Affiliated Connected Vehicle Test Bed Summit: Lessons Learned, Next Steps

ITS Industry Forum on Connected Vehicles: Moving from Research towards Implementation

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Key Objectives of the Affiliated Test Bed Concept

"Harness the abilities of existing researchers and installations to move the technology toward full deployment"

- Create an organizational structure
- Share deployment lessons learned
- Develop a common technical platform
- Expand Test Bed options for users
- Share tools and resources across all facilities
- Serve as models for future deployments

Presentation Outline

- Overview of the Affiliated Test Bed Summit
- Highlights of the Seven Test Beds
  - Purpose
  - Assets
  - Applications
  - Geographic layout
- Developing Lessons Learned
- Concept for Affiliated Test Beds
- Next Steps

Connected Vehicle Test Bed Summit

- One-day Summit held at Turner-Fairbank Research Center on July 19,2012
- 50 participants
- Multiple Public Sector Test Beds Represented
  - Arizona / Maricopa County
  - California
  - Florida
  - Michigan / RCOC / US DOT
  - Minnesota
  - New York
  - Virginia / STOL

Highlights of Individual Test Beds

Arizona *Anthem*

- Purpose
  - Advance multiple vehicle signal priority technology in a ‘live’ traffic environment
  - Deploy on emergency response vehicles (EV)
- Assets
  - 6 pole mounted RSEs (Savari StreetWave)
    - Integrated with signal controller (Econolite ASC3)
    - Each RSE has DSRC, Wi-Fi/Bluetooth capabilities
  - Traffic Signal Priority Applications
  - Fiber communications along the test bed
  - CCTV
  - Loop detection
- Applications
  - Priority Based Traffic Signal Control for EV and Transit (MCDOT/UA)
  - InFusion: Performance improvements of traffic Controllers by data fusion and analysis

    (SBIR Phase I – Savari, UA, SCSC)
  - SmartCross: Smartphone Signal Alert Status

    (SBIR Phase I – Savari, UA, SCSC)

