New York City’s
Connected Vehicle Pilot Deployment Project
Operational Capability Showcase
Today’s Agenda

- **Purpose of this webinar**
  - Demonstrate the *Operational Capability* of CV safety technology in NYC
  - Share *challenges and lessons learned* in deploying CV technology in NYC

- **Webinar Content**
  - NYC CV Pilot Deployment Program and Project Overview and Goals
  - NYC CV Pilot Operational Capability Showcase
  - Q&A

- **Webinar Protocol**
  - Please mute your device during the entire webinar.
  - You are welcome to ask questions in the chatbox. Questions will be answered during the Q&A section at the end.
New York City CV Pilot Deployment Project

Concept of Operations

Operational Capability Showcase Host

Dr. Mohamad Talas
NYCDOT
Presenters (Administration)

- Dr. Mohamad Talas – NYCDOT, CVPD Project Manager, Director of ITS Management and System Engineering
- Ken Leonard – USDOT, Director of ITS Joint Program Office (JPO)
- Margaret Forgione – NYCDOT, First Deputy Commissioner
- Keith Kerman – NYC DCAS, Chief Fleet Officer and Deputy Commissioner
- Dr. Jonathan Walker – USDOT, Chief of Policy, Architecture, and Knowledge Transfer
Presenters (Technical)

- **David Benevelli** – JHK Engineering (TransCore), CVPD System Engineering Lead
- **Dr. Kaan Ozbay** – NYU, Professor at the Dept of Civil and Urban Engineering (CUE) Director of the C2SMART Center
- **Eric Richardson** – NYC DCAS, Deputy Chief Fleet Management Officer
- **Keir Opie** – Cambridge Systematics, CVPD Performance Measurement Lead
- **Bob Rausch** – JHK Engineering (TransCore), CVPD System Deployment Lead
- **Dr. Arthur O’Connor** – USDOT, Sr. ITS/Operations Engineer Office of Program Management
USDOT Connected Vehicle Pilot Program

Ken Leonard
USDOT
New York City

NYCDOT Vision Zero and CV Program

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

The NYC pilot will evaluate the safety benefits and challenges of implementing CV technology with a significant number of vehicles in the dense urban environment.
New York City

NYC Fleet Management and DCAS Participation

Keith Kerman
NYC DCAS
# Safe Fleet Transition Plan

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Note: Entries in bold are potential updates for 2018 (see explanations below)

* = Only apply to vehicles with gross vehicle weight rating of 10,000 lbs. or greater.
New York City

USDOT CV Program Goals

Dr. Jonathan Walker
USDOT
CONNECTED VEHICLE PILOT DEPLOYMENT PROGRAM

PROGRAM GOALS

- Spur Early CV Tech Deployment
- Measure Deployment Benefits
- Resolve Deployment Issues
- Wirelessly Connected Vehicles
- Safety
- Technical
- Mobility
- Institutional
- Infrastructure
- Environment
- Financial

PILOT SITES

- WYDOT
- NYCDOT
- Tampa (THEA)

NYCDOT SCHEDULE

- PHASE 1 (12 months): Concept Dev.
  - Progress Gate: Sep 2015
- PHASE 2: Design/Build/Test
  - Progress Gate: Sep 2016
- PHASE 3: Maintain/Operate Pilot
  - Progress Gate: Jan 2021
  - Transition: Dec 2021
- CV tech integrated into operational practice
- Routine Operations (ongoing)
- Post-Pilot Operations
CV Pilot Deployment Objectives

- Transition from research and development to practical sustainable deployment of CV infrastructure and applications

- Provide a roadmap for future deployers:
  - CV Pilots utilized the Systems Engineering Process to lead and inspire future developers of connected vehicles
  - CV Pilots produced a common documentation set for reference by future deployers
  - CV Pilots demonstrated their devices are interoperable
CV Pilots Interoperability Test

- **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), Independent Evaluator (TTI), Photographers (BAH)

Video: https://youtu.be/0dja4B9qCSU
NYCDOT CV Project Goals and Accomplishments

Dr. Mohamad Talas
NYCDOT
Project Objectives

- Support the Vision Zero initiative by providing drivers with information regarding potential safety situations

