INTELLIGENT MOBILITY: SAFER. GREENER. SMARTER.
WHAT TO EXPECT IN THIS SESSION

- Technical Panel Discussion of the technical issues each site encountered and their solutions.
  - Facilitator: Jonathan Walker, Program Manager of R&D, ITS JPO
  - Panelists:
    - Robert Rausch, Vice President, TransCore
    - Steve Novosad, Associate Vice President, HNTB
    - Tony English, Owner, Neaera Consulting Group
SESSION AGENDA

- 3:30 – 3:40 PM  Overview of Program Lessons Learned  
  Jonathan Walker, Program Manager of R&D, ITS JPO

- 3:40 – 4:00 PM  NYCDOT Pilot Technical Challenges  
  Robert Rausch

- 4:00 – 4:20 PM  Tampa (THEA) Pilot Technical Challenges  
  Steve Novosad

- 4:20 – 4:40 PM  Wyoming DOT Pilot Technical Challenges  
  Tony English

- 4:40 – 4:45 PM  Q&A
WE DOCUMENT DEPLOYMENT EXPERIENCES

- [https://www.its.dot.gov/pilots/index.htm](https://www.its.dot.gov/pilots/index.htm)

**Connected Vehicles**

**Connected Vehicle Pilot Deployment Program**

**CV Pilots News & Events**

- Tampa (THEA) Connected Vehicle Pilot Investigated Roadside Unit (RSU) Transient Surge Immunity 5/14/19
- CV Pilots presentation sessions at the ITS America Annual Meeting in Washington DC 5/16/19
- Connected Vehicle Pilots Phase 2 Interoperability Test Report is now available 4/26/19
- Connected Vehicle Pilot Deployment Program: Driving Towards Deployment: Lessons Learned from the Design/Build/Test Phase is now available 4/26/19
- New York City CV Pilot to Use High-Accuracy Positioning Techniques 3/25/19
- Wyoming DOT (WYDOT) Connected Vehicle Pilot Determines Appropriate Tractor-Trailer Antenna Placement and Equipment Configuration 3/20/19

**CV Pilots Deployment Resources**

- Program Overview
- **Success Stories and Lessons Learned**
- Technical Events/Publications (list view)
- Technical Events/Publications (table view)
- Featured Links

**CV Device Deployment Status**

- NYC DOT Pilot
- THEA Pilot
- Tempe-Hillsborough Expressway Authority Pilot
- WYDOT Pilot

**Success Stories**

- Keeping Stakeholders and the Public Informed
- Bringing Local Agencies to Work Together
- Promoting Interoperability
- Providing Open Source CV Applications and Sharing Data
- Accelerating Collaboration and CV Deployment

**Lessons Learned**

- Driving Towards Deployment: Lessons Learned from the Design/Build/Test Phase
- Connected Vehicle Pilot Deployment Program Phase 1 Lessons Learned
- Interoperability Testing amongst the three Connected Vehicle Pilots
- NYC Pilot’s demonstration at the ITS-NY Annual Meeting and Technology Exhibition
- Integrating and Testing Large Disparate Systems
NYCDOT Pilot Deployment

Robert Rausch
Lessons and Challenges from the –

The New York City Connected Vehicle Pilot Deployment Project

Understand The Complexity and Maturity of the Technology!
TOPICS

- System Complexity
- Infrastructure Challenges
  - Vehicle Interfaces
  - Communications Security
- Data Challenges
  - RSU installation & management
  - OTA management
  - Data Collection
- Standards
- Testing
- Connections to external systems
- Firewalls
- Media Management
- Servers to manage
- ICD’s to be developed
- SCMS access and profiles

Development
- PED Application
- V2I Applications
- O&M Applications
- Asset Management
- Installation Procedures
Project Deployment required addressing all of these elements:

- Controller Firmware Updates
  - SPaT and Configuration
- ITS Communications Security
  - DTLS and X.509 certificates
- Pedestrian Detection
- RSU Installation
  - Cross Intersection Connection
  - Precise Location X,Y,Z
- MAP message generation
- Data Collection for Travel Time
- Backhaul IP addressing
  - Firewalls
  - Proxy servers
- O&M support – all elements
VEHICLE INTERFACE

- CAN BUS
  - Interference from other devices (e.g. GeoTab)
  - Active retrieval – can create vehicle errors
  - Electrical interference issues
  - What data is available at OBD2 port
  - 10 Hz speed needed
- Solution was a passive coupler
  - Directly “on” CAN bus
  - Downside: cannot read VIN – only what happens to be active on the CAN bus!