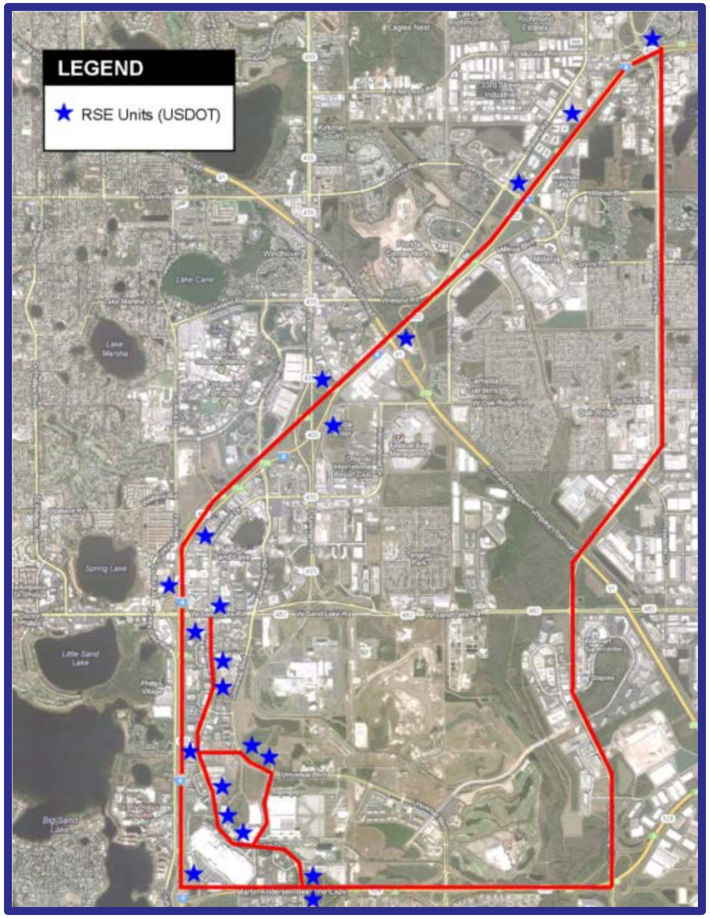
California *Palo Alto*

- Purpose
  - Assess/evaluate real-world implementations of VII
  - Inform future investment decisions on system management programs
- Assets
  - Vehicles: OEMs; transit buses; commercial trucks
  - OBEs from multiple vendors
  - Infrastructure Components
    - RSE, PC104, Signal Sniffer, Signal Controllers (Being updated from 170 to 2070)
  - Back End Servers
    - SDN @ 511 TIC in Oakland, Health Monitoring and management, Signage server

- Applications
  - Traveler Information (using 511)
  - Electronic Payment and Toll Collection
  - Ramp Metering
  - CICAS
  - Curve Over-Speed Warning
  - Auto Industry Applications (i.e., customer relations and vehicle diagnostics)
  - Multi-Modal Intelligent Traffic Signal System (Pooled fund study project)
    - ISIG
    - TSP
    - PED-SIG
    - PREEMPT
    - FSP
  - PATH Cooperative "Green Wave": Nissan and BMW
  - At-Grade Light Rail Crossing Safety Research
  - Intelligent Transit Stop Information System

Florida *Orlando*

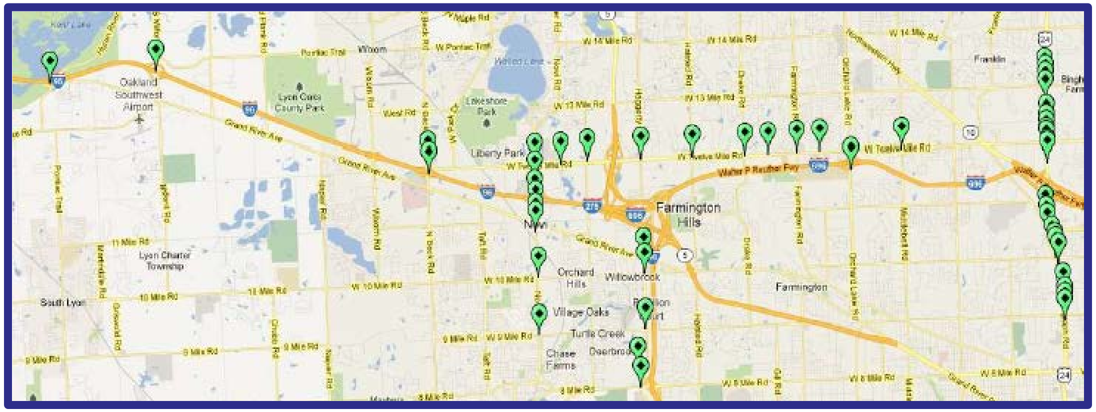
- Purpose
  - Support 18th ITS World Congress Technology Showcase demos in Orlando
- Assets
  - Vehicles (Road Rangers, Lynx buses, I-Ride Trolleys)
  - Infrastructure Components
    - 24 RSEs connected to FDOT fiber network
  - Back End Servers
    - District 5 RTMC SunGuide production servers
  - SunGuide Data Management Systems
- Applications
  - Developed - SunGuide Software Connected Vehicle module
    - Captures and stores BSMs
    - Use BSMs to calculate travel times
    - Broadcast TAMs as part of standard Incident/Event Management
    - RSE Image



