CONNECTED VEHICLE PILOT Deployment Program

Performance Measurement and Evaluation Support Plan
New York City

Jonathan Walker, NYC CV Pilot Site COR
Mohamad Talas, NYC CV Pilot Site Program Management Lead
Keir Opie, NYC CV Pilot Site Task 5 Co-Lead

ITS Joint Program Office
TODAY’S AGENDA

- Purpose of this Webinar
  - To share the Performance Measurement and Evaluation Support plan from the New York City pilot with the stakeholders of connected vehicle technologies.

- Webinar Content
  - Connected Vehicle Pilot Deployment Program Overview
  - New York City Performance Measurement and Evaluation Support Plan
  - Stakeholder Q&A
  - How to Stay Connected

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

PROGRAM GOALS
- Participate in Concept Development Phase Webinars for the three Pilot Sites (see website for exact dates and times)
- Visit Program Website for Updates: http://www.its.dot.gov/pilots
- Contact: Kate Hartman, Program Manager, Kate.hartman@dot.gov

PILOT SITES
- ICF/Wyoming DOT
- NYCDOT
- Tampa (THEA)

STAY CONNECTED
New York City Performance Measurement and Evaluation Support Plan

- Presentation Overview
  - System Overview
  - Goals and Objectives
  - Performance Measures
  - Confounding Factors
  - Impact Evaluation Design
  - Data Collection Plan
  - Performance Reporting and Data Sharing
  - Next Steps
New York City CV Pilot System Overview

Mohamad Talas,
NYC CV Pilot Site Program Management Lead
NYC Primary Focus: SAFETY

- New York City is aggressively pursuing its “Vision Zero” initiative:
  
  “Traffic Death and Injury on City streets is not acceptable”

  Vision Zero Goal: to eliminate traffic deaths by 2024

- CV technology is another potential tool for the Vision Zero initiative.

- The project will evaluate the safety benefits and challenges of implementing CV technology with a significant number of vehicles in the dense urban environment.
NYC CV Pilot Site: Manhattan – Arterial Grid

- Grid (600’ x 250’)
- Day vs. Night conditions
- Residential/commercial mix
- High accident rate arterials (2012-2014)
  - 20 fatalities
  - 5,007 injuries
- 202 intersections – avenues
- 97 intersections – cross town

Source: NYCDOT
NYC CV Pilot Site: Manhattan - FDR Drive Freeway

- Limited access highway
- Excludes trucks/buses
- Short radius curves
- Over-Height restrictions
- ~$2M in Over-Height incident delay costs (2014)
  - 24 % of City-wide total
- 8 RSE locations

Source: NYCDOT
NYC CV Pilot Site: Brooklyn – Flatbush Avenue

- Over-Height restrictions
  - Tillary St.
  - Manhattan Bridge

- High accident rate arterial 2012-2014 (red dots)
  - 1,128 injuries
  - 8 fatalities

- Average speed 15 mph (AM inbound)

- 28 intersections

Source: NYCDOT
New York City CV Pilot
Goals and Objectives

Keir Opie,
NYC CV Pilot Site Task 5 Co-Lead
NYC CV Pilot Goals and Objectives

- **Primary Goal:**
  - Improving safety through the reduction of vehicle and pedestrian crashes, injuries, and fatalities

- **Secondary Goal:**
  - Improving mobility and reliability through crash prevention and lower crash severity

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

- Deployment of CV Technology in a Dense Urban Environment
  - Up to 10,000 fleet vehicles with After Market Safety Devices (ASDs):
    - ~7,500 Taxis (Yellow Cabs)
    - ~1,500 MTA Buses
    - ~500 Sanitation & DOT vehicles
    - ~500 UPS vehicles
  - Pedestrian ASDs ~100 units
  - Roadside Equipment at ~280 Locations
    - ~8 on FDR
    - ~28 on Flatbush
    - ~204 Manhattan
    - ~38 Other locations
Identified Use Cases

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
Use Case #1: Manage Speeds

- Encourage safe operations on the city’s roadways by:
  - Reducing speeding and increasing adherence to posted speed limits
  - Reducing crashes on sharp reduced speed curves on roadways
  - Improving work zone safety