- Power Consumption
  - Quiescent power needed for GPS history
    - 25 microamps
  - Power needed to avoid Linux file corruption
  - Power needed to complete transfers
    - Upload & Download
  - Battery Preservation
    - Solution:
      - Mandatory step-down watchdogs
      - Time-out for “completion”

- Lesson Learned
  - ALWAYS DISCONNECT BATTERY BEFORE ANY INSTALLATION OR REPAIR
SECURITY CHALLENGES

- **Communications Security**
  - TMC to ATC: (DTLS, TLS, VPN …)
  - ATC to RSU: DTLS – SNMPv1
  - TMC to RSU: DTLS – SNMPv3
  - Encryption requirements
    - OBS software completion
    - X.509 certificate management
  - Where are messages “signed” (1609.2)
    - RSU (SPaT), TMC (MAP, TIM)
    - HSM at TMC

- **Network Security Interfaces**
  - Amazon Cloud
  - SDC
  - SCMS
  - NYU

- **Firewall Management**
  - Rules & Proxy Servers
  - Configuration Management
  - Redundancy and reliability

- **Security Profiles for DSRC messages**
- **Separate PSIDs**
  - BSM
  - MAP
  - OTA Upload
  - V2X Locate
  - SPaT
  - TIM
  - OTA Download

- **Issues of Re-Enrollment**
  - Bench and trusted environment

- **Interoperability issues**
  - Test Certs will not interoperate with Pilot Certs
  - Devices must be re-enrolled to change
  - Production Installation vs. prototype testing

- **Proxy server needed for SCMS access**
  - Inconsistent with OBS security provisions

- **Certificate quantities and lifespan**
  - 60/week 2 week life
RSU CHALLENGES

- “Ideal Location” vs. what is available!
  - Line of sight – Avenues and Streets
- No Conduit to Traffic Controller
  - Implemented cross intersection wireless ethernet link
- Mast Arms already “crowded”
  - Developed alternative mounting to avoid damage
- Changes After Installation
  - Scaffolding – compromised V2X Locate
- RSU functionality issues – extensive testing (NY CVPD is different)
  - OTA upload (logs) OTA download (Firmware & Application Tuning)
- Time sync Traffic controller (AC Line) vs. RSU/ASD (GPS)
  - Future goal – all GPS
OTA – Application Updates & Data Collection

- Data collection
  - Limit data to “events”
  - Travel Times only need 1 BSM
    - Per vehicle
    - Per Intersection
  - RF Monitoring only 2 BSMs/vehicle
- Bandwidth Limitation of Backhaul
  - RSU acts as store and forward
  - Multiple RSUs at some locations

- OTA updates to firmware & ASD configuration
  - Developed a network coding scheme
  - Broadcast for bulk of downloads
  - On demand for the “stragglers”
  - Maximize channel utilization
  - Target “groups” to manage options
- Extensive System Testing & complexity
  - ASD, RSU, Backhaul, Network, TMC
  - Large file sizes Up and Down – Still Testing

Keep in mind the cost to physically access the vehicle – prohibitive
STANDARDS ISSUES

- Security issues
  - Understanding and managing 1609.2
  - Number of certificates
  - What PSIDs are covered by each Cert.
  - Guide coming from USDOT!
  - Certificate Change criteria

- Security Library Performance Issues
  - Still testing

- 1202v3 – did not exactly meet the need
  - Modified to transmit block object
  - Time-tick for RSU to track the LFC-GPS difference

- J2735 3 CVPD Sites collaborated
  - Consistent interpretation of the meaning
  - Consistent use of optional elements
  - Consistent use of security
  - Issues with MAP message interpretation
UNDERSTANDING THE COMPLEXITY OF TESTING!

- ASD
  - Functional – V2V
  - Functional – V2I
  - OTA – Uploading
  - OTA – Downloading
  - RF receiver and transmitter
  - Validating Data Collected
  - Operational Stability
  - Security Support
  - Power consumption
  - Startup-shutdown – power interruption
  + Routine Env., Shock, Vibration, ESD

- System
  - Security
  - O&M support
  - Configuration Support
  - Data Collection, obfuscation, aggregation, and export
  - MAP and TIM management

- RSU
  - Validating data collection
    ▪ Travel time
    ▪ RF levels
  - Configuration of operation
  - Functional – SPaT, MAP, TIM
  - Operational Stability – Failsafe recovery
  - Communications Stability to ATC & TMC & recovery
  - Security Support
  - RF receiver and transmitter
  - OTA – Uploading
  - OTA – Downloading
  - Startup-shutdown – power interruption
  - SCMS gateway
  - Startup-shutdown – power interruption
  + Routine Env., Shock, Vibration, ESD
  - Time management

- PID (pedestrian Device)
- Urban Canyon & Open Sky

There a lot of moving parts and players!
NYCDOT Technical Challenge Panel Discussion