Michigan

Oakland County

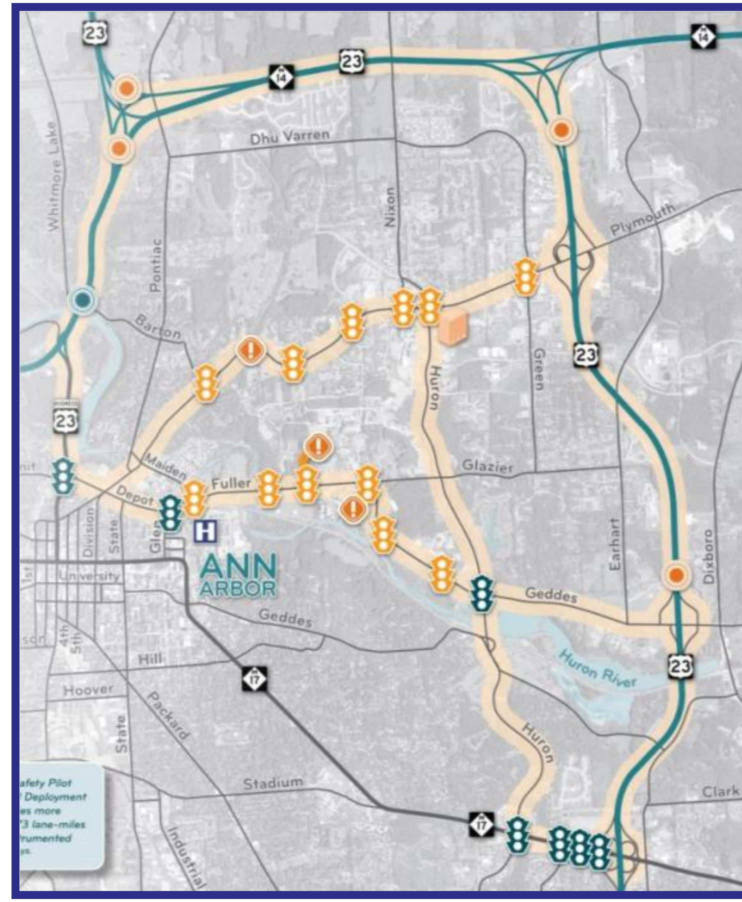
- Purpose
  - Research and testing resource for private developers to test DSRC-enabled applications
- Assets
  - 50 RSEs utilizing the 2007 version of the 802.11p and1609 standards
  - SPaT on 22 Telegraph Rd RSEs broadcasting both J2735 and CICAS-V standards
  - 30 RSEs have complete IPv4 and IPv6 connectivity to datacenter and internet
  - 9 vehicles dedicated for research and development
  - 2 portable SPaT listeners, along with a DSRC sniffer
  - 2 custom, portable, solar powered trailers for road side equipment in targeted locations
- Applications
  - SPaT (with portable listener and GUI)
  - Security Credential Management System (SCMS)