- Provide the opportunity for selected NYC fleets to be early adopters of this safety-focused technology

- Create a CV technology deployment to inspire spreading the technology throughout North America

- Support the overall CV technology implementation by providing project experience, benefits, and feedback regarding the challenges and opportunities for implementing this technology in a dense urban environment
NYC CV Infrastructure

- Infrastructure: 450 Roadside Units (RSU)
- Vehicles: 2800+ increasing to 3000
- Safety applications: 13
- Operations applications: 8
- This is a large-scale deployment with challenges:
  - Location accuracy – urban canyons
  - RSU density
  - Application arbitration/interference
  - DSRC media only – channel management
  - First full-scale security deployment
  - Security boundary expanded to include all ITS communications
  - Utilize edge computing concepts to minimize bandwidth
Fleet Weekly Operations

Criteria | Jan 3 – May 29, 2021 Totals
--- | ---
VMT | 4,138,000
Hrs | 277,000
BSM Generated | 15,967,000,000
BSM Evts/Ops Used | 26,000,000

Date

--- | --- | --- | --- | --- | ---
Miles (x100) | Hrs (x10) | Veh (CV-GT)
Project Accomplishments

- Infrastructure installation of RSU and OBU/ASD
- Proven operational concepts for managing CV devices
- Improved CV device operations with improvements in the areas of:
  - Location accuracy
  - Safety applications
  - Security operations
  - Communications
  - Spectrum utilization
- Extensive project deployment lessons are contributing to further standards evolution and procurement guidelines
New York City

NYCDOT CV Safety Applications

David Benevelli
JHK Engineering
Manhattan South Crashes

4-week period ending July 4, 2021  Total: 643

U.S. Department of Transportation
Vehicle-to-Vehicle (V2V) Safety Applications

- Forward Collision Warning (FCW)
- Emergency Electronic Brake Light (EEBL)
- Blind Spot Warning (BSW)
- Lane Change Warning/Assist (LCA)
- Intersection Movement Assist (IMA)
- Vehicle Turning Right in Front of Bus Warning (VTRW)
Vehicle-to-Infrastructure (V2I) Safety Applications

- Red Light Violation Warning (RLVW)
- Speed Compliance (SPDCOMP)
- Curve Speed Compliance (CSPDOMP)
- Speed Compliance/Work Zone (SPDCMPWZ)
- Oversize Vehicle Compliance (OVC)
  - Prohibited Facilities (Parkways)
  - Over Height
- Emergency Communications and Evacuation Information (Using the traveler information features) (EVACINFO)
Other Applications

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

Operations, Maintenance, and Performance Analysis

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

To Meet USDOT Requirements for Benefit Analysis
New York City

NYC CV Pedestrian Signal Application

Dr. Kaan Ozbay
NYU
Pedestrian Signal Application

PED-SIG: Mobile Accessible Pedestrian Signal System
Advancing Social Equity with CVs

Assist visually impaired pedestrians in safely crossing the streets

- Equip 25+ pedestrians with a Personal Information Devices (PID)
- Field tests with predefined routes
- Obfuscate, encrypt, and transmit data to secure servers to protect privacy
- Learn the participants’ experiences through the CV-equipped intersections

Pedestrian Information Device (PID)
Visually Challenged Pedestrian Application Context Diagram

- Encrypt the collected data and transmit the encrypted data to a configured IP address through the broad-band carrier service

- Connected Vehicle Support System

- Participant coordination and support
- Transmit obfuscated data
- Database management
- Performance Evaluation

- Mobile application development and testing

NYCDOT

C2SMART/ NYU

Application vendor

U.S. Department of Transportation
Data necessary for the PED-SIG application:
- PID Operations Logs
- Field test observations
- Pre- and Post Experiment Survey

