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JUNE 2019
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# CONNECTED VEHICLE PILOT
## Deployment Program

# Resolving Technical Challenges

Session Moderator: Jonathan Walker

# 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

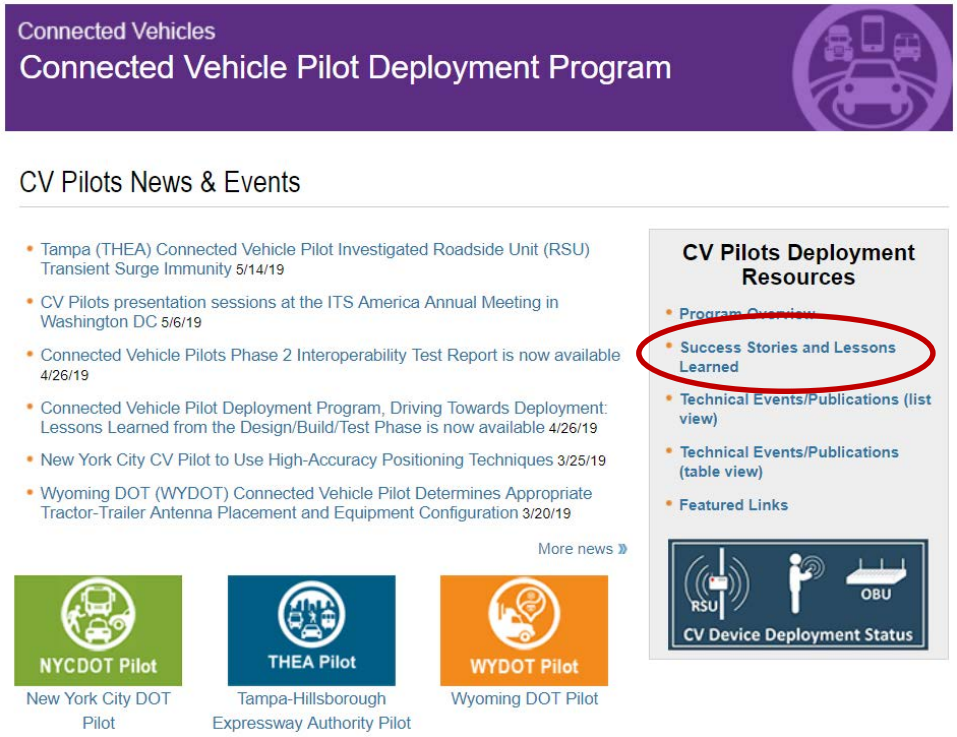
  *Robert Rausch*
- 4:00 – 4:20 PM Tampa (THEA) Pilot Technical Challenges