<table>
<thead>
<tr>
<th>Improvement Category</th>
<th>NYCDOT Needs</th>
<th>CV Application(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety, Mobility</td>
<td>Discourage Spot Speeding</td>
<td>Speed Compliance (SPD-COMP)</td>
</tr>
<tr>
<td>Safety</td>
<td>Improve Truck Safety</td>
<td>Curve Speed Compliance (CSPD-COMP)</td>
</tr>
<tr>
<td>Safety</td>
<td>Improve Work Zone Safety</td>
<td>Speed Compliance / Work Zone (SPDCOMPWZ)</td>
</tr>
</tbody>
</table>
Use Case #2: Reduce Vehicle to Vehicle Crashes

- Reduce the number fatalities and injuries from crashes on NYC’s roadways from vehicle to vehicle crashes

<table>
<thead>
<tr>
<th>Improvement Category</th>
<th>NYCDOT Needs</th>
<th>CV Application(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Reduce Number of Crashes and Reduce Severity of Crashes</td>
<td>Forward Collision Warning (FCW)  Emergency Electronic Brake Light (EEBL)  Blind Spot Warning (BSW)  Lane Changing Warning/Assist (LCW)  Intersection Movement Assist (IMA)</td>
</tr>
<tr>
<td>Safety</td>
<td>Reduce Crashes at High Incident Locations</td>
<td>Red Light Violation Warning (RLVW)</td>
</tr>
<tr>
<td>Safety</td>
<td>Reduce Vehicle to Bus Crashes</td>
<td>Vehicle Turning Right in Front of Bus Warning (VRTW)</td>
</tr>
</tbody>
</table>
Use Case #3: Reduce Vehicle to Pedestrian Crashes

- Reduce the number pedestrian fatalities and injuries from crashes on NYC’s roadways from pedestrian-involved crashes

<table>
<thead>
<tr>
<th>Improvement Category</th>
<th>NYCDOT Needs</th>
<th>CV Application(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Improve Pedestrian Safety and Reduce Pedestrian-Involved Crashes</td>
<td>Pedestrian In Signalized Crosswalk Warning (PEDINXWALK)</td>
</tr>
<tr>
<td>Safety</td>
<td>Improve Safety of Visually Impaired Pedestrians</td>
<td>Mobile Accessible Pedestrian Signal System (PED-SIG)</td>
</tr>
</tbody>
</table>
Use Case #4: Reduce Vehicle to Infrastructure Crashes

- Reduce the fatalities and injuries from truck crashes on NYC’s roadways with low clearance bridges
- Improve operations created by lengthy clearance times of truck / bridge strike crashes

<table>
<thead>
<tr>
<th>Improvement Category</th>
<th>NYCDOT Needs</th>
<th>CV Application(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety, Mobility</td>
<td>Address Bridge Low Clearance Issues &amp; Enforce Truck Routes</td>
<td>Oversize* Vehicle Compliance (OVC) (*overheight only)</td>
</tr>
</tbody>
</table>
Use Case #5: Inform Drivers of Serious Incidents

- Improve safety and mobility for the traveling public through improved information dissemination during serious incidents

<table>
<thead>
<tr>
<th>Improvement Category</th>
<th>NYCDOT Needs</th>
<th>CV Application(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety, Mobility</td>
<td>Inform Drivers of Serious Incidents</td>
<td>Emergency Communications and Evacuation Information (EVACINFO)</td>
</tr>
</tbody>
</table>
Use Case #6: Provide Mobility Information

- Collect mobility information from CV technologies and compare to speed and travel time data collection from existing data collection technologies to support NYC’s adaptive signal control system

<table>
<thead>
<tr>
<th>Improvement Category</th>
<th>NYCDOT Needs</th>
<th>CV Application(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>Replace Legacy Data Collection</td>
<td>CV Data for Intelligent Traffic Signal System (I-SIGCVDAT)</td>
</tr>
</tbody>
</table>
Use Case #7: Manage System Operations

- Manage System Operations and ensure proper operations of the NYC CV Pilot system

<table>
<thead>
<tr>
<th>Improvement Category</th>
<th>NYCDOT Needs</th>
<th>CV Application(s)</th>
</tr>
</thead>
</table>
| System Operations    | Ensure Proper Operations of the CV Deployment | RF Monitoring (RFMON)  
OTA Firmware Update (FRMWUPD)  
Parameter Up/Down Loading (PARMLD)  
Traffic Data Collection (TDC)  
Event History Recording (EVTRECORD)  
Event History Upload (EVTCOLLECT) |
New York City CV Pilot
Performance Measures
# NYC CV Pilot Performance Measurements

