CONNECTED VEHICLE PILOT Deployment Program

New York City (NYC) Concept of Operations

Jonathan Walker, NYC CV Pilot Site COR
Steve Galgano, NYC CV Pilot Site Project Manager

ITS Joint Program Office
Purpose of this Webinar

To share the Concept Development Activities from the NYC Pilot site with the stakeholders of connected vehicle technologies.

Webinar Content

- Connected Vehicle Pilot Deployment Program Overview (Jonathan Walker)
- NYC Concept of Operations (NYC Team)
- Stakeholder Q&A (Jonathan Walker & NYC Team)
- How to Stay Connected (Jonathan Walker)

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
PROGRAM GOALS

- Participate in Concept Development Phase Webinars for the three Pilot Sites (see website for exact dates and times)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✫ ✫</td>
<td></td>
<td></td>
<td>✫ ◆ ◆</td>
<td></td>
<td></td>
<td>◆ ◆ ◆ ◆</td>
</tr>
</tbody>
</table>

Concept of Operations Webinars

Performance Measurement Webinars

Comprehensive Deployment Plan Webinars

STAY CONNECTED

- 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)
New York City
Site Orientation and Key Issues

Mohamad Talas
Deputy Project Manager
Project 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 Pilot Deployment - Users

- Up to 10,000 **fleet** vehicles with *After Market Safety Devices (ASD)*:
  - ~7,500 Taxis - Yellow Cabs
  (Authorized for “hail” fares in lower Manhattan and airports.)
  - ~1,500 MTA Buses – which frequent lower Manhattan
  - ~500 Sanitation & DOT vehicles servicing Manhattan
  - ~500 UPS vehicles servicing Manhattan
NYC Pilot Deployment - Users

- Working with Pedestrian Applications
Dense Urban Environment
NYC Advanced Infrastructure

- 12,600 Signalized Intersections – already “Advanced Traffic Controllers”
- Megabit Wireless communications backhaul covers all 5 Boroughs
- Extensive fiber network for backhaul at key locations
- Central system that integrates all traffic signal and ITS devices City-wide
- Aggressive maintenance program with 2 Hr response time 24x7x365 and 311
Pilot Deployment Site

**Manhattan - Arterial**

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

*Note that the west side can be used for comparison*
Pilot Deployment Site

**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

Note that FDR includes higher speeds to evaluate the V2V under limited freeway conditions
Pilot Deployment Site
Brooklyn – Flatbush Ave.

- 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)
- 38 intersections
Project area:
- Manhattan Arterials (below 67th street)
- Manhattan “freeway” – FDR Drive
- Brooklyn (Flatbush Ave.)

Fleets will experience V2I applications where CV infrastructure is installed

Fleets will experience V2V applications throughout the City

City fleets (MTA, DOT, & Sanitation) return to “barn” daily

Taxis – return to “barn” for shift changes

RSE Locations:
- 8 on FDR, 38 on Flatbush, 204 Manhattan (Avenues), 40 Manhattan Cross-Town, 38
  Other locations = ~ 320 (TBD)
NYC CV Challenges - *Everywhere*

- Density of Roadside DSRC Transponders (RSE)
  - ~76 M for short blocks
  - ~200 M for the long blocks (between avenues)
- DSRC only communications
  - Need to develop applications for system operation and management
- Bandwidth limitations of the wireless backhaul (RSE to TMC)
- Stakeholder privacy concerns vs. USDOT desire for broad evaluation data
- Stakeholder requirements to avoid distracting “cockpit” displays
- Ongoing maintenance and support (in-vehicle and infrastructure) of the large scale deployment (10,000 Vehicles and ~320 RSEs)

  *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
- Location accuracy in the urban canyons (*both relative V2V and absolute V2I*).
User Safety Needs

- Need to “manage” speed (25 MPH city-wide except Fwy)
- Need to reduce vehicle-to-vehicle crashes
- Need to reduce pedestrian injuries
- Need to reduce crashes & injuries at intersections
- Need to reduce crashes involving buses
- Need to reduce the crashes of vehicles with infrastructure
  - Overheight, and restricted roadways
- Need to inform drivers of serious incidents and major travel restrictions
  - Evacuation, special event restrictions, detour
  - Likely restricted by area and roadway
Other User Needs

- Minimize introduction of additional **driver distractions**
- Ensure **privacy** for the drivers
- Minimize union concerns for fleet drivers – **performance monitoring**
- Manage CV applications for the changing (daily) traffic environment

- Determine utility of CV BSM data for input to the City’s Adaptive Control System (MIM-ACDSS)
- Evaluate use of CV technology to reduce PED injuries
- Evaluate use of CV technology with **Smartphone** applications for disabled pedestrians
  - Notifications to Vehicles, Stakeholders: **do NOT notify pedestrians**
- Needs for data to measure system performance
- Needs to manage the overall operational integrity of the system
- Data needs for the Independent Evaluator
The Approach