Michigan

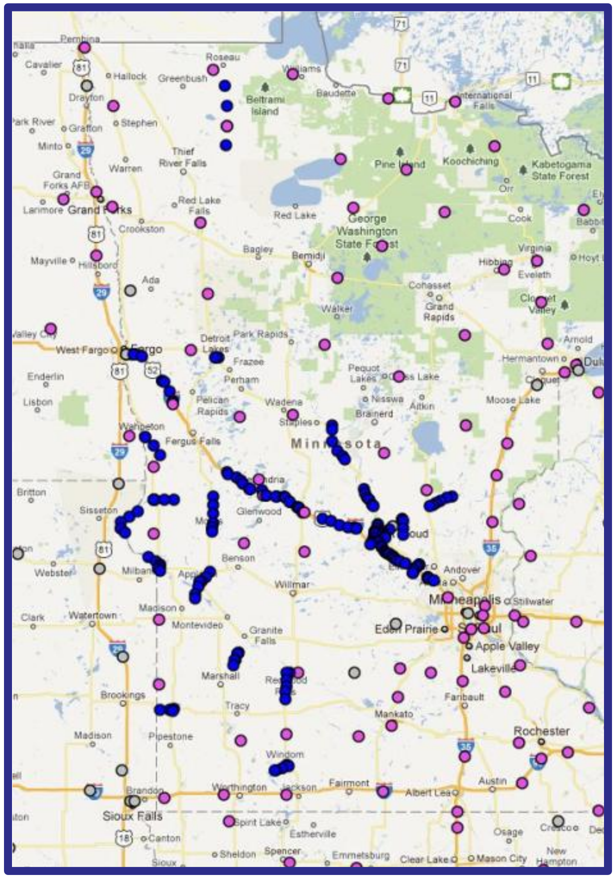
Safety Pilot, *Ann Arbor*

- Purpose
  - 1 year of data collection to support NHTSA decision
- Assets
  - More than 2,800 vehicles
  - Cars, commercial trucks, transit
  - Integrated Safety Systems, Vehicle Awareness Devices, and Aftermarket Safety Devices
  - 73 lane-miles of roadway instrumented with 29 roadside-equipment installations



Minnesota *Various Locations*

- Purpose
  - Minnesota Road Fee Test
    - Demonstrate technical feasibility of MBUF
    - Demonstrate flexibility of in-vehicle signage
    - Collect anonymous traveler info from consumer devices
  - CICAS-SSA
    - Obtain driver feedback on CICAS-SSA
  - Clarus
    - Collect, process and use mobile weather data
- Assets
  - Vehicles
    - Minnesota Road Fee Test – 500 volunteer vehicles
    - CICAS-SSA – “Driver clinic” type demo
    - Clarus – 80 MnDOT snow plows
  - OBEs
    - Minnesota Road Fee Test – Android smart phone
    - CICAS-SSA – Android smart phone + Arada DSRC
    - Clarus – AVL system with cellular communications



CICAS-SSA & Clarus

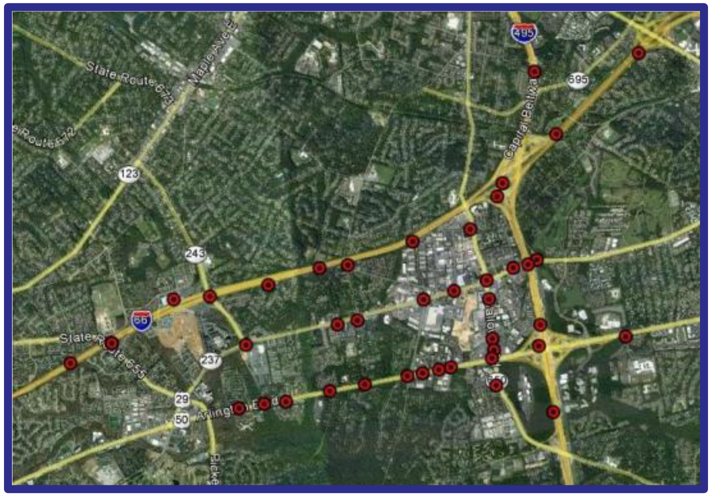
New York  *Long Island*

- Purpose
  - To support the 2008 ITS World Congress in Manhattan and demonstrate CV capabilities of connected vehicle technologies.
- Assets
  - Vehicles: 4 plow trucks (Mack & International)
  - OBEs: Retrofitted 5.9 GHz DSRC (Kapsch) plus 20 Aftermarket Devices (Kapsch)
  - Infrastructure Components: 31 Interstate RSEs plus 8 Arterial @ traffic signals
  - Enhanced e-screening site with 2 RSEs
  - RSE along I-40, Greensboro, NC (CVII Testing)

- Applications
  - CVII compliant 5.9 GHz DSRC OBE system
  - CVII DSRC applications:
    - CV driver I.D and verification
    - Wireless vehicle safety inspection (brake condition, tire pressure, light status, etc.)
    - CV to maintenance vehicles communication
  - Grade Crossing Driver Warnings (In-vehicle signage & crossing signal activation)
  - Heavy Vehicle to Light Vehicle Driver Safety Warnings