<table>
<thead>
<tr>
<th>User Need</th>
<th>Category</th>
<th>NYCDOT Needs</th>
<th>CV App.</th>
<th>No.</th>
<th>Performance Measure Metrics</th>
<th>Question for Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage Speeds</td>
<td>Safety, Mobility</td>
<td>Discourage Spot Speeding</td>
<td>Speed Compliance</td>
<td>1a</td>
<td>Number of stops (average and distribution measures)</td>
<td>Does speed limit adherence and speed variability within the vehicle fleet on a given study roadway segment for a given time period (cycle length basis) decrease?</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>1b</td>
<td>Speeds (average and distribution measures)</td>
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<td></td>
<td>1c</td>
<td>Emissions</td>
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<td></td>
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<td>1d</td>
<td>Reduction in speed limit violations</td>
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<td></td>
<td></td>
<td>1e</td>
<td>Speed variation</td>
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<td>1f</td>
<td>Vehicle throughput (average and distribution measures)</td>
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<td>1g</td>
<td>Driver actions and/or impact on actions in response to issued warnings</td>
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</tr>
<tr>
<td>Safety</td>
<td>Improve Truck Safety</td>
<td>Curve Speed Compliance</td>
<td>2a</td>
<td>Speed related crash counts, by severity</td>
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<td></td>
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<td></td>
<td></td>
<td>2b</td>
<td>Vehicle speeds at curve entry</td>
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<td></td>
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<td>2c</td>
<td>Lateral acceleration in the curve</td>
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<td>2d</td>
<td>Driver actions and/or impact on actions in response to issued warnings</td>
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<td></td>
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<td></td>
<td>2e</td>
<td>Number of curve speed violations at each instrumented location</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>Improve Work Zone Safety</td>
<td>Speed Compliance / Work Zone</td>
<td>3a</td>
<td>Speed in work zone (average and distribution measures)</td>
<td>Do the number of work zone speed violations on each applicable studied roadway segment decrease?</td>
<td></td>
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<tr>
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<td>3b</td>
<td>Speed variation (distribution) at work zone</td>
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<td>3c</td>
<td>Number of vehicle speed limit violations in variable speed zone areas</td>
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<td>3d</td>
<td>Work Zone-related crash counts in reduced speed zones, by severity</td>
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<td>3e</td>
<td>Driver actions and/or impact on actions in response to issued warnings</td>
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</tr>
</tbody>
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## NYC CV Pilot Performance Measurements

