USDOT Connected Vehicle Activities
Vehicle to Infrastructure Workshop

FHWA 2015 V2I Deployment Guidance
Welcome

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  Director, Office of Transportation Management

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  Federal Highway Administration
  Connected Vehicle Program Manager
The Path To Deployment

Defined Safety (V2I), Mobility (V2V & V2I), AERIS and Weather Apps

Pilots/Early Deployments

Application Development

NHTSA Decision Light Vehicles

NHTSA Decision Heavy Vehicles

FHWA Deployment Guidelines

Image Source: USDOT
FHWA’s Plans and Objectives
Guidance on Infrastructure Implementation

• Guidance - not regulation
• What and how to implement infrastructure and supporting systems
  – Guidelines
  – Best Practices
  – Toolkit
• Supporting high-priority applications
  – V2I safety applications (crash warnings at traffic signals, etc.)
  – Dynamic mobility
  – Road-weather
  – Environmental
• Based on DOT research and AASHTO analysis of infrastructure needs and deployment approaches
Structure of the meeting

- Presentation on Guidance Topics
- Presentation on a Deployment Coalition
- Parallel Breakout Sessions for Discussion:
  - Breakout #1: Draft Guidance-Does it meet needs
  - Breakout #2: Deployment Coalition-How can it work?
- Updates:
  - Footprint Analysis
  - Communications Models
- How do you stay engaged?
Overview of Guidance

• Efforts and Rationale for Guidance: Implementers’
  1. Needs
     • Deployment is coming
     • How do you prepare?
     • Existing guidance on ITS is insufficient for CV
  2. FHWA Analysis: USDOT has results to share
  3. Note: This guidance is not coupled with the NHTSA proposed rulemaking on V2V Communications

• Walk Through the Sections of the Draft Guidance
• Product/Tools Under Development
• Next Steps
Deployment is Coming!

• V2V auto industry deployments moving forward
• NHTSA announcement about regulatory proposal that would require V2V in new vehicles
• V2I prototype deployment testing nearing completion
• Ongoing supporting research such as AASHTO Footprint Analysis and Pooled Fund Studies
How Do You Prepare?

• Infrastructure will be deployed and operated by State and local DOT’s
  – Not a “shall” – Use of V2I is not mandated
  – But, you need to know about planning, funding, deployment, etc.

• What investments could be made to leverage a nationwide fleet of equipped vehicles in support of state and local policy and operational objectives?
US DOT has Results to Share

• Benefits of V2V
• V2I Deployments and Evaluations
• Footprint Analysis Developed
• Pooled Fund Studies
• Policy Analysis
Existing guidance on ITS is insufficient for CV

• CV Resembles ITS Deployments But Is Different In Many Ways
• Guidance Defines the V2I Components of a CV Environment
• Other V2I Deployment Considerations are described
CV Resembles ITS Deployments But Is Different In Many Ways

• Technologies go beyond connected to be cooperative, allowing data and information to be fused in real-time
• CV technology requires a level of national interoperability and functionality not found in today’s ITS deployments
• Security and Privacy needs for CV are greater than for today’s ITS
• Basic CV technologies are evolving at a dynamic pace
V2I Components of a CV Environment

• Applications: Safety, Mobility, Environment
• Roadside Units (RSUs)
• Signal Phasing and Timing (SPaT) enabled traffic signal controllers
• Data links between V2I components and a traffic management center (TMC) or other back office
• Any sensors or relays that link to or serve those components
V2I Safety Applications

Curve Speed Warning

Red Light Violation Warning

Smart Roadside

Stop Sign Gap Assist

Image Source: USDOT
V2I Mobility Applications

MMITSS:
Multimodal Intelligent Traffic Signal System  
Ben McKeever

INFLO:
Intelligent Network Flow Optimization  
Mohammed Yousuf

R.E.S.C.U.M.E.:
Response, Emergency Staging and Communications, Uniform Management, and Evacuation  
Linda Dodge

Enable ATIS:
Enable Advanced Traveler Information Systems  
Bob Rupert

IDTO:
Intelligent Dynamic Transit Operations  
Ron Boenau

FRATIS:
Freight Advanced Traveler Information Systems  
Randy Butler

Other Programs:  
ICM
ATDM
Weather

Image Source: USDOT
DSRC Roadside Unit

• Specification 3.0 (prototype unit) is available
  – Used for Safety Pilot

• Specification 4.0 underway (pre-production unit) based on lessons learned – due in Summer 2014
  – Purpose of Update: to improve performance reliability, strengthen security protocols and promote common configurations and user interfaces across different vendors
  – Key changes
Signal Phase and Timing Application

• SPaT tested in Safety Pilot:
  – 6 intersections
  – Transit application
  – SPaT data
• Deploying in Affiliated Test Beds to support testing of Multi-Modal Intelligent Traffic Signal System (MMITSS) applications
• ConOps, Interface Control documents, and System Requirements available now – ask Deborah.Curtis@dot.gov
Other V2I Deployment Considerations

• V2I deployment sites can serve more than one application, strategy, or impact area.