  *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




- 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

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# BEFORE YOU START A *CONNECTED VEHICLE* PROJECT

***Lessons and Challenges from the –***

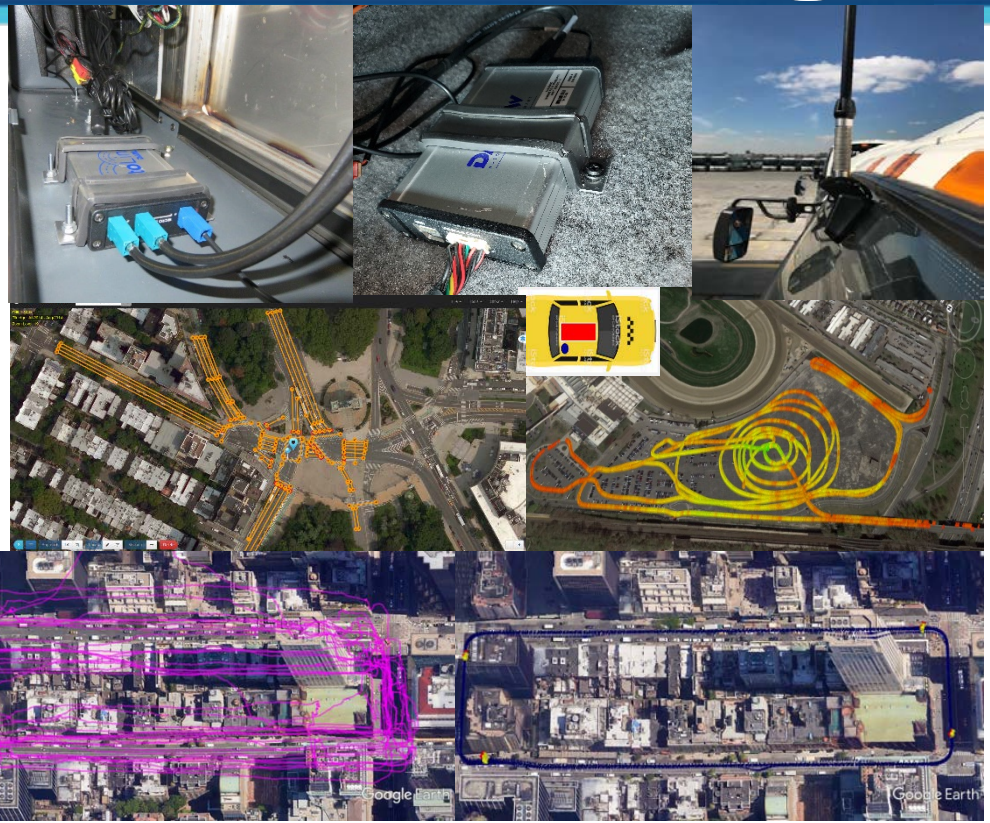
**The New York City Connected Vehicle Pilot Deployment Project**



***Understand The Complexity and Maturity of the Technology !***

# TOPICS

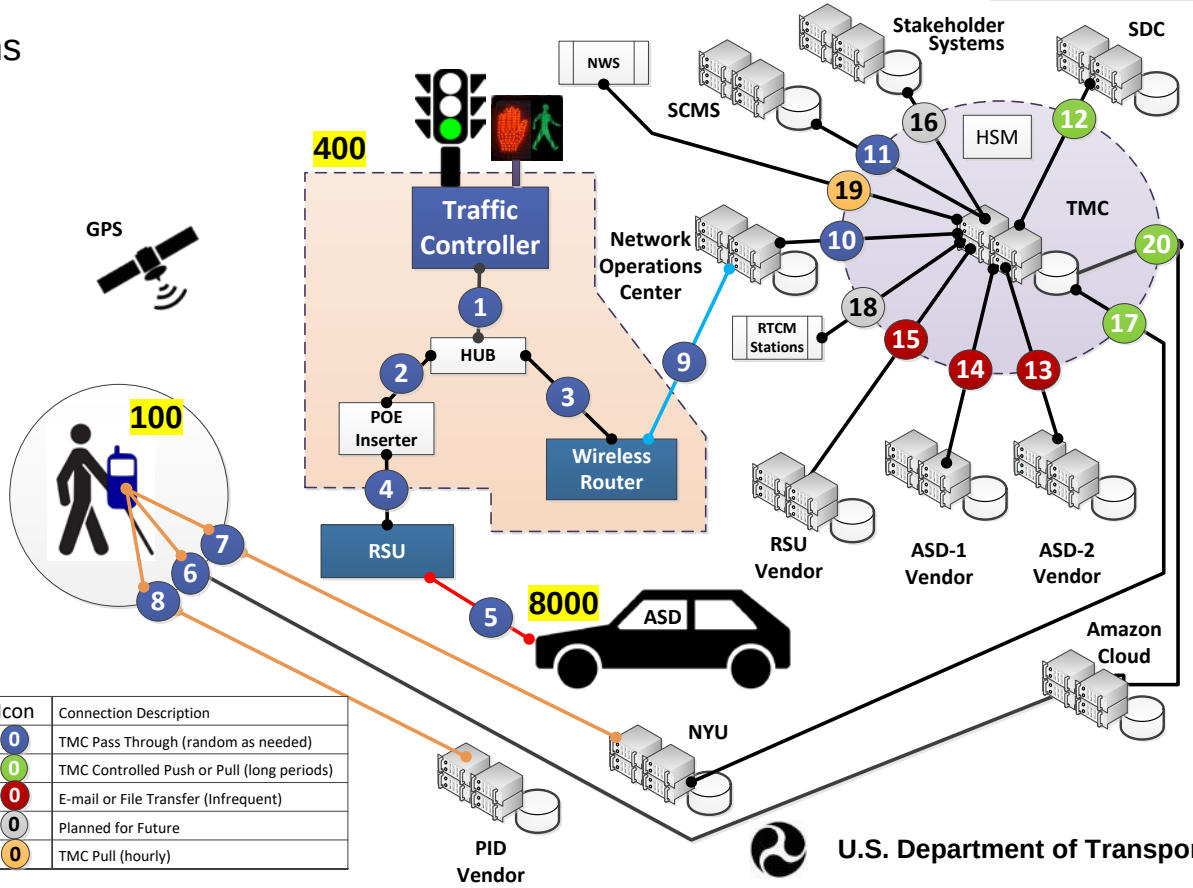
- System Complexity
- Infrastructure Challenges
  - Vehicle Interfaces
  - Communications Security
- Data Challenges
  - RSU installation & management
  - OTA management
  - Data Collection
- Standards
- Testing