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<th>Performance Measure Metrics</th>
<th>Question for Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Safety</td>
<td>Reduce Crashes</td>
<td>FCW EEBL BSW LCW IMA</td>
<td>4</td>
<td>Fatality crash counts</td>
<td>Do the number of reportable crashes decrease?</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>4a</td>
<td>Injury crash counts</td>
<td></td>
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<td>4b</td>
<td>Property damage only crash counts</td>
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<td></td>
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<td></td>
<td></td>
<td>4c</td>
<td>Time to Collision (vehicle to vehicle)</td>
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</tr>
<tr>
<td>Reduce Vehicle to Vehicle Crashes</td>
<td>Safety</td>
<td>Reduce Accidents at High Incident Intersections</td>
<td>Red Light Violation Warning</td>
<td>5</td>
<td>Red light violation counts</td>
<td>Do the number and severity of red light violations at each studied intersection decrease?</td>
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<td></td>
<td>5a</td>
<td>Red light violation related crash counts, by severity</td>
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<td>5b</td>
<td>Time To Collision (vehicle to cross vehicle path) at the intersection</td>
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<td>5c</td>
<td>Driver actions and/or impact on actions in response to issued warnings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td>Reduce Incidents, Improve Safety</td>
<td>Vehicle Turning Right in Front of Bus Warning</td>
<td>6</td>
<td>Bus and right turn related crash counts, by severity</td>
<td>Do the number of bus / right turn vehicle crashes decrease?</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>6a</td>
<td>Right-turning related conflicts</td>
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<td></td>
<td>6b</td>
<td>Time to collision (vehicle to bus)</td>
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<td></td>
<td></td>
<td>6c</td>
<td>Number of warnings generated</td>
<td></td>
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<td></td>
<td>6d</td>
<td>Driver actions and/or impact on actions in response to issued warnings</td>
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<td>6e</td>
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<th>Question for Evaluation</th>
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<tbody>
<tr>
<td>Reduce Vehicle to Ped Crashes</td>
<td>Safety</td>
<td>Improve Pedestrian Safety</td>
<td>Pedestrian in Signalized Crosswalk Warning</td>
<td>7a</td>
<td>Pedestrian related crash counts, by severity</td>
<td>Do the number of pedestrian related crashes decrease?</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>7b</td>
<td>Number of warnings generated</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>7c</td>
<td>Pedestrian-related conflicts/hard braking events</td>
<td></td>
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<td></td>
<td>7d</td>
<td>Time to collision (vehicle to pedestrian)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>7e</td>
<td>Driver actions and/or impact on actions in response to issued warnings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td>Improve Safety of Visually Impaired Pedestrians</td>
<td>Mobile Accessible Pedestrian Signal System (PED-SIG)</td>
<td>8a</td>
<td>Number of pedestrian crossing violation reductions</td>
<td>Do the number of pedestrian related crashes decrease?</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>8b</td>
<td>Visually-impaired pedestrian-related crash counts, by severity</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8c</td>
<td>Conflicts with visually impaired pedestrians</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>8d</td>
<td>Time to collision (vehicle to pedestrian)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>8e</td>
<td>Waiting time at intersection for crossing</td>
<td></td>
</tr>
<tr>
<td>Reduce Vehicle to Infra. Crashes</td>
<td>Mobility</td>
<td>Bridge Low Clearance &amp; Truck Routes</td>
<td>Oversized Vehicle Compliance</td>
<td>9a</td>
<td>Number of Warnings generated</td>
<td>Do the number of low clearance violations decrease?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9b</td>
<td>Number of truck route violations</td>
<td></td>
</tr>
<tr>
<td>Inform Drivers Serious Incidents</td>
<td>Mobility</td>
<td>Inform Drivers</td>
<td>EVACINFO</td>
<td>10a</td>
<td>Number of vehicles receiving information when generated</td>
<td>Do CV vehicles receive the information warnings when generated?</td>
</tr>
<tr>
<td>Provide Mobility Info</td>
<td>Mobility</td>
<td>Replace Legacy Data Collection</td>
<td>I-SIG CVDATA</td>
<td>11a</td>
<td>Segment speed (average and distribution measures) from CV compared to legacy detection systems</td>
<td>Do the CV based mobility metrics compare favorably to legacy detection systems or provide better information?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11b</td>
<td>Travel time (average and distribution measures) from CV compared to legacy detection systems</td>
<td></td>
</tr>
<tr>
<td>Manage System Ops</td>
<td>System Operations</td>
<td>Ensure Operations</td>
<td>Several</td>
<td>12a</td>
<td>System performance statistics (system activity, down time, radio frequency monitoring range on ASD's and RSU's, number of event warnings by app)</td>
<td>Does the system operate reliably?</td>
</tr>
</tbody>
</table>
New York City CV Pilot
Confounding Factors
### NYC CV Pilot Confounding Factors

<table>
<thead>
<tr>
<th>Confounding Factor</th>
<th>Impact on System Performance</th>
<th>Relative Difficulty to Quantify</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Demand Variations</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Weather</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Accidents and Incidents</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Traffic Signal Timing Updates</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Work Zones (Short Term or Unplanned)</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Work Zones (Long Term or Planned)</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Planned Special Events</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Economic Conditions</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Fuel Prices</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>E-Hail and For Hire Vehicles</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Citi Bike</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Changes in Transit – New SBS / BRT Routes</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Changes in Transit – 2nd Avenue Subway</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Changes in Transit – Canarsie Tube</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>6th Avenue Reconstruction</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Vision Zero Projects</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>
## NYC CV Pilot Confounding Factors