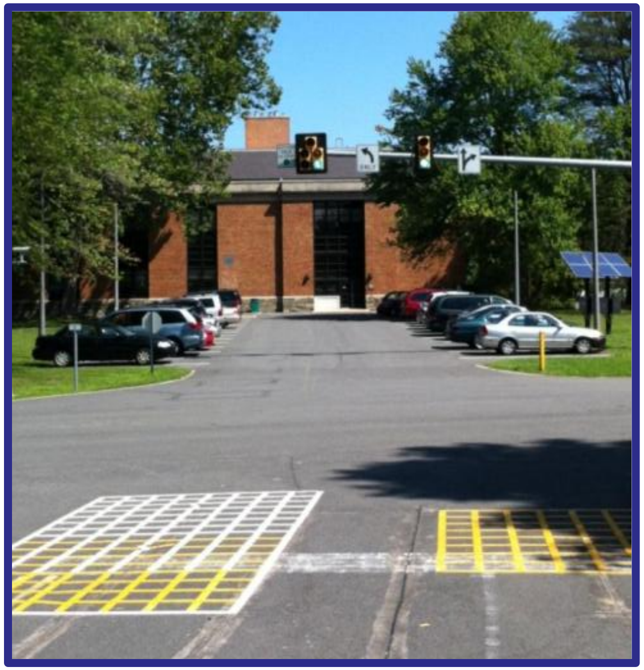
Virginia *NoVA*

- Purpose
  - Test connected vehicle technologies in congested urban areas.
- Assets
  - Vehicles: VTTI Fleet Vehicles (10 light vehicles, 1 motorcoach, 1 semi-truck. 220 Portable systems in personal vehicles)
  - OBEs (DSRC): Savari MobiWAVE & DENSO WAVE Radio; plus VTTI DAS
  - OBEs (Cellular): VTTI cellular-based ASDs; plus VTTI DAS
  - RSEs: 45 Savari StreetWAVE RSEs in NoVA; 10 at the Smart Road (VT)
  - Infrastructure Components: 10 Gigbit-ethernet backhaul
  - Back End Servers: VDOT network and transferred to servers off-site
  - Data Management Systems: VT petascale Scientific Data Warehouse
- Possible Applications:
  - Safety and Congestion Issues Related to Public Transportation, Pedestrians, and Bicyclists
  - Adaptive Lighting
  - Freeway Merge Management
  - Cooperative Intersection Control
  - Freeway Speed Harmonization
  - Freeway CACC Systems
  - Emergency V2V Communication
  - Eco-Speed Control Using V2I Communication
  - “Intelligent" Awareness System for Roadside Workers
  - Pavement Condition Measures and Utility Assessment
  - Adaptive Stop/Yield Signs



Saxton Laboratory – TFHRC *Mclean*

- Purpose
  - To focus on enhancing the state of the art of transportation operations research
- Asset
  - 2 Jeep Grand Cherokees
  - OBEs and RSEs
  - Fully instrumented intelligent Intersection with left turn and pedestrian signaling
- Applications:
  - Communications Network Simulation
  - Advanced Freeway Merge
  - Cooperative Adaptive Cruise Control
  - Advanced Signal Control
  - Applications for the Environment (AERIS)
  - Signal, Phase, and Timing (SPaT)
  - Vehicle Warnings
  - Emergency priority



Lessons Learned & Issues from Test Beds - Technical

- Consensus on design and freezing of ConOps for applications after fine-tuning early in the lifecycle
- Remote monitoring of roadside equipment is necessary
- DSRC is highly reliable
  - Location of antenna important
- Clock Synchronization Critical
  - Using absolute time for traffic control/priority
- Overlapping MAPs
  - When two RSE's have range that overlaps, the OBE must determine which is the current and active MAP
- Non-safety critical operations are deployable now
- Heavy vehicles generally seen as easier to deploy

Lessons Learned & Issues from Test Beds – Technical (Cont.)