• V2I deployments and CV technology should consider pedestrians, bicycles, and other possible non-motorized users that may be within highways rights-of-way.

• Autonomous vehicles are not addressed in this guidance at this time.
Walking Through The Sections of the FHWA Draft Guidance

• Jonathan Walker will discuss each section of the guidance as well as the supporting tools and products that are under development.

• Our breakout sessions this afternoon are dedicated to gathering your feedback.

• We welcome feedback beyond the scope of this meeting—
  www.its.dot.gov/meetings/V2I_Feedback.htm
Topics of Discussion

• Document Divided in Three (3) Sections
• V2I Technology is NOT Mandatory
• What is the Big Picture?
• Purpose of the Products/Tools Section
• 9 - Products/Tools
• Purpose of Guidance Section
• The Guidance/Subheadings
• Questions During Breakout Session
The document is divided into the following sections:

1. Guidance Section
2. Products/Tools Section
3. Appendices A & B
   a) Appendix A – This subsection has quick reference web links to fundamental principles of connected vehicle technology (e.g., several videos, slide presentations, and information modules).
   b) Appendix B – This subsection contains terms, descriptions, symbols, and abbreviations.
V2I Technology is NOT Mandatory

• Deployment of V2I technologies is NOT mandated and is NOT coupled with the National Highway Traffic Safety Administration’s (NHTSA) advance notice of proposed rulemaking (ANPRM) for Vehicle-to-Vehicle (V2V) communications.
• The NHTSA rulemaking will NOT require State and local DOTs to deploy V2I technology.
• However, the guidance and products/tools are useful resources to help those considering V2I deployment and to leverage developments via V2V communications.

What is the Big Picture?

It is important for the State and local agencies to understand the following:

a) What the decision could mean to them?
b) What they need to know to prepare for an emerging connected vehicle environment?
c) What investments could be made to leverage a nationwide fleet of equipped vehicles in support of State and local policies and/or operational objectives?
Purpose of the Products/Tools Section

• The products/tools section is intended to support the guidance section with a number of best practices guides, cost analysis tools, and technology documents with an emphasis on V2I interoperability and effective planning/procurement/operations of the system.
1. **System Engineering Process for Vehicle to Infrastructure**

This document will augment the Systems Engineering (SE) for Intelligent Transportation Systems manual and discuss the evaluation, selection, and implementation of V2I technology.

2. **V2I Benefit Cost Analysis Tool**

This tool will assist with an investment strategy that dedicates funding to the capital and ongoing operational costs for V2I technology.

References:
1) The AASHTO National Connected Vehicle Field Infrastructure Footprint Analysis has some preliminary infrastructure deployment and operations cost estimates.

2) Currently, there is a cost database, available as a national resource, for ITS deployment cost estimates. The database can be used to develop project cost estimates during the planning or preliminary design phase, and for policy studies as well as cost-benefit analyses. Both capital and operating & maintenance (O&M) costs are provided where possible. (see [http://www.itscosts.its.dot.gov/](http://www.itscosts.its.dot.gov/))
3. **V2I Planning Guide**

This guide will provide planning staff with an increased awareness of the benefits, long range planning, and opportunities for deploying V2I technology by State Department of Transportations (DOTs) and Metropolitan Planning Organizations (MPOs).

Reference:

1) Currently, Regional ITS Architecture Guidance is a guide for transportation professionals who are involved in the development, use, or maintenance of regional ITS architectures. The document describes a process for creating a regional ITS architecture with supporting examples of each architecture product.
4. **Guide to V2I Cyber-Security**

This guide will provide the following:

1. An analysis of security and trust systems as it relates to V2I hardware/software, backhaul, and other avenues;
2. An analysis of additional risks from extensibility (i.e., a system design principle where the implementation takes future growth into consideration);
3. An analysis of the potential impacts on the existing transportation system network along with various cost models for operations and maintenance.
5. **Guide to Licensing DSRC Roadside Units**

This guide will assist in the navigation process of licensing DSRC Roadside Units for transportation owner/operator whether they are in the position to develop/manage an outsourcing contract or understand/deal with private sector commercial deployments.