<table>
<thead>
<tr>
<th>Confounding Factor</th>
<th>Current Data Available to NYC DOT</th>
<th>Supplemental Data Proposed for CV Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Demand Variation</td>
<td>Semi-annual, two-week counts at NYC DOT screenlines, bridges and county crossings (coverage of continuous traffic monitoring devices is very limited in the study area) Traffic flow conditions along study corridors from segment travel time information (Midtown in Motion, MTA Bus Time, taxi GPS data)</td>
<td>Deploy continuous count locations</td>
</tr>
<tr>
<td>Weather</td>
<td>Central Park Weather station (KNYC) current conditions; snow plow clearing status from Department of Sanitation</td>
<td>Record windshield wiper status</td>
</tr>
<tr>
<td>Accidents and Incidents</td>
<td>NYPD Crash Database; including type, vehicle type(s), severity, location and time</td>
<td>None</td>
</tr>
<tr>
<td>Signal Retiming</td>
<td>NYC DOT official timing sheets with retiming dates</td>
<td>None</td>
</tr>
<tr>
<td>Work Zones (short)</td>
<td>Incident reporting in TRANSCOM OpenReach; work under emergency permits (ConEd, Verizon) not captured</td>
<td>Deploy NYCDOT monitoring vehicle(s)</td>
</tr>
<tr>
<td>Work Zones (long)</td>
<td>Incident reporting in TRANSCOM OpenReach; permit database (NYC DOT OCMC)</td>
<td>Deploy NYCDOT monitoring vehicle(s)</td>
</tr>
<tr>
<td>Planned Special Events</td>
<td>City Hall Street Activity Permit Office (SAPO) calendar and event details; calendar of street closures (NYPD)</td>
<td>None</td>
</tr>
<tr>
<td>E-Hail and For-Hire Vehicles</td>
<td>TLC trips and GPS breadcrumbs, including spatial/temporal routing and activity patterns for all yellow and green taxis</td>
<td>None</td>
</tr>
<tr>
<td>Changes in Transit</td>
<td>Project details, extents and implementation dates; ridership data (NYC DOT &amp; MTA)</td>
<td>None</td>
</tr>
<tr>
<td>6th Avenue Reconstruction</td>
<td>Project details, extents and implementation dates (NYC DOT &amp; DDC)</td>
<td>Deploy NYCDOT monitoring vehicle(s)</td>
</tr>
<tr>
<td>Vision Zero Projects</td>
<td>Project details, extents and implementation dates for design/safety improvements (NYC DOT); locations and implementation dates of new enforcement measures (NYPD); findings of Years 1 and 2 “after” analyses (City Hall)</td>
<td>None</td>
</tr>
</tbody>
</table>
New York City CV Pilot Impact Evaluation Design
Two Modes of Operation for ASDs

- **Silent Mode** (or Without CV): System fully deployed and operational but *without* user notification of ASD perceived warnings.
  - In silent mode, the ASDs will record normal driver behaviors and reactions during conditions that the ASDs would have issued a warning if active.

- **Active Mode** (or With CV): System fully deployed and operational but *with* user notification of ASD perceived warnings.
  - In active mode, the ASDs will record the normal driver behaviors before the issue of the ASD warning and the modified or revised behavior and actions following that warning.
NYC CV Pilot Impact Evaluation
Design Considerations

- Maximize potential for reducing accidents and saving lives
- Maximize market penetration of active CV devices
- Account for nature of fleet operations
  - Regular shifts of drivers between vehicles
- Account for confounding factors

- Considered Options:
  - Before and After - Selected
  - Control and Treatment Groups – Selected for Taxis only
### NYC CV Pilot Impact Evaluation Design