- Focus on “proven” **Safety Applications** – rather than mobility
  - BAA stressed that R&D has shown the benefits
  - Pilot Deployment will evaluate the benefits on a larger scale – dense urban situation
- Leverage “existing” safety applications – rather than “re-invent”
- Modify several existing applications to encourage speed compliance
  - Note that the City recently reduced city-wide speed from 30 MPH to 25 MPH!
- Use the **Systems Engineering Process** to:
  - Develop the operations and maintenance support applications
  - Develop the pedestrian applications
  - Develop the data collection applications
  - Develop benefit evaluation applications
After Market Safety Device (ASD)

GPS
DSRC (2 channel)

Vehicle
CAN of J Bus

POWER

DSRC V2V
DSRC V2I

DSRC V2V

Alerts, warnings, driver information
Verify Proper Operation

Traffic Controller

nycwin
City Owned Network (Fiber or citynet)

Option Required

Optional Traffic Controller

Typical Vehicle

GPS
DSRC (2 channel)

After Market Safety Device (ASD)

RSU

Typical Roadside

Traffic Controller
V2V Safety Applications

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

V2V applications based on existing demonstrations and prior developments and documentation
V2I Safety Applications

- Red Light Violation Warning  RLVW
- Speed **Compliance**  SPD-COMP
- Curve Speed **Compliance**  CSPD-COMP
- Speed **Compliance**/Work Zone  SPDCOMPWZ
- Oversize Vehicle **Compliance**  OVC
  - Prohibited Vehicle (Parkways)
  - Overheight

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

- Emergency Communications and Evacuation Information  (Using the traveler information features)  EVACINFO
Other Applications

- Mobile Accessible Pedestrian Signal System     PED-SIG
- Pedestrian in Signalized Intersection Warning   PEDINXWALK
- CV Data for Intelligent Traffic Signal System      I-SIGCVDAT

Operations, Maintenance, and Performance Analysis

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

To Meet USDOT Requirements for Benefit Analysis
## Application Distribution by Fleet

<table>
<thead>
<tr>
<th>CV Application</th>
<th>Qty Pct</th>
<th>Vehicle Fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicle Fleet</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vehicles</strong></td>
<td>7500</td>
<td>500</td>
</tr>
<tr>
<td><strong>Taxi &amp; Limousine</strong></td>
<td>500</td>
<td>1500</td>
</tr>
<tr>
<td><strong>NYC DOT / Sanitation</strong></td>
<td>1500</td>
<td>500</td>
</tr>
<tr>
<td><strong>MTA / NYCTA Buses</strong></td>
<td>500</td>
<td><strong>TBD</strong></td>
</tr>
<tr>
<td><strong>Commercial Vehicle</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pedestrian</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Features

- **Speed Compliance**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Curve Spd Compliance**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Speed/work zone Compliance**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Frwd Crash Warning**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Emer Elec Brake**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Blnd Spot Warning**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Ln Change Warning**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Int Mvmt Assist**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **Vehicle Turning in Front of Bus**
  - No*
  - No*
  - Yes
  - No*
  - No

- **Red Lt Violation Warning**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **PED in Sig Xwalk**
  - Yes
  - Yes
  - Yes
  - Yes
  - Yes

- **PED-SIG**
  - No
  - No
  - No
  - No
  - Yes

- **Oversize Veh Compliance**
  - No
  - No
  - No
  - No
  - No

- **EVAC Info**
  - Yes
  - Yes
  - Yes
  - Yes
  - No

- **I-SIGCVDATA**
  - No
  - No
  - No
  - No
  - No

* Only warns the Bus
Back Office Processing

- SCMS* - managing Security Credentials for Infrastructure Components
  *Security Credential Management System
- Analysis of RF data to track ongoing RF performance
- Analysis of vehicle “events” for performance metrics
  - Crash avoidance data
  - Evaluation of alarm data
  - Normalization (anonymization) for future storage/export
- Management & adjustment of application parameters
- Working with equipment vendors to support OTA updates
- Registration of disabled pedestrians and management of their security credentials
  *Midtown-in-motion
- Analysis of traffic data for input to MIM* adaptive control
- Interface to RDE and the Independent Evaluator (USDOT)
Focus on the standard messages for the safety applications using latest version of SAE J2735
- Basic Safety Message (BSM)
- Signal Phase and Timing (SPaT) from the traffic controller
- Geometric information for the intersections (MAP)
- Signal Request Message (SRM) for pedestrian priority
- Signal Status Message (SSM) for interaction with the pedestrian
- Traveler Information Message (TIM) for evacuation messages

Focus on SAE J2945/1 for V2V safety applications

Use final versions of IEEE 1609.x as they are completed

Stay with IEEE 802.11p

Working with the traffic controller NTCIP updates for 1103, 1201, 1202, 1211

Stay connected with the standards programs (SAE, NTCIP, IEEE)
Adding project oriented data collection

RF Measurements

- Vehicles: collect the “first” and “last” SPaT message and the vehicle location from each RSE they “hear”

- RSEs: collect the “first” and “last” BSM message from vehicles they “hear”
  Supports statistical analysis of “communications” zone around each RSE and each vehicle.

- Vehicles: collect the BSM for each “new” vehicle they “hear” anywhere;
  Allows us to see how frequently vehicles encounter each other throughout the City.

