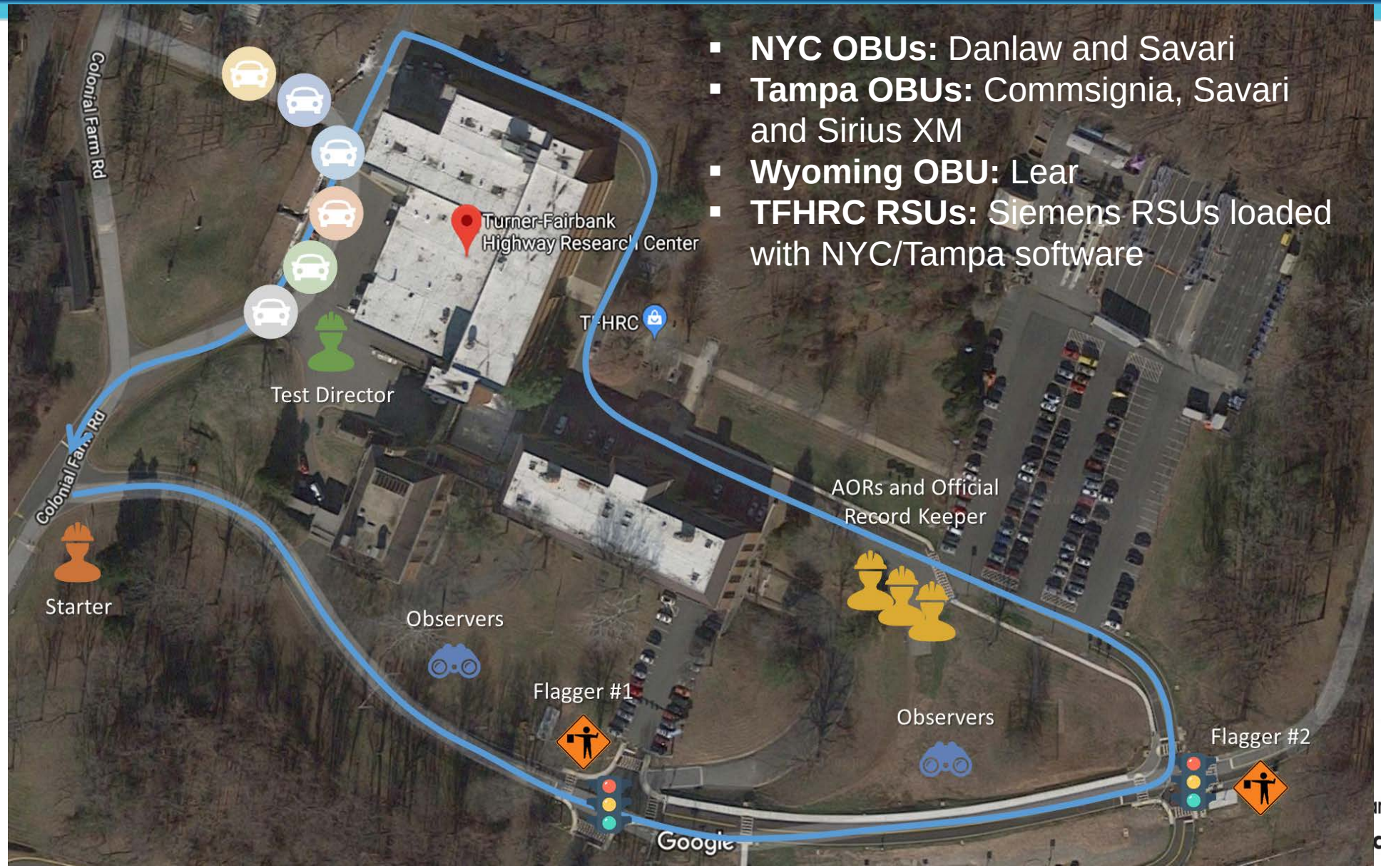
Interoperability Test Information

- Dates/Location: June 25 – 28, 2018 at FHWA Turner-Fairbank Highway Research Center (TFHRC)
- Participating Organizations (63 attendees in total):
  - USDOT, technical support contractor (Noblis), Saxton Laboratory (STOL) contractor (Leidos)
  - New York City Pilot: NYCDOT and Transcore
  - Tampa Pilot: THEA, HNTB, Siemens, CUTR and Brandmotion
  - Wyoming Pilot: ICF and Neaera Consulting Group
  - OBU/RSU Vendors: Commsignia, Danlaw, Lear, Savari, Siemens and Sirius XM
  - Others: Certification (OmniAir), CV Pilots Independent Evaluator (TTI), Photographers (BAH)