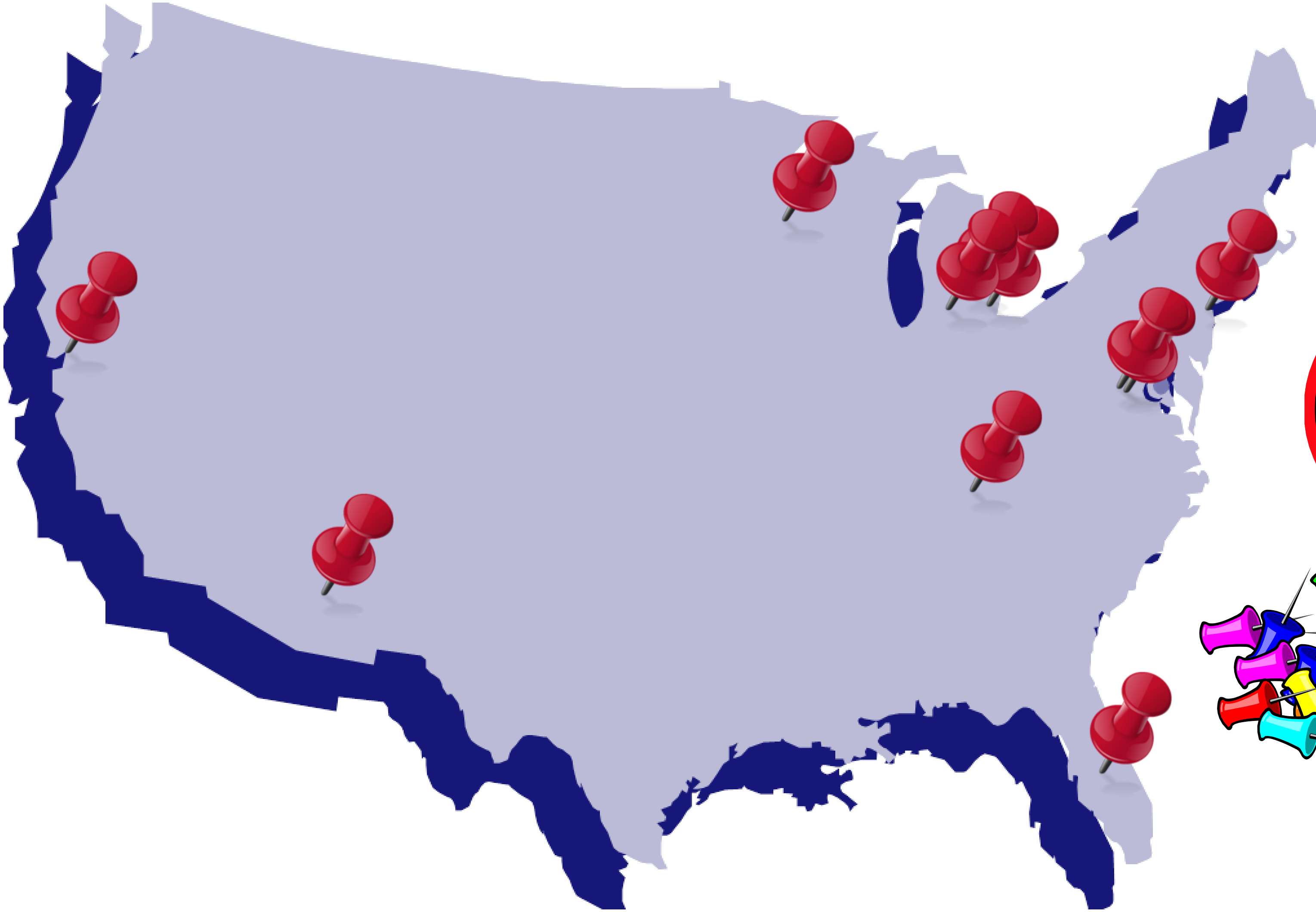
- Better change management and proper documentation of hardware and software is required
- Need management application for startup/shutdown of RSEs and the ability to log and retrieve data
- VISSIM Hardware-in-the-loop simulation environment to support development testing would be a useful tool
- Federal changes to standards and requirements drastically impact ability to deploy operational systems.
- Interpretation of standards still differs amongst system designers which adversely affects interoperability.
- Existing back office systems (GIS platform/mapping capabilities, system health and status, safety data feeds) require modification/enhancement to work in a connected vehicle environment
- Agreement on inter-system interfaces is necessary