#### Recommended Experimental Design

<table>
<thead>
<tr>
<th>Category</th>
<th>Pre-deployment (BEFORE)</th>
<th>Post-deployment (AFTER)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Taxis - Control Group</strong></td>
<td>No Treatment (Silent Warnings/Alerts)</td>
<td>No Treatment (Silent Warnings/Alerts)</td>
</tr>
<tr>
<td></td>
<td>Taxi\textsubscript{CB1} Taxi\textsubscript{CB2} Taxi\textsubscript{CBn}</td>
<td>Taxi\textsubscript{CA1} Taxi\textsubscript{CA2} Taxi\textsubscript{Ca}_n</td>
</tr>
<tr>
<td><strong>Taxis - Treatment Group</strong></td>
<td>No Treatment (Silent Warnings/Alerts)</td>
<td>Treatment (Active Warnings/Alerts)</td>
</tr>
<tr>
<td></td>
<td>Taxi\textsubscript{TB1} Taxi\textsubscript{TB2} Taxi\textsubscript{TBn}</td>
<td>Taxi\textsubscript{TA1} Taxi\textsubscript{TA2} Taxi\textsubscript{Ta}_n</td>
</tr>
<tr>
<td><strong>NYC DOT / Sanitation Vehicles - Treatment Group</strong></td>
<td>No Treatment (Silent Warnings/Alerts)</td>
<td>Treatment (Active Warnings/Alerts)</td>
</tr>
<tr>
<td></td>
<td>NYC\textsubscript{TB1} NYC\textsubscript{TB2} NYC\textsubscript{TBn}</td>
<td>NYC\textsubscript{TA1} NYC\textsubscript{TA2} NYC\textsubscript{Ta}_n</td>
</tr>
<tr>
<td><strong>MTA / NYCTA Buses - Treatment Group</strong></td>
<td>No Treatment (Silent Warnings/Alerts)</td>
<td>Treatment (Active Warnings/Alerts)</td>
</tr>
<tr>
<td></td>
<td>Bus\textsubscript{TB1} Bus\textsubscript{TB2} Bus\textsubscript{TBn}</td>
<td>Bus\textsubscript{TA1} Bus\textsubscript{TA2} Bus\textsubscript{Ta}_n</td>
</tr>
<tr>
<td><strong>Commercial Vehicles - Treatment Group</strong></td>
<td>No Treatment (Silent Warnings/Alerts)</td>
<td>Treatment (Active Warnings/Alerts)</td>
</tr>
<tr>
<td></td>
<td>Com\textsubscript{TB1} Com\textsubscript{TB2} Com\textsubscript{TBn}</td>
<td>Com\textsubscript{TA1} Com\textsubscript{TA2} Com\textsubscript{Ta}_n</td>
</tr>
<tr>
<td><strong>Pedestrians - Treatment Group</strong></td>
<td>No Treatment (Silent Warnings/Alerts)</td>
<td>Treatment (Active Warnings/Alerts)</td>
</tr>
<tr>
<td></td>
<td>Ped\textsubscript{TB1} Ped\textsubscript{TB2} Ped\textsubscript{TBn}</td>
<td>Ped\textsubscript{TA1} Ped\textsubscript{TA2} Ped\textsubscript{Ta}_n</td>
</tr>
</tbody>
</table>

**Legend**

- CB1, CB2, ..., CBn: BEFORE data collection/measurement for control group
- TB1, TB2, ..., Tbn: BEFORE data collection/measurement for treatment group
- CA1, CA2, ..., Ca\_n: AFTER data collection/measurement for control group
- TA1, TA2, ..., Ta\_n: AFTER data collection/measurement for treatment group

**Controlled Assignment of Taxis**

**Calculate BEFORE Perf. Measures**

**Calculate AFTER Perf. Measures**
Before and After Comparison of Crash Records

- Traditional before / after comparison of crash records
- Empirical Bayes methods

- Before Period:
  - Extend back to November 7, 2014 (citywide speed limit change) for larger before period

- After Period
  - CV post-deployment (only when treatment group have ASDs in active mode)

- Comparison groups:
  - Complicated by city-wide V2V deployment
  - V2I instrumented vs non-instrumented corridors
Safety Impacts: Safety Surrogate Measures (SSM) Simulations

- Assess changes in driver behavior from CV deployment and estimate changes in risk of crashes

- Small scale very-detailed microsimulations needed building on existing SSM simulation research
  - Customize driver behavior models based on observed changes in driver behavior and reactions from observed ASD datasets
  - Calibration of vehicle movements (trajectory level calibration)

- Multiple simulation scenarios under pre- and post-CV deployment for:
  - Different geometric conditions
  - Confounding factors (demands, weather, etc.)
  - Stochastic Randomness
Non-Safety Impacts: Systemwide Simulation

- Assess impacts on mobility and reliability of reduced number and/or severity of crashes from the CV deployment

- Use the Manhattan Traffic Model (MTM)
  - An Aimsun microsimulation of Midtown Manhattan
    - 14th Street to 66th Street, Hudson River to East River
  - Incorporate changes on mobility from ASD datasets
    - Reduced speeding or speed variation on roadways

- Multiple simulation scenarios under pre- and post-CV deployment for:
  - Multiple types, locations, and severity of crashes
  - Prevented crashes or reduced severity crashes (faster clearance)
  - Assess differences in system user impacts of each scenario
  - Assessment of mobile emissions using simulation outputs
New York City CV Pilot
Data Collection Plan
CV Device Based Data Collection