Testing Map and Equipment



- **NYC OBUs:** Danlaw and Savari
- **Tampa OBUs:** Commsignia, Savari and Sirius XM
- **Wyoming OBU:** Lear
- **TFHRC RSUs:** Siemens RSUs loaded with NYC/Tampa software

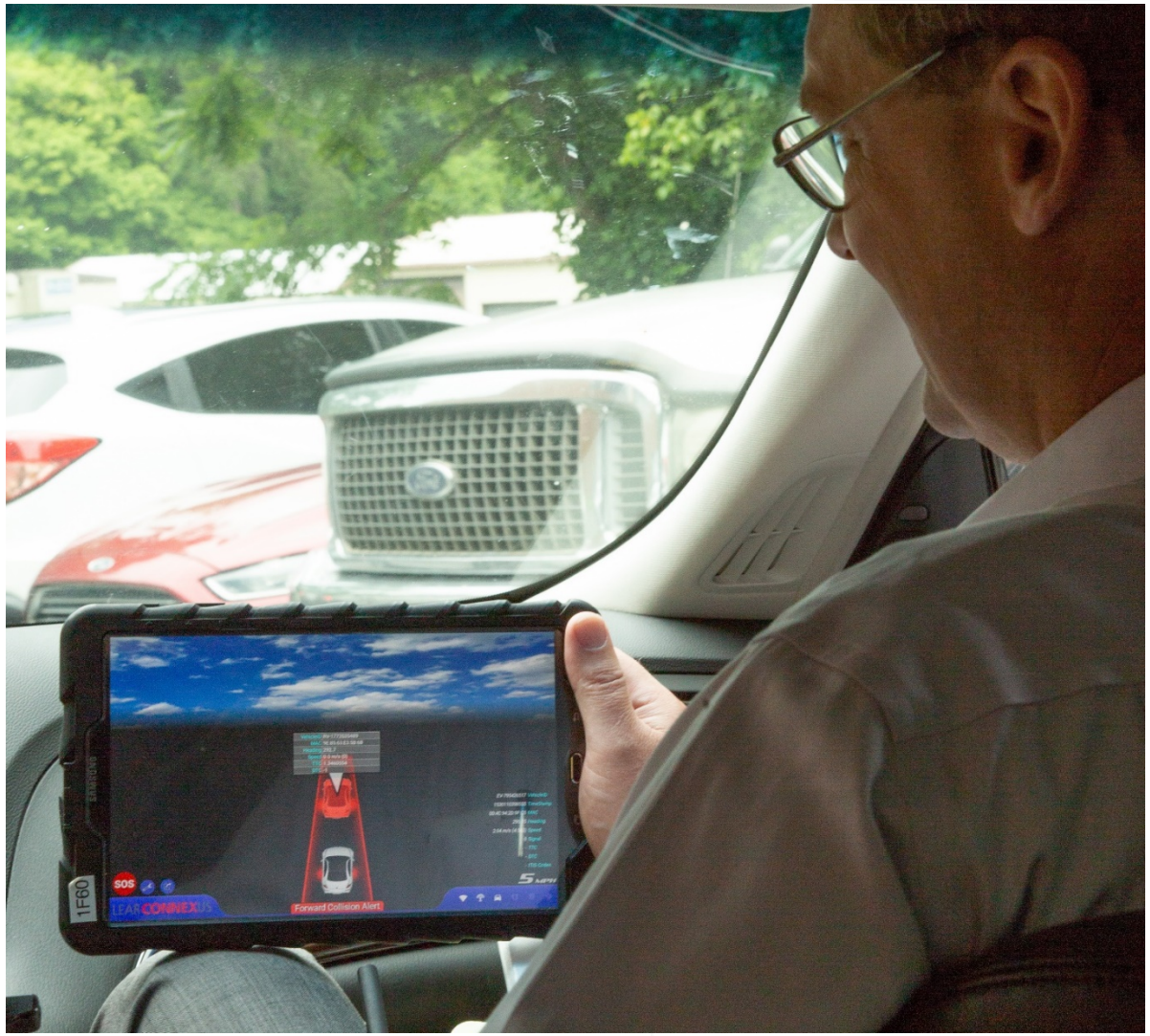
Overview of Test Plan

- CV Pilots Phase 2 Interoperability Test demonstrated interactions among different site's OBUs and among selected OBUs and RSUs.
  - OBU Interactions :
    - Receive Basic Safety Messages (BSMs) transmitted by the other site's OBUs via DSRC; authenticate them as needed; parse them; and process them in accordance with SAE J2945/1.
    - CV applications: Forward Collision Warning (FCW), Electronic Emergency Brake Light (EEBL), and Intersection Movement Assist (IMA) - only NYC/Tampa
  - OBU and RSU interactions:
    - Signal Phase and Timing (SPaT) and MAP (only NYC and Tampa)