# CONNECTION DIAGRAM FOR NYC CV PILOT SYSTEM

- 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



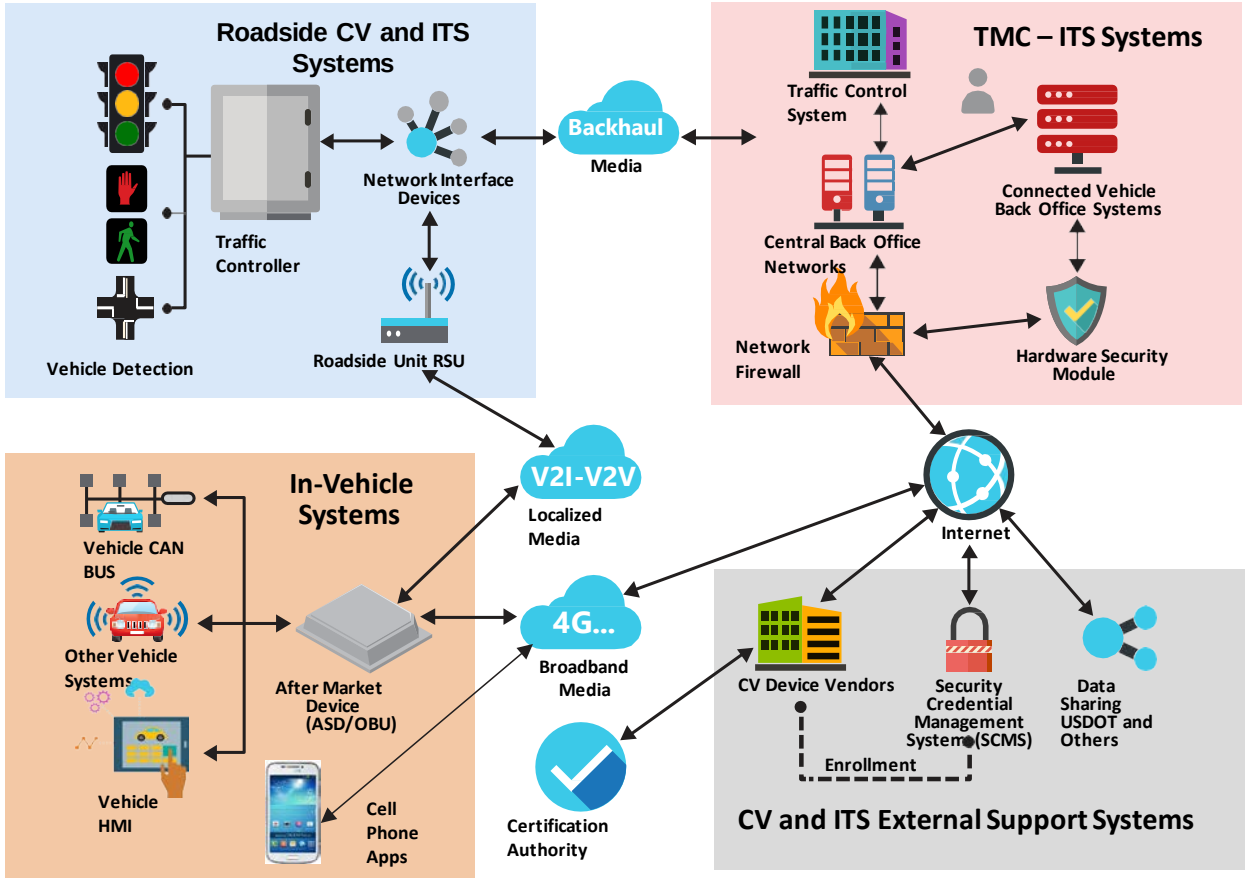

| Icon | Connection Description |
|---|---|
| 0 | TMC Pass Through (random as needed) |
| 0 | TMC Controlled Push or Pull (long periods) |
| 0 | E-mail or File Transfer (Infrequent) |
| 0 | Planned for Future |
| 0 | TMC Pull (hourly) |

NYC Connected Vehicle Project
For Safer Transportation

U.S. Department of Transportation

# CONNECTED VEHICLE END-TO-END ECO SYSTEM

- 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
  - SPaT
  - MAP
  - TIM
  - OTA Upload
  - OTA Download
  - V2X Locate
  - TIM
- 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

