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)
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 and 1609 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
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 Gigabit-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
• 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