FCW Stationary Remote Vehicle - Same Lane

- To have an OBU from each CV Pilot deployment project demonstrate that they can produce a FCW to a driver when receiving BSMs from one of the other site devices.

- Photo: a Wyoming (Lear) vehicle received a FCW alert from a stationary NYC (Danlaw) vehicle in the same lane.



FCW Stationary Remote Vehicle - Adjacent Lane

- To have an OBU from each CV Pilot deployment project demonstrate that they do not produce an FCW warning when approaching another vehicle producing BSMs in an adjacent lane.
- Photo: a Tampa (Commsignia) vehicle drove in an adjacent lane without triggering a FCW alert from a stationary NYC (Savari) vehicle.

Reception of SPaT/MAP Messages

- To have an OBU from the NYC and THEA CV Pilot sites demonstrate that they can receive SPaT and MAP messages from the other CV Pilot deployments RSUs.
- Photo: a Tampa (Savari) vehicle approached an intersection with a TFHRC RSU (Siemens) configured for NYC.

IMA Host Vehicle Stopped

- To have an OBU from the NYC and THEA CV Pilot sites demonstrate that they can produce an IMA warning to a driver when receiving BSMs from one of the other site devices.
- Video: a Tampa (Commsignia) vehicle received an IMA warning being triggered by a NYC (Danlaw) vehicle.

FCW Stationary Remote Vehicle - Same Lane with Parallel Platoon

- Add-on Test: To have an OBU from each CV Pilot deployment project demonstrate that they can produce a FCW alert to a driver when receiving BSMs from one of the other site devices with a parallel platoon in an adjacent lane.
- Video: a Wyoming (Lear) vehicle received a FCW alert being triggered by a NYC (Savari) vehicle with the other four vehicles driving by the adjacent lane.

SUMMARY OF KEY RESULTS

- **More than 100 test runs within three days.** In total, 102 interoperability test runs were conducted for four test cases – FCW, IMA, EEBL, and SPAT/MAP Messages and 90% plus were successful.

- **Successful message transfer via multiple communications.**
  - Results of the testing indicated successful transfer of messages between the six vehicles from five different vendors. Out of the five vendors, four used DSRC and one used DSRC and SiriusXM Radio.
  - Additionally, equipment from each vendor demonstrated the successful transfer of messages between the RSUs and each sites' OBUs.

- **Interoperability demonstrated inclusive of SCMS enrollment**. All devices used for the test were enrolled with a commercial security credential management system (SCMS) that the sites plan to use for their Phase 3 Operational Phase.

- **Nearly 5 GB of test data generated for analysis**.
  - Data was collected by each site and its vendors and will be uploaded to the USDOT's Secure Data Commons (SDC).
  - The USDOT plans to continue to work with the CV Pilot sites to develop a Test Report documenting the results of the Phase 2 Interoperability Test.

Testimonials with Respect to Value

- Test Team did outstanding job planning and organizing tests.
  - Test plan were generally thorough, clear, and concise.
  - Installation of equipment went relatively smoothly.
  - Sites well prepared for test.
  - Overview and Q/A discussion added before each test proved beneficial.
- Everyone had a good experience with the testing.
  - Good to interact with other teams.
  - Allowed developers to test applications using equipment they don't generally have.
  - It was the most successful CV testing they had ever participated in.
  - A unicorn event - six vendors, three sites, multiple communications media - and it worked!
- A test of this nature had never been conducted before.
  - A watershed moment for connected vehicle technology, and an important milestone in the maturation of these technologies for operational deployment.
  - Just from the security standpoint alone, more than worth the effort to conduct.

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Panel Discussion

Building a Checklist for Robust CV Technology Deployment

Facilitator: Kate Hartman

Panelists: Bob Rausch, Bob Frey, Deepak Gopalakrishna

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Question and Answers

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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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