Challenges in testing the PED-SIG application in NYC urban environment
- **COVID-19 pandemic impacts:** New precautions will need to be taken. **Proposed solution:** Follow COVID-19 mitigation strategies required by local research sites
- **Smartphone-based issues:** For example, the digital compass needing recalibration when the phone is near a large metal object in the environment. **Proposed solution:** Designed routes with multiple batches of participants + field tests accompanied by IRB-certified NYU researchers to ensure safety

Aggregated Performance Measures for the PID / PED-SIG Application

- Pedestrian Crossing Speed and crossing Travel Time
- Pedestrian Crossing Waiting Time
- PID Compliance Rate
- Inadequate Crossing Time
- Pedestrian Crossing Violations
- Time to Step into the Crosswalk when Walk Phase is On
- Times Out of Crosswalk
New York City

NYC CV Stakeholder Participation

Eric Richardson
NYC DCAS
NYC Fleet Participating Agencies

- Department of Transportation (DOT)
- Parks Department (Parks)
- Department of Corrections (DOC)
- Department of Buildings (DOB)
- Dept. of Environmental Protection (DEP)
- Dept. of Homeless Services (DHS)
- Taxi and Limousine Commission (TLC)
- Human Resources Administration (HRA)
- Administration for Children's Services (ACS)
- Dept. of Design and Construction (DDC)
- Housing Preservation & Development (HPD)
- Office of Chief Medical Examiner (OCME)
- Dept. of Education (DOE)
- Dept. of Health and Mental Hygiene (DHMH)
- Office of Emergency Management (OEM)
- Dept. of Consumer Affairs (DCA)
- Dept. of Info. Tech. & Telecom. (DOITT)
# Safe Fleet Transition Plan

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NYC in Real Time

New York's new telematics command center is not only transforming fleet management, it is also improving the delivery of direct services and enhancing core operations, writes NYC Chief Fleet Officer Keith Kerman.

The system is a major step forward for the NYC Department of Transportation in its mission to reduce injuries and fatalities in the city. The technology is a key component of the city's broader efforts to improve safety and efficiency in its fleet operations. The system includes advanced analytics and predictive modeling tools that allow the DOT to identify and prioritize safety risks in real-time.

Telematics are devices that collect data about vehicle performance, such as speed, location, and fuel consumption. This data is then analyzed to identify areas where safety improvements can be made. For example, if the system detects that a particular type of vehicle is being driven at excessive speeds, it can alert the DOT to take action to address the issue.

In addition to improving safety, telematics can also help the DOT manage its fleet more efficiently. By tracking the location and performance of each vehicle in real-time, the DOT can optimize routes and schedules, reducing fuel consumption and lowering costs.

The system is also designed to be user-friendly, allowing DOT employees to access the data from anywhere and at any time. This flexibility allows the DOT to quickly respond to incidents and emergencies, such as accidents or mechanical failures, and to make real-time adjustments to its operations as needed.

Overall, the telematics system is an important tool in the DOT's efforts to improve safety and efficiency in its fleet operations. By leveraging this technology, the DOT can better protect its drivers and the public at large, while also saving money and resources in the process.
NYC Fleet Show: CV on Display

32nd ANNUAL EQUIPMENT & VEHICLE SHOW

Rescheduled Date: Wednesday, September 22, 9am to 2pm
Rain Date: Friday, September 24

Flushing Meadows Corona Park, Queens, by the Unisphere

NYC Fleet

NYC DCAS
Citywide Administrative Services

This show highlights vendors who support NYC’s Clean Fleet and Vision Zero initiatives, as well as daily operations. We will have vendors offering a wide array of products to improve vehicle safety including cameras, truck side guards, systems to track and manage fleets, and systems to avoid or mitigate collisions. The show also highlights vehicles and equipment with alternative fuels and emissions reducing technologies, along with the latest in light and heavy-duty vehicles, trucks, horticultural equipment, tools, fleet services, and more.

Free to all exhibitors and attendees.

RSVP forms will be available soon at https://www1.nyc.gov/site/dcas/agencies/fleet-news.page

Accessibility Questions? Contact DCAS Accessibility at 212-386-0256, or accessibility@dcas.nyc.gov by Wednesday, September 15.
NYC CV Performance Measurement

Keir Opie
Cambridge Systematics
Safety is Job #1.
- Once alerts are activated in a vehicle, they won’t be silenced.