- Facilitator: Jonathan Walker
- Panelists:
  - Robert Rausch
  - Steve Novosad
  - Tony English

NYCDOT Pilot Technical Challenges
- System Complexity
- Infrastructure Challenges
  - Vehicle Interfaces and Communications Security
- Data Challenges
  - RSU management, ASD management and Data Collection
- Standards
- Testing
Tampa (THEA) Pilot Deployment

Steve Novosad
PILOT DEPLOYMENT AREA

Traffic Flow Optimization
Traffic Flow Optimization/Bus Priority
Pedestrian Safety
Rush Hour Collision Avoidance
Wrong-Way Entry Prevention
Traffic Management
Traffic Flow Optimization
Streetcar Safety

U.S. Department of Transportation
IF WE COULD DO IT OVER AGAIN, WE WOULD:

- 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
- 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
- Understanding of Vendor’s Readiness for “True” deployment
- Require Test tools from each Vendor
Tampa (Thea) Pilot Technical Challenges

- Innovative ways to incentivize the public to participate
- Cross functional coordination is absolutely critical
- Importance of face to face progress meetings
- Deployment in an area undergoing significant redevelopment complicated Pilot to deal with confounding factors
- Establish Communication usage on your channels early
- Certification process outside of Pilot control
- Adequate incentives with community/media support engage the driver/consumer community
- Recognizing the need for a complete and experienced project team - systems, infrastructure, vehicle systems, performance measurement, etc.
TAMPA (THEA) PILOT TECHNICAL CHALLENGES

- OBUS - DON’T DO IT!!! Hire auto professionals to manage!
  - Multiple Technical Scans using RFPs (with on the road testing)
  - Early Sourcing of Suppliers to Create a Collaborative Environment
  - Early real-life testing with infrastructure in place to verify end-to-end system/application performance
  - Distributed Team Across the Country and in Europe, be careful can they support you from overseas
  - New development efforts - OTA and security - need to be piloted, i.e. tested early in the program
  - Vendor Testing Environments – Sharing equipment was not enough
Onsite Integration Testing

ONSITE Integration Testing

ONSITE INTEGRATION TESTING
THEA TECHNICAL CHALLENGE PANEL DISCUSSION

- Facilitator: Jonathan Walker
- Panelists:
  - Robert Rausch
  - Steve Novosad
  - Tony English

- Tampa (THEA) Pilot Technical Challenges
  - Applications and Devices Maturity.
  - Integration Testing.
  - Public Participation.
  - Certification Process.
  - Communication Channel Usage.
  - OTA and Security.
Wyoming DOT Pilot Deployment

Tony English
Fully integrated and secure CV System that transmits and receives data to/from other equipped vehicles and roadside infrastructure.

- This entails:
  - Complete integration with existing/future WYDOT systems and infrastructure.
  - Secure data management.
  - Innate interoperability with all external equipment/vendors and neighboring deployments.
  - Continuous maintenance of its robust CV infrastructure.
However… Testing for pilot ≠ Testing for scale

There can be a gap between testing and operating at scale!
Issues and Challenges

**Issues:**

- Trucks are not cars, many standards and solutions do not fully apply—e.g., antenna location.
- Data volume increasing.
- OBU failing at scale, constant hardware and firmware updates.
- Technical challenges in ensuring a secure network—e.g., SCMS integration and firewall compatibility.
- General code stability (crashing, GPS not coming on line, HMI disconnecting, offloading random).
- DSRC performance for OTA and offloading.
- *And more*…
OUR SOLUTION?

- Use Basic Security Message Parts 1 and 2
  - Tractor trailers can be described in BSM part 1 only (core)
    - Big car option
  - Tractor trailers can also be described using both BSM part 1 and part 2 BSM part 2
    - Tractor in BSM part 1 (core)
    - Trailer(s) in BSM part 2
  - NY, THEA, and WYDOT have agreed to use BSM part 2
    - Can support tractrix algorithm for trailer(s) movement with only one IMU/OBU/GPS unit
    - Better support for standards (pivots described correctly)
    - Be careful if you acquire an OBU that only support BSM part 1 (will see on the tractor, making for an unsafe implementation)
WYDOT TECHNICAL CHALLENGE PANEL DISCUSSION

- Facilitator: Jonathan Walker
- Panelists:
  - Robert Rausch
  - Steve Novosad
  - Tony English

Wyoming DOT Pilot Technical Challenges
- Trucks are not cars, many standards and solutions do not fully apply—e.g., antenna location.
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- General code stability (crashing, GPS not coming on line, HMI disconnecting, offloading random).
- DSRC performance for OTA and offloading.
Q&A

NYCDOT

Tampa (THEA)

WYDOT

USDOT
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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.wyroad.info/