- **In-vehicle ASDs:**
  - ASD ‘Action Log’ Datasets
    - 10Hz BSMs from host and nearby vehicles
    - MAP and SPaT messages received by ASD
    - Recorded for time period surrounding an issued warning/advisory/alert (an ‘event’) from the ASD
    - Preserve time and location anonymity of records: **Obfuscation**
  - ASD Breadcrumb Data
    - Periodic (1-5 second) locations data to calculate speed/travel time data

- **Pedestrian ASDs:**
  - Details under development
  - Preserve time and location anonymity of records

- **Roadside Equipment:**
  - RF monitoring
  - ASD data uploads over DSRC
Obfuscation of ASD Action Logs

Raw ASD Action Log Data

Obfuscation process to scrub precise time and location data and to represent in bins

Obfuscated ASD Action Log Data

Non-obfuscated data will be destroyed following the obfuscation process
Non-CV Based Data Collection

- Confounding dataset quantifications
  - Real-time
  - Non-real-time

- Crash reports and databases (police report generated)

- Other Mobility Data Collection Sources
  - Volume monitoring
  - Travel time monitoring from Midtown-in-Motion adaptive signals
  - Travel time monitoring from Taxi and Bus GPS-based datasets

- Qualitative Operator/Driver Feedback Surveys
New York CV Pilot Performance Reporting and Data Sharing
Methods for Evaluating Performance of the CV Deployment

- ASD Action Log Data (10 Hz datasets around events)
- Other CV-based System Data (less than 10 Hz data)
  - Assess changes in driver behavior and actions
    - Before/after comparisons
    - Control/treatment comparisons for taxis
- Non-CV device generated data (‘Field Data’)
  - Before and After Comparisons of Crash Data
- Simulation Modeling Assessments
  - Safety Surrogate Measures Simulation: Safety benefits
  - System Performance Simulation: Non-safety benefits
Fusion of Confounding Data in Obfuscation Process

CV Device Data
- ASD Action Log
- ASD Pedestrian Log

ASD Action Log with Confounding Factors

Confounding Factor Data – Real Time
- Traffic Count Data
- Midtown in Motion Segment Travel Time Data
- Weather Data
- TRANSCOM Traffic Incident Data

Confounding Factor Data – Historical
- Crash Data
- Taxi Activity and MTA Bus Time Data
- Special Events and Related Street Closures Summary Log
- Short- and Long-term Work Zone Presence Summary Log
- External Project Related Changes

Obfuscated ASD Action Log with Confounding Factors

New York City Transportation Management Center Server Database

Store

Fuse
Performance Reporting

- Performance Reporting of CV Impacts

- Dashboards of System Performance for DOT and Stakeholders
  - NYCDOT TMC Operators
  - NYCDOT TMC Managers
  - NYCDOT Engineers
  - NYCDOT Decision Makers
  - Stakeholders
Data Sharing

- Obfuscated Data will be shared with USDOT for evaluation by the selected independent evaluator contractor.

- Selected subsets of obfuscated data will be uploaded to the Research Data Exchange for research community use:
  - Subsets to be reviewed for time and location anonymity first.
New York City CV Pilot
Next Steps
NYC CV Pilot Next Steps

- Phase 1 Additional Tasks:
  - Finalize System Requirements
  - Develop Deployment Plans
  - Finalize Partnership MOUs
  - Preliminary testing of ASDs and RSEs

- Phase 2 Performance Measures Related:
  - Develop the obfuscation time and location binning protocols
  - Develop the data warehouse and data handling protocols
  - Develop simulation work plans
Please keep your phone muted

Please use chatbox to ask questions

Questions will be answered in the order in which they were received
Contact for CV Pilots Program:
Kate Hartman, Program Manager
Kate.Hartman@dot.gov

Join us for the Getting Ready for Deployment Series

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

Website: http://www.its.dot.gov/pilots
Twitter: @ITSJPODirector
Facebook: https://www.facebook.com/USDOTResearch

CV Pilot Sites’ Performance Measurement Webinars

- 6/6/2016, 2:00 pm – 3:00 pm ET
  ICF/WYDOT Performance Measurement Webinar

- 6/6/2016, 3:30 pm – 4:30 pm ET
  NYCDOT Performance Measurement Webinar

- 6/7/2016, 12:00 pm – 1:00 pm ET
  Tampa (THEA) Performance Measurement Webinar

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