User Needs related to Performance Measurement
- Maintain privacy of users throughout pilot and data collection
- No enforcement
- No driver evaluation

Consider impacts of CV data combined with data from other sources.

Approach to collecting the performance information.

Approach to using data collection bins of performance information.

Control Group vs. Treatment Group
# Performance Measures

**FHWA-JPO-16-302**

## Connected Vehicle Pilot Deployment Program Phase 2

**Performance Measurement and Evaluation Support Plan — New York City**

www.its.dot.gov/index.htm  
FINAL REPORT — January 13, 2020  
Updated: March 31, 2021  
FHWA-JPO-16-302

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<th>User Need</th>
<th>Category</th>
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<th>CV Application</th>
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<th>Performance Measure Metrics</th>
<th>Question for Evaluation</th>
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| Manage Speeds | Safety Mobility | Discourage Spot Speeding | Speed Compliance | 1 | 1a. Number of stops (average and distribution measures)  
1b. Speeds (average and distribution measures)  
1c. Emissions  
1d. Reduction in speed limit violations  
1e. Speed variation  
1f. Vehicle throughput (average and distribution measures)  
1g. Driver actions and/or impact on actions in response to issued warnings | Does speed limit adherence increase and speed variability decrease within the vehicle fleet on a given study roadway segment for a given time period (cycle length before) from the Before period to the Pilot period, and from control group to the treatment group? Is this accompanied by an overall increase, decrease or no change in average segment speed? |
| Manage Speeds | Safety Improve Truck safety | Curve Speed Compliance | 2 | 2a. Speed related crash counts, by severity  
2b. Vehicles speeds at curve entry  
2c. Lateral acceleration in the curve  
2d. Driver actions and/or impact on actions in response to issued warnings  
2e. Number of curve speed violations at each instrumented location | The number of curve speed violations on each applicable studied roadway segment decrease from the Before period to the Pilot period, and from control group to the treatment group? |
| Manage Speeds | Safety Improve Work Zone Safety | Speed Compliance / Work Zone | 3 | 3a. Speed in work zone (average and distribution measures)  
3b. Speed variation (distribution) at work zone  
3c. Number of vehicle speed limit violations in variable speed zone areas  
3d. Driver actions and/or impact on actions in response to issued warnings | Do the number of work zone speed violations on each applicable studied roadway type decrease from the Before period to the Pilot period, and from control group to the treatment group? |
| Reduce Vehicle to Vehicle Crashes | Safety Reduce Vehicle to Vehicle Accidents | FCW, EEBL, BSW, LSW, IMA | 4 | 4a. Fatality crash counts  
4b. Injury crash counts  
4c. Property damage only crash counts  
4d. Time to Collision (vehicle to vehicle) | The number of reportable crashes decrease from the Before period to the Pilot period, and from control group to the treatment group? |
| Reduce Vehicle to Vehicle Crashes | Safety Reduce Accidents at High Incident Intersections | Red Light Violation Warning | 5 | 5a. Red light violation counts  
5b. Time To Collision (vehicle to vehicle path) at the intersection  
5c. Driver actions and/or impact on actions in response to issued warnings  
5d. Right-turn related conflicts  
5e. Time to collision (vehicle to bus)  
5f. Number of warnings generated  
5g. Driver actions and/or impact on actions in response to issued warnings  
5h. Right-turn related conflicts  
5i. Time to collision (vehicle to pedestrian)  
5j. Number of warnings generated  
5k. Driver actions and/or impact on actions in response to issued warnings  
5l. Right-turn related conflicts  
5m. Time to collision (vehicle to bicycle)  
5n. Number of warnings generated  
5o. Driver actions and/or impact on actions in response to issued warnings | The number and severity of red light violations at each studied intersection decrease from the Before period to the Pilot period, and from control group to the treatment group? |
| Reduce Vehicle to Vehicle Crashes | Safety Reduce Bus Incidents, Improve Safety | Vehicle Turning Right in Front of Bus Warning | 6 | 6a. Right-turn related conflicts  
6b. Time to collision (vehicle to bus)  
6c. Number of warnings generated  
6d. Driver actions and/or impact on actions in response to issued warnings | The number of bus / right-turn vehicle crashes decrease from the Before period to the Pilot period, and from control group to the treatment group? |
| Reduce Vehicle to Pedestrian Crashes | Safety Improve Pedestrian Safety on Heavily-Traveled Bus Routes | Pedestrian in Signalized Crosswalk Warning | 7 | 7a. Pedestrian related crash counts, by severity  
7b. Number of warnings generated  
7c. Pedestrian-related conflicts/sharing events  
7d. Time to collision (vehicle to pedestrian)  
7e. Driver actions and/or impact on actions in response to issued warnings | The number of pedestrian related crashes decrease from the Before period to the Pilot period, and from control group to the treatment group? |
| Reduce Vehicle to Pedestrian Crashes | Safety Improve Safety of Visually and Audibly-impaired pedestrians | Mobile Accessible Pedestrian Signal System (Peds-Sig) | 8 | 8a. Qualitative Operator Feedback  
8b. Pedestrian Crossing Speed and Crossing Travel Time  
8c. Times Out of Crosswalk  
8d. Waiting time at intersection for crossing | Does the mobile app improve participants' perceived safety when crossing signalized intersection? |
| Reduce Vehicle to Infrastructure Crashes | Safety Address Bridge Low Clearance Issues/Enforc e Truck Route Restriction | Oversized Vehicle Compliance | 9 | 9a. Number of Warnings generated  
9b. Number of truck route violations | Do the number of low clearance violations decrease from the Before period to the Pilot period, and from control group to the treatment group? |
| Inform Drivers of Serious Incidents | Mobility Inform Drivers | Emergency Communications and Evacuation Information | 10 | 10. Number of vehicles receiving information when generated | Do CVs receive the information warnings when generated? |
| Provide Mobility Information | Mobility Replace Legacy Measurement s | Intelligent Traffic Signal System Connected Vehicle Data (I-TSSCVDATA) | 11 | 11a. Segment speed (average and distribution measures) from CV compared to legacy detection systems  
11b. Travel time (average and distribution measures) from CV compared to legacy detection systems | Do the CV based mobility metrics compare favorably to legacy detection systems or provide better information? |
| Manage System Operations | System Operation s | Ensure Operations of the CV Deployment | NA | 12. System performance statistics (system activity, down time, radio frequency monitoring range ASDs and RSUs, number of event warnings by app) | Does the system operate reliably? |
CV Event Records