NOTE: The DSRC service involves vehicle-to-vehicle and vehicle-to-infrastructure communication to protect and enhance the safety of the traveling public. Also, the band is also eligible for use by non-public safety entities and for private commercial operations. However, the safety applications always have primary status over non-safety applications. Roadside infrastructure is licensed to both public safety and non-public safety entities pursuant to 47 CFR Part 90, while on-board units are licensed by rule (i.e., no individual license is required) under 47 CFR Part 95.
6. Guide to V2I Communication Technology Selection

This guide will describe various communication options when deploying V2I technology and why certain options may be more appropriate for some applications than others.
7. **V2I Message Lexicon**

This document will list the allowable standard messages and formats for transmitted information for In-Vehicle use. Although the Original Equipment Manufacturers (OEMs) will control the message/warning type provided to the end-user, the form/type of information from the RSU must be standardized.

Reference: Also, developers should visit the Connected Vehicle Reference Implementation Architecture (CVRIA) because it will identify the key interfaces of a connected vehicle environment. Likewise, the CVRIA will form the basis for integrating the connected vehicle environment into the National ITS Architecture and provide the interface information needed for standardization planning. (see [http://www.standards.its.dot.gov/DevelopmentActivities/CVReference](http://www.standards.its.dot.gov/DevelopmentActivities/CVReference))
8. Guide to Initial Deployments
This guide will support transportation system owner/operators who are on a path from no V2I deployment to a build out of the various scenarios. This would include prioritization methodology, staged deployment applications, co-location with existing ITS infrastructure, legacy equipment, and utility based on V2V market penetration, among other guidelines.
9. Warrants for Deployment
A set of criteria which can be used to define the relative need for and appropriateness of a particular V2I application.
Purpose of the Guidance Section

• This guidance is intended to assist Federal Highway Administration (FHWA) staff and transportation system owner/operators with deploying Vehicle to Infrastructure (V2I) technology.

• The guidance section is focused on the Federal-aid Highway program requirements as it relates to V2I deployments.

• Also, the guidance section is centered on ensuring interoperability with several standards as well as any standards that will be utilized in Vehicle to Vehicle (V2V) {e.g., DSRC}
### Guidance Subheadings

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Background: The Connected Vehicle Environment</th>
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<tbody>
<tr>
<td>V2I Deployment Policy Statement</td>
<td>Planning</td>
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<tr>
<td>Federal-aid Eligibility of V2I Equipment and Operations</td>
<td>V2I Deployments and NEPA</td>
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<td>Interoperability</td>
<td>Evaluation</td>
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<td>ITS Equipment Capability and Compatibility</td>
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# Guidance Subheadings

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<thead>
<tr>
<th>Hardware/Software Device Certification</th>
<th>Reliability</th>
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<td>Allowance of Private Sector Use</td>
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<td>Design considerations for facilities</td>
<td>Use of existing structures and infrastructure</td>
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<td>Use on public sector fleets (including incident responder vehicles)</td>
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<td>Legacy systems/devices</td>
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## Guidance Subheadings

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<th>Communication Technology</th>
<th>Dedicated Short Range Communications (DSRC) Service Licensing</th>
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<td>Data Connection and Latency</td>
<td>Connected Vehicle Privacy Principles</td>
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<td>Connected Vehicle Security</td>
<td>Data Access</td>
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<tr>
<td>Manual on Uniform Traffic Control Devices</td>
<td>Using Public-Private Partnerships (P3s)</td>
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<tr>
<td>Conclusion</td>
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Seeking Your Input

Questions For Breakout Session:
1. Out of the 9-Products/Tools, what is missing?
2. What details should be included in the various Products/Tools?

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Questions For Breakout Session:
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2. What subheading is missing

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2. What subheading is missing?

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<td>18. Legacy systems/devices</td>
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Questions For Breakout Session:

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2. What subheading is missing?