# NYCDOT Technical Challenge Panel Discussion

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

NYCDOT | Tampa (THEA) | WYDOT | USDOT

- 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

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# Pilot Deployment Area

# 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

# TAMPA (THEA) PILOT TECHNICAL CHALLENGES

**Onsite Integration Testing**

**ONSITE Integration Testing**

**ONSITE INTEGRATION TESTING**

# THEA Technical Challenge Panel Discussion

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

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- 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

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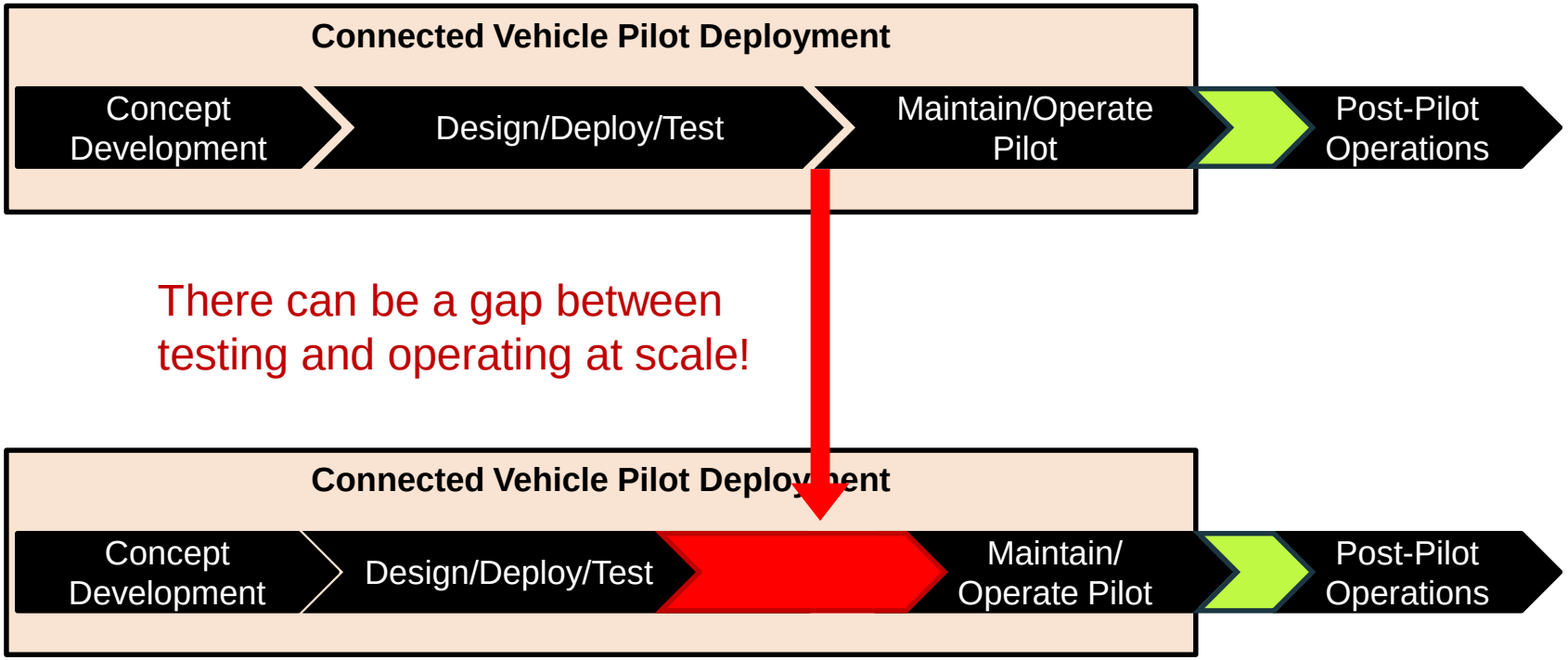
# Pilot Vision