- Data from ASD/OBU to time period surrounding a warning issued
- Detailed information:
  - Identifies exact time and precise location
  - Records detailed vehicle trajectory and movement
- Data retention keeps data from event until it can be transmitted to the TMC

![Diagram of event records and data flow](image-url)
CV Event Obfuscation Process

NWS Weather Data
DSNY PlowNYC Data
TRANSCOM Link Conditions
TRANSCOM TMC Events Records

Field Collected CV Event Record

Fuse Data

Fused Field Collected CV Event Record

Time & Location Bins and Obfuscation

Obfuscated Field Collected CV Event Record

Upload to ITS DataHub

NYC CVPD Performance Eval.

Discard after verification

Discard after verification

Verify, then discard earlier versions
ASD Event Log Obfuscation

Raw 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
CV Events by Type

MAY 2021

- 14,520 Total Fleet Events
- 2640 Installed Vehicles
- May VMT: 957,000 (Est)
- May Hrs: 66,000 (Est)
- Includes Both Silent and Active Alerts

Notes:
- Disregards early ASD firmware versions
- Disregards Test Vehicle Events
- Includes Events passing error tests
- Includes Treatment and Control Vehicles
FCW Events

- May 2021 Events
SPDCOMP Events

- May 2021 Events
- V2I areas only
Obfuscated Event Analysis
Sample: EEBL Warning