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Next Steps

• Prepare and Publish Proceedings From This Meeting

• Additional Input Welcome
  www.its.dot.gov/meetings/V2I_feedback.htm

• Expect to Issue Final Guidance in 2015
Contact Us

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Deployment Coalition

- Being formed by: AASHTO, ITE, ITS America
- Objective is similar to the 511 Coalition and the Center for Excellence in Operations
- Introduction:
  - Gummada Murthy, AASHTO
  - Doug Noble, ITE
  - Scott Belcher, ITS America
Vehicle to Infrastructure (V2I) Stakeholder Workshop
September 12, 2014
Connected Vehicle (CV) Program
Current and Ongoing Efforts

- **AASHTO CV Deployment Efforts**
  - CV Deployment Coalition
  - CV Executive Leadership Team (ELT)

- **ITE CV Efforts**
  - Management and Operations/ITS Council
    Ad hoc Committee on Connected / Autonomous Vehicle Outreach
  - Connected Vehicle Task Force
  - ITS Standards Program

- **ITSA CV Efforts**
  - CV Technical Working Group
  - ITS Management Council
AASHTO CV Deployment Efforts
AASHTO CV Deployment Coalition

- **Technical** group consisting of states, counties, associations interested in advancing the connected vehicle program in their own locations and nationally known as the “AASHTO Deployment Coalition”

- **Leadership** group of states, counties, auto manufactures, USDOT and associations interested in advancing the CV program nationally
  - Known as the “Executive Leadership Team” or “ELT”
Who are they?

• Palm Beach County, Florida; Oakland County, Michigan; Maricopa County, AZ; Metropolitan Transportation Commission Bay Area, CA
• Transport Canada
• FHWA

What do they Do?

• Stakeholder meetings ~ 6 per year
  ▪ Security, Data Management
• Webinars, discussions and updates
• Cooperative Transportation System Pooled Funds
• Conferences, workshops
• Members of ITE and ITSA CV Task Force
• Oversee projects such as National Infrastructure Footprint Analysis
Deployment Coalition Activities

• **2008 States Partnered with FHWA, ITS-JPO, others**
  – Held a facilitated session with FHWA and states discussing most effective ways to work together

• **2009 “AASHTO IntelliDrive℠ Strategic Plan**
  – Leadership, Partnerships, Communications, Stable environment, Research, Deployment
  – Much of this work is still valid today

• **2011 AASHTO Connected Vehicle Deployment Analysis - themes**
  – setting the direction, showing success, Jump starting deployments, expanding the field, taking solutions to market, growing to meet demand
  – Strategies 2011 – 2020
  – Implementation of a national DSRC Footprint

• **AASHTO National Infrastructure Footprint Analysis**

• **Positive reputation and a sustaining institution for technical engagement**
AASHTO CV Executive Leadership Team

**Auto Industry**
- GM, Ford, Chrysler
- Toyota, Honda, Nissan
- Hyundai, Audi, KIA
- Mercedes, BMW, VW
- Global Auto Makers Alliance
- VII Consortium
- Transport Canada

**USDOT**
- NHTSA, JPO, FHWA

**AASHTO States**
- MI, UT, CA, AZ, NY
- VA, WS, MN, TX, FL, PA, CO, MTC, AASHTO
  - President

**Associations**
- NACO, ITE, ITSA, IBTTA, AASHTO

**ELT Activities...**
- Two or more meetings every year
- Discuss issues such as:
  - Security, privacy, education, infrastructure, aftermarket devices, implementation, support resolutions on joint development, receive briefings on the program
- Learn about the internal and external issues facing each group and ways we might work together
AASHTO CV ELT Activities Contd.

- Privacy Guidelines
- Auto industry site visits
- Resolution supporting research to implementation
  - **PASSED AND ADOPTED** by the VII Executive Leadership Team on May 15th, 2008
- Aftermarket device discussions
- DSRC spectrum discussions and leadership
- Conversations and understanding of the different business environments
- Security and Infrastructure discussions
- Positive reputation and a sustaining institution for engagement
Where are we today?