- Data containing potential PII is encrypted at the time of recording.
- Data recorded in-vehicle is collected by RSE at entry to garage or similar “bottleneck”
- Data is sent to back office server for anonymization, analysis, and distribution
Event Data

- Note on additional sensors:
  
  \textit{ASD will include accelerometers (X, Y, Z) as well as an interface to the CAN bus or OBD2 bus (steering wheel angle, brake status, heading, speed)}

- Vehicles continuously record (0.1 sec.) the BSM data and ASD data in a “rotating buffer”.

- Whenever a configurable event occurs, the data prior to the event (for a configurable time) is stored in the ASD (\textit{pre-event data}).

- Following the event (for a configurable time) the same type of data is also stored (\textit{post event data}).

- Both are combined and encrypted into what becomes an “event” record.

- Data recorded in-vehicle is collected by an RSE at entry to garage or similar “bottleneck”

- The encrypted data is sent to back office server for analysis, anonymization, and aggregation – and ultimate export to USDOT
Adding project oriented data collection

- Note on scalability:

  Fleet size and backhaul bandwidth limits data collection. Not practical to collect every BSM from every active vehicle and RSE and those heard by every other active vehicle.

- Vehicles continuously log BSMs into their local buffer at a configurable rate (expect 1 sec. or configurable distance, whichever is less).

- Data is encrypted as stored – can only be decrypted at TMC

- Whenever vehicle passes any RSE, the data will be uploaded to the TMC

- Data at TMC will be analyzed and compared to the travel times received from the ETC

- Goal: to determine if and how this data can replace the current RTMS and ETC data

**All data has a limited lifespan!**
Next Steps (CV Technology)

- Using ConOps as basis for detailed system requirements
  - Use *Security Management and Operations Plan* – inputs to SyRS
  - Use *Performance Management Plan* – inputs to SyRS
  - Use *Safety Management Plan* – inputs to SyRS
- Working with Vendors to establish parameters that can be configured
  - V2V and V2I applications
- Refining data analysis software to use CV data
- Evaluation of Driver Interface options – audio
  - Tones vs. verbal direction/alert
- Developing the IPv6 network support approach for NYCWiN and CV networks
Stakeholders

The NYC CVPD program has worked with the following stakeholders to understand their needs and concerns.

Presented the CV Safety Applications “available”

- NYCDOT Bureau of Traffic Operations
- NYCDOT Fleets
- Department of Sanitation Fleet Operations
- Metropolitan Transit Authority / NYC Transit
- UPS
- Taxi & Limousine Commission
- New York State Motor Truck Association
- Pedestrians for Accessible and Safe Streets (PASS)
- Department of Information Technology and Telecommunications (DoITT) (NYCWiN)
- NYCDOT IT Department (Security issues)
Stakeholder Input workshops

- Multiple concept reviews with stakeholders in November, 2015
- Concept of Operations review in February, 2016
- Concept of Operations review in March, 2016

General Comments and Concerns/user needs

- Minimize introduction of additional **driver distractions**
  - Stakeholders liked the concept of an audio interface
- Ensure **privacy** for the drivers
- Minimize union concerns for fleet drivers – *performance monitoring*
- Manage CV applications for the changing (daily) traffic environment
- Concern over how to support the installation
  - Taxi – special high tech shops
  - UPS – they will do their own
  - MTA/DOT – likely in their own garage
- Stakeholder interaction to determine defective equipment
Ongoing Contract Work

- NYCDOT is continuing to move forward with the various concept documents
  - Security Management and Operations Plan
  - Performance Measurement and Evaluation Plan
  - Safety Management Plan
  - Maintenance and Operations Plans – still in review
  - Installation and testing/certification plans – will impact the SyRS
- Iterating changes to the ConOps and System Requirements Specification

The ConOps is a “living document” and will be further modified and refined
- Review with vendors
  - feasibility
  - cost models (looking toward Phase 2)
Stakeholder Q&A

- Please keep your phone muted

- Please use chatbox to ask questions

- Questions will be answered in the order in which they were received
Public ConOps Webinars:

- **ICF/Wyoming Pilot Site**
  2/5/2016, 1:00 – 2:00 pm ET

- **Tampa (THEA) Pilot Site**
  2/8/2016, 2:00 – 3:00 pm ET

- **NYC Pilot Site**
  4/1/2016, 1:00 – 2:00 pm ET

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

**Future Site-Specific Public Webinars:**

- **Performance Measurement Plan Webinar – June 2016 (TBD)**
- **Comprehensive Deployment Plan Webinar – August 2016 (TBD)**

Please visit the CV pilots website for announcements of future public webinars.

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 2015 CV Pilot Sites
- Learn the Essential Steps to CV Deployment
- Engage in Technical Discussion

Website: [http://www.its.dot.gov/pilots](http://www.its.dot.gov/pilots)
Twitter: [@ITSJPODirector](https://twitter.com/ITSJPODirector)
Facebook: [https://www.facebook.com/USDOTResearch](https://www.facebook.com/USDOTResearch)