**Vision**

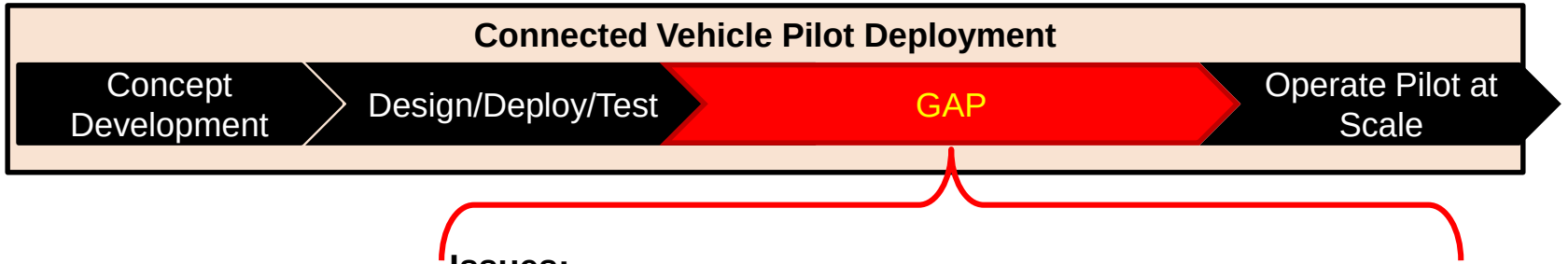
Fully integrated and secure CV System that transmits and receives data to/from other equipped vehicles and roadside infrastructure.

- **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



# Issues and Challenges

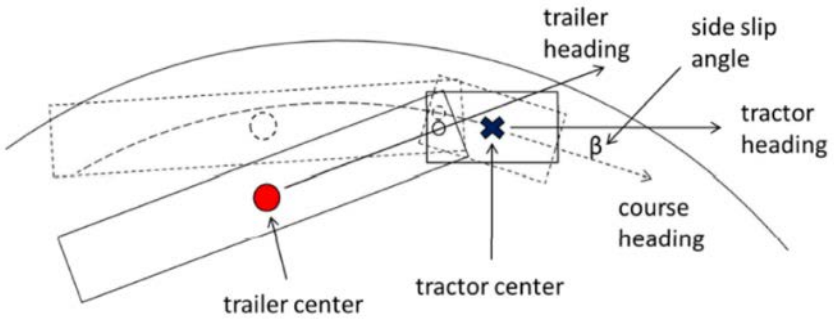



**Issues:**

- 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

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- Wyoming DOT Pilot Technical Challenges
  - 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.

# Q&A

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Tampa (THEA)

WYDOT

USDOT

# STAY CONNECTED

## Contact for CV Pilots Program/Site AORs:

- Kate Hartman, Program Manager, Wyoming DOT Site AOR; Kate.Hartman@dot.gov
- Jonathan Walker, NYCDOT Site AOR; Jonathan.b.Walker@dot.gov
- Govind Vadakpat, Tampa (THEA) Site AOR; G.Vadakpat@dot.gov

## 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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