• NHTSA decision clarified and moving toward clear statement on safety value

• Advanced state of development & emerging timelines for implementation:
  – AASHTO Footprint being completed
  – FHWA Implementation Guidance 2015
  – JPO pilot Sites in 2015
  – Auto industry
    ▶ Substantial technology available on vehicles
    ▶ connected consumers

• Penn DOT - strategic directions for agency fall 2014

• Florida - automated vehicle workshop fall 2014

• ARUP - impacts of automated vehicle on design 2014
ITE
CV Deployment Efforts

Douglas E. Noble, P.E., PTOE
Senior Director, Management and Operations
ITE Engagement

- Connected Vehicle Task Force
- Management and Operations/ITS Council Ad hoc Committee on Connected Vehicle/Automated Vehicle Outreach
- ITS Standards Program
ITE Engagement

Active participation in:

• V2I Deployment Coalition
• AASHTO Executive Leadership Team
• AASHTO Connected Vehicle Roadmap
• TRB Cyber Security Subcommittee
Connected Vehicle Task Force

• Role: provides comment, review and input to major areas of the connected vehicle program. Updates to keep community up to date
  ▪ NHTSA decision on V2V
  ▪ FHWA 2015 V2I deployment guidance development
  ▪ Updates on DSRC, V2V and AASHTO Footprint analysis
• Representation:
  ▪ Public and Private sectors, co-chair from each
• Relationships
  ▪ AASHTO, ITS America, NACE, TRB, SAE, IEEE
• Supported thru ITS-JPO
Connected Vehicle Task Force

• 2014 Focus Areas
  - Cyber and infrastructure security
  - Applications for C.V. common interface environment
  - Roadside unit specifications and standards
ITE CV/AV Outreach

The Management and Operations/ITS Council Ad hoc Committee on Connected Vehicle/ Automated Vehicle Outreach developed a presentation to:

• Increase awareness
• Lead in to discussion panels at ITE District and Section Meetings
• Outreach to wider transportation and decision-maker community
ITE CV/AV Outreach

ITE hosted conference sessions:

• Connected and Automated Vehicles – Urban Myths, Social Truths and Controversy Held (August 2014)
• Plenary address by Andrew Chatham, Principal Software Engineer, Google Self-Driving Cars (March 2014)
• Connected Vehicle and Infrastructure Cybersecurity session (March 2014)
ITS Standards Program Elements

• Development
  ▪ Advanced Traffic Controller
  ▪ ITS Cabinet
  ▪ ATC Application Programming Interface
  ▪ Strategic 2-Year Planning:
    • Connected Vehicle Roadside Equipment
    • Network Security
  ▪ NTCIP 1202 v3
  ▪ NTCIP 1204 v4.03
  ▪ ATC 5401
ITSA
CV Deployment Coalition
Efforts
ITS America Role

• In the Field of Transportation
  ▪ Serve the transportation and technology ecosystem in providing a forum to assist in deploying V2I systems

• In collaboration with FHWA, AASHTO, ITE
  ▪ Engage its stakeholders, coordinate its work, and bring thought leadership and technical competencies to bear to support the initiative
ITS America Initiatives

• Leadership circle
  ▪ Dedicated group focused on V2I
• Standards: ISO TC 204 includes several working groups addressing connectivity
• Convening role for both U.S. DOT and ITS America members on connected vehicles
ITS America Initiatives

• Support for U.S. DOT on connected vehicle issues
  ▪ Technology scan projects (e.g., connectivity, cyber security, machine to machine)
  ▪ DSRC
    – Licensee along with AASHTO
    – Coalition to insure spectrum sharing is done properly
    – Study on the impact of other communications media
    – Licensing guide
    – Market study
ITS America Stakeholders: Initial Observations

• ITS America’s stakeholders are engaged in several ways:
  ▪ State chapters provide access to regional and local gov’ts where much of DSRC deployment would occur
  ▪ ICT community who will likely develop the communications and security backbone
  ▪ Device manufacturers who are developing the in vehicle and road side equipment
  ▪ OEM members who are developing the V2V applications and some V2I applications
ITS America Stakeholders: Initial Observations

- Providing link to academia and their ongoing research
  - University of Michigan Trans. Research Inst.
  - Texas Transportation Institute
  - Cal Berkeley PATH
  - Virginia Tech Transportation Institute
  - Carnegie Mellon Traffic 21
  - Others
Emerging V2I Deployment Coalition Framework
USDOT FHWA and ITS JPO Outreach Efforts to Establish V2I Coalition

- December 4, 2013, FHWA and ITS-JPO facilitated a discussion on establishing a V2I Coalition with ITE, ITSA, AASHTO, Academia, and Industry stakeholders
- In follow up, a wide range of stakeholder meetings were held in conjunction with 2014 TRB Annual Meeting
- Additional follow up discussions with AASHTO, ITE and ITSA were held to identify base level V2I Deployment Coalition (V2I-DC) with following as guidelines:
  - Collaborate with FHWA on 2015 connected vehicle deployment guidance
  - Promote collaboration among USDOT, owner/operator associations, AASTHO, and trade & professional associations
  - Support the development of second phase Connected Vehicle Footprint Analysis
  - The Vehicle-to-Infrastructure Deployment Coalition Chair and Connected Vehicle Executive Leadership Team Chair to provide executive input to other Federal, State, and local transportation groups associated with V2I technology deployment.
Vehicle-to-Infrastructure Deployment Coalition (V2I-DC)