Warning Issued in Host Vehicle at:
(X,Y) = (0, 0) meters
Time = 0 seconds

Direction of Travel

Time:

[Graphs showing speed and acceleration over time]
Obfuscated Event Data at ITS DataHub

- https://www.its.dot.gov/data

- Event data in the Sandbox updates weekly
System Operations Dashboards
NYC DOT Website: CVP.NYC

NYC Connected Vehicle Project
For Safer Transportation

Event Data
May 2021

# of Event Files Uploaded by Type

- Speed Compliance: 9,586
- Forward Collision Warning: 3,927
- Intersection Movement Assist: 1,067
- Curve Speed Compliance: 920
- Speed Compliance in Work Zone: 52.8%
- Emergency Communications and Evacuation Information: 25.2%
- Lane Change Warning: 6.3%
- Light: 6.3%
- Other: 0.8%

Event Description
- Red Light Violation Warning
- Blind Spot Warning
- Oversize Vehicle Compliance - Height Clearance Limit
- Emergency Electronic Brake Light

Connected Vehicle technology is coming to the streets of New York City! This technology holds the potential to make our streets safer and smarter.
New York City

NYC CV Project Lessons

Bob Rausch
JHK Engineering
Challenges - *Everywhere*

- Stakeholder privacy concerns vs. USDOT desire for broad evaluation data
- Stakeholder requirements to avoid distracting “cockpit” displays
- Density of Roadside DSRC Transponders (RSU)
  - ~76 M for short blocks  \[DSRC – Nominal 300M\]
  - ~200 M for the long blocks (between avenues)
- Bandwidth limitations of the wireless backhaul (RSU to TMC)
- Ongoing maintenance and support (in-vehicle and infrastructure) of the large-scale deployment (3,000 Vehicles and 450 RSUs)

*Security Credential Management System*

- SCMS* for all applications & DSRC Over-the-air (OTA) certificate distribution
- OTA [DSRC] data collection – bandwidth limited
- OTA [DSRC] software updates
- OTA [DSRC] parameter management
- Location accuracy in the urban canyons  (both relative V2V and absolute V2I)
Lessons Learned

- **Location accuracy remains a challenge in the urban canyon environment.** Urban location accuracy requires more than GPS.

- **Grade separation is a challenge** in dealing with elevation element of location accuracy. Elevation is an essential component of the safety applications in the urban environment.

- The number of FCW and SPDCOMP events dominate the data collected and tend to skew any analysis of events spanning multiple types.

- **Breadcrumb were essential to analyzing anomalies and operational issues.**

- O&M data collected confirms RF data reception ranges impact OBU & RSU device loading due to device density.

- **Need to collect additional data:** Until we began analyzing events, we couldn’t determine that there is additional information that would make analysis easier. For example, for RLVW, adding the specific intersection identification triggering the alert in the event header would make analysis easier. Also, when analyzing BSMs, the MAP/SPaT/TIM being heard would impact interpretation of driver behavior.
New York City

NYC ITS Sub Regional Architecture
Dr. Arthur O’Connor
USDOT
NYC Sub Regional Architecture

- NYC CV Pilot program successes
- NYC CV Pilot’s relationship to the ITS Sub Regional Architecture
- Urban environment model experience
- Next steps
NYC CV Team Members

Dr. Mohamad Talas
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NYC CV Team Members

- USDOT Team
- NYCDOT Team
- NYC DCAS Team
- NYC Fleet
- Consulting Team
  - JHK Engineering (TransCore)
  - Cambridge Systematics
  - KLD Engineering
  - University Transportation Research Center (UTRC)
  - New York University (NYU)
Questions?

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- Learn the Essential Steps to CV Deployment
- Engage in Technical Discussion

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CV Pilot Sites Document Repository
[http://www.its.dot.gov/pilots/cv_pubs.htm](http://www.its.dot.gov/pilots/cv_pubs.htm)

Please visit the CV pilots website for the recording and the briefing material of the previous webinars:
[http://www.its.dot.gov/pilots/technical_assistance_events.htm](http://www.its.dot.gov/pilots/technical_assistance_events.htm)