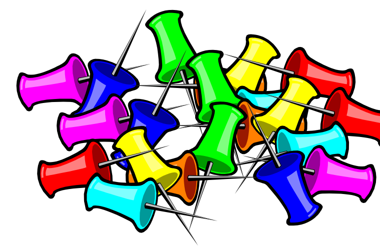
Lessons Learned – Policy / Institutional

- Business models are extremely important as we lead to deployment
- Choose a clear direction and clearly assign and define roles for all participants
- Effective communication is vital to success
- Develop rich set of applications to attract users
- Ensure optimal set of equipped vehicles
- Enhanced synergy between software development teams and also between system architects
- Effectively engage private partners

Concept for Creating Affiliated Connected Vehicle Test Beds

Moving Toward the Concept of Affiliated Test Beds





Create an Initial Organizational Structure

- Open to all
- Mutually beneficial – able to arrive at a consensus
- Does not restrain trade

- Considering an ad hoc organization to benefit this research area
  - Authorized under MAP-21, Sec 52012(g) COLLABORATIVE RESEARCH AND DEVELOPMENT
  - Operate under the terms of a Memo of Cooperation
  - Voluntary, identified contributions
  - Voluntary acceptance of results
  - Focused projects or tasks to be accomplished such as
    - RSE specification update
    - SPaT message definition and distribution
    - Accommodation of other communication media

Possible Benefits of Being a Member

- Having a structured forum to share information and discuss issues associated with building, operating and maintaining a test bed.
  - Webinars
  - Face-to-Face meetings (member driven agendas)
- Having a recognized standing as an “official” test bed
  - “Intel Inside” – type logo
- Tech transfer
  - Share lessons learned with other members
    - Implement those lessons learned where appropriate
  - Distributed work load (and requisite tech transfer) so that agencies and test beds can focus on projects relevant to their specific needs
  - Tech Transfer not limited to Affiliated Test Bed members – Information needs to flow out to all state and local agencies.

What a Common Platform Might Look Like

Initial steps:

- Use Common Third Generation RSEs (Safety Pilot)
  - RSEs must be easily upgradeable
- Use of the Security Credential Management System (SCMS) for security
- Coordinate on Data Issues
  - Share data with other users/parties
    - Provide data to the USDOT RDE
  - Standard data formats
- Share Installation, Operations and Maintenance guidance and tools
- Begin Refinements

Likely First Refinement Task Assignment

- Start with RSE Specification ver. 3.0
- Review key RSE capabilities, reasons for the migration from Generation 2.0 to Generation 3.0
- Review experience with certification testing and Model Deployment installation
- Edit specification up to ver. 3.1
  - Start a weekly series of 2 hour web conferences in mid October, 2012
  - Review background during first 3 sessions
  - Determine refinements or additions during the second 3 sessions
  - Conduct two edit and comment cycles
  - Publish final release

Next Possible Steps

- Obtain Feedback at Chicago Workshop
  - Elements of a Memo of Cooperation
  - Details of first task assignment
- Publish an Affiliated Connected Vehicle Test Bed Status Report
- Develop a Memo of Cooperation for an Affiliated Connected Vehicle Test Bed Group
- Determine Guidelines for Participation and Membership

Discussion Points

- Elements of a Memo of Cooperation
  - Benefits and responsibilities
  - Organizational structure and membership
- Details of first task assignment
  - Timeline