V2I-DC Executive Committee
Core Stakeholders

V2I-DC Chair
(Open Discussion – possible chair from AASHTO subcommittee or core group membership)

Vehicle-to-Infrastructure Deployment Coalition will be Supported by the Technical Teams drawn from the Following Groups

- **USDOT**
  - FHWA, FTA, ITS - JPO, NHTSA, ETC.

- **Transportation System Owners/Operators**
  - State and local DOTs, Transit system agencies, Toll facility organizations etc.

- **Owner/Operator Associations**
  - AASHTO, ITE, ITSA, TRB, APTA, IBTTA, American Association of Port Authorities

- **Trade Associations**
  - Cellular Telecommunications Industry Association (CTIA), CVTA, OmniAir, Intelligent Car Coalition etc.

- **Other**
  - Cooperative Transportation Systems Pooled Fund Study, HOV HOT PFS etc.

**Connected Vehicle Deployment Coalition key functions**

1. Collaborate with FHWA on 2015 connected vehicle deployment guidance
2. Promote collaboration among USDOT, owner/operator associations, AASTHO, and trade & professional associations
3. Support the development of second phase Connected Vehicle Footprint Analysis
4. The Vehicle-to-Infrastructure Deployment Coalition Chair and Connected Vehicle Executive Leadership Team Chair to provide executive input to other Federal, State, and local transportation groups associated with V2I technology deployment.
Vehicle-to-Infrastructure Deployment Coalition (V2I-DC) Proposed Objectives

• Support implementation of FHWA’s Vehicle-to-Infrastructure (V2I) Guidance
• Provide leadership on Connected Vehicle (CV) Deployment Guidance
• Establish Connected Vehicle (CV) and Automated Vehicle (AV) Deployment Strategies
• Lead and Provide Support on Continued Technical Research to Support CV and AV Deployment
• Support Standards Development
Vehicle-to-Infrastructure Deployment Coalition (V2I-DC) Key Tasks

• V2I Strategies
• V2I Readiness
• V2I Research
• V2I Standards and Deployment support
• V2I Outreach
We need input from Stakeholders

- The proposed V2I Coalition Framework is preliminary and open for additional refinements
- The stakeholders input is key to making this framework meet expectations and function successfully.
- Input can be provided at:

  www.its.dot.gov/meetings/V2I_feedback.htm
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Break Out Sessions

• FHWA V2I Guidance Discussion – 310 A
• Deployment Coalition Discussion – 310 B
AASHTO National Connected Vehicle Field Infrastructure Footprint Analysis

Implementation Workshop
September 12th, 2014
The Challenge!

- **Infrastructure Requirements**
  - DSRC Primarily + preliminary look at Cellular
  - Scale of effort

- **How will infrastructure be deployed?**
  - Funding
  - Schedules
  - Governments role

- **Long term sustainability**
  - 10 year design 20 year life cycle
  - DSRC 5 year replacement cycles
Foundations to Deployment

• Value to transportation agencies
  ▪ Applications in safety & mobility

• Value to our society
  ▪ Support National Transportation Vision

• Keeping pace with global innovations
  ▪ Connected vehicles
  ▪ Automated vehicles
Footprint Development Process

- Develop a **Tech Memo** to initiate engagement with State and local agencies (Task 3)
- Assess the range of **applications** and their **enabling requirements** such as data & communication needs (Task 4)
- Develop **deployment concepts** (Task 5)
- Develop **deployment scenarios**, a preliminary **national footprint**, and **cost estimates** (Task 6)
A 2040 Vision for V2I

- 80% of traffic signals are DSRC enabled
- 50% ITS field sites are DSRC enabled
- 90% of the nations roads have real-time localized information
- Multi-model regionalized active traffic management systems operational nationally
Building up to National Deployment

• The CV environment emerges over time from the mix of applications deployed in pursuit of specific operational objectives

• Deployment is likely to follow the same pattern seen in other infrastructure and ITS innovations
DSRC Cost Estimation

• Deployment Costs
  ▪ DSRC RSUs ~ $18k
  ▪ Backhaul ~ $22k
    – ($4k - $48k)
  ▪ Signal Controller Replacement ~ $3k
  ▪ Total Deployment ~ $43k ($25k - $79k)

• Other Costs
  ▪ O&M ~ $3k/year
    ✓ ($2k - $3k)
  ▪ Backend Systems ~ ?
Cellular Cost Estimates

- Cellular Modems Government Prices
  - Government quote 2014 $35/month/unlimited data
- LTE Wi-Fi Hotspot Personal
  - $80/10Gb + $10/1Gb extra ~ $550/month at times
- OEM’s Connected Consumer
  - Can TMC connect with OEM ~ Connected Consumer?
- We don’t really understand what the model looks like?
Next Phase (overview)

- Process & tool for prioritizing **application** deployments
- Process & tool for phasing V2I **infrastructure** deployments
- **Life cycle costs** for V2I application deployments
- Propose **phasing scenarios**
- **Plan** to create **decision tool** for agencies
Next phase (Tasks)

- **Applications**
  - Bundles for 1st five years
  - Value proposition
  - OEM consensus/non-consensus
  - Prototype priority tool & user guide

- **Infrastructure**
  - Based on case studies
  - Project level & program level
  - Prototype phasing tool & user guide
Next Phase (Tasks)

• Life Cycle Costs
  ▪ First 5 years
  ▪ Plan, design, deploy, operate, replacement

• Deployment Scenarios
  ▪ Urban, rural, corridor, smart roadside, DOT operations?

• Future Operational Agency Tool
  ▪ Estimate costs, time line, testing procedures for operational tool
Connected Vehicle Pooled Fund

- Members:
  - VA, CA, FL, MI, MN, NJ, NY, PA, TX, UT, WA, WI, Maricopa County and FHWA

- Sample Projects:
  - Connected Vehicle Traffic Signal Control Algorithm
  - 5.9GHz DSRC Vehicle Based Road and Weather Condition Application
  - Traffic Management Centers in a Connected Vehicle Environment
Where are the States Going

- 20 state CEO’s to ITSWC
  - 11th AASHTO International Day
  - Google Car - meeting
  - NCHRP Workshop for strategic direction
- State Test Sites:
  - Michigan, Virginia, Arizona, California, New York, more emerging
- AASHTO Committees high interest!
Website for Documents

- Footprint Documents AASHTO
  http://stsmo.transportation.org/Pages/Connected-Vehicles.aspx.
- JPO web site for Final Report (after 6/30)
  http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm
- JWright@aashto.org
- Ben.McKeever@dot.gov
- Kyle.Garrett@synesis-partners.com
Use of Other Communications
• Selection of V2I communications to be based on a systems engineering analysis and consistent with application interoperability across the Nation.

• Use must comply with established requirements for non-interference.
  – 47 C.F.R. §15.5 is an existing FCC regulation to ensure that unlicensed devices do not cause interference with licensed users and require operators of unlicensed devices to immediately correct the problem or cease operation if interference occurs.

• Although DSRC is accepted technology for cash-avoidance applications, there may be other communications available or better suited for V2I mobility applications.
Opportunities

Types of Media
• Cellular
• Wi-Fi
• Satellite
• Others

Examples of Applications
• Advanced Traveler Information Systems
• Dynamic Ridesharing
• Eco-Lanes Management
• Smart Parking
• Weather Responsive Traffic Information
A Variety of Communication Media, Data Needs

**Resources:** wired and wireless, the Internet

- 3,000 miles, 3,000 meters, 300 meters, 3 meters.

**Requirements:** Two types of data distribution:

- To all, To one.
Supporting Research

• **Footprint Analysis** illustrates use of different media

• **Southeast Michigan** project:
  – Advancing new data protocols to allow seamless exchange over any media

• **DMA Prototype Sites & CV Pilots** using a range of media

• **Report: Communications Data Delivery System (CDDS)** illustrates costs and issues
Decision Factors

• Important factors when considering alternatives to DSRC are:
  – Capability of V2V On-board Units (OBUs)
  – National interoperability
  – Certified application support
  – Technology’s attributes to meet the needs of the application/installation:
    • For instance, reliability of existing media, particularly under congested conditions

• Additional Factors:
  – Level of security needed and whether existing media options require subscriptions
  – Privacy
Additional Questions

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