U.S. Department of Transportation

Intelligent Transportation Systems (ITS)
Joint Program Office (JPO)

ITS Architecture and Standards Evolution to Integrate Automation

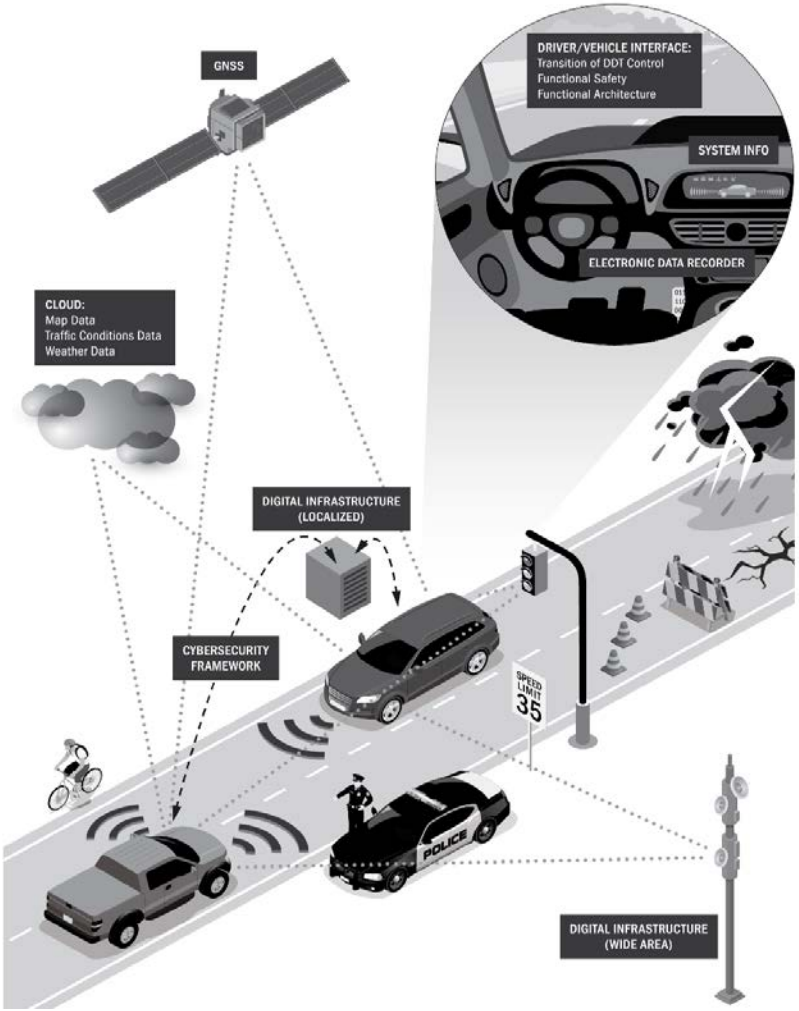
Steve Sill, ITS Architecture and Standards Program Manager
Tom Lusco, Senior Systems Engineer, Iteris
John Harding, Connected/Automated Vehicle and Emerging Technologies Team Lead

July, 2018

Agenda

- Overview: Interoperability in the automation environment
  - Discussion : How are IOOs handling interoperability today?
- Interoperability tools: ITS architecture and standards
  - Discussion: What do users need from ITS architecture and standards?
- Challenges with integrating automation into the system
  - Discussion: What challenges to you see?
- How to engage the entire stakeholder community efficiently?
  - Discussion: What else should we be doing to engage stakeholders?

An Automated Vehicle Landscape



Cooperative, Interoperable Integration?

- Automated systems can – and often do – operate without any communication or coordination with the transportation system Infrastructure Owner - Operator (IOO)
  - Similar to other mobile participants in the system today
  - Is this optimal?
- Increased communication and cooperation can aid both safety and mobility
- Interoperable integration between infrastructure and mobile participants in the transportation system requires agreement on architecture and key standards … and many other things.

Interoperability in the Automation Context

- The ability of two or more systems or components to exchange information and use the information that has been exchanged
  - IEEE Std. 610.12-1990

- For automated vehicles to successfully integrate into the transportation system, interoperability with the ITS Infrastructure is (arguably) not optional.

- In the context of automated vehicles, interoperability might be defined as using a common set of interfaces to interact with ITS infrastructure across jurisdictional boundaries across the US (and preferably North America)
  - Are multiple approaches supportable? When?

Balancing Interoperability with Innovation

- Introducing new capabilities while supporting existing systems can be challenging – how to assure benefits for all users?
- Life-cycle mismatch:
  - ITS infrastructure may be expected to be in place for decades
  - Light vehicles in service 1-2 decades, heavy vehicles longer
  - Devices can be obsolete in only a few years.
- How/when/whether to break interoperability?
  - Better to have a plan…
  - Transition periods?
  - Hardware/firmware/software solutions?
  - Multiple approaches in service indefinitely?
    - How to support obsolete systems?
- Ownership mismatch – multiple parties in control:
  - IOOs and vehicle operators each control only parts of the system
  - Both may be dependent on communications service providers

Discussion

- What benefits from automation with connectivity do you expect? Want? Need?
- What might US DOT's preferred role be?
- How do IOOs handle interoperability today?
  - How important is interoperability?
- Are IOOs using systems engineering processes when building out ITS infrastructure systems?
  - Life cycle planning?
- Vehicle owner/operator/manufacturer perspective?

ITS Architecture & Standards Programs

- Provides tools to help IOOs deploy ITS infrastructures and support interoperable interfaces with mobile participants in the transportation system and other infrastructures.
  - **Architecture** provides a framework to guide planning and interoperable deployment of ITS and identifies interfaces for standardization.
  - **Standards** define interfaces within architectures to enable required interoperability and support efficient implementation.
  - International Cooperation seeks to leverage global resources and expertise to (1) maximize commonality of ITS implementations, (2) share labor resources and (3) access best-available expertise in order to facilitate ITS implementation and efficient markets.

What Can ITS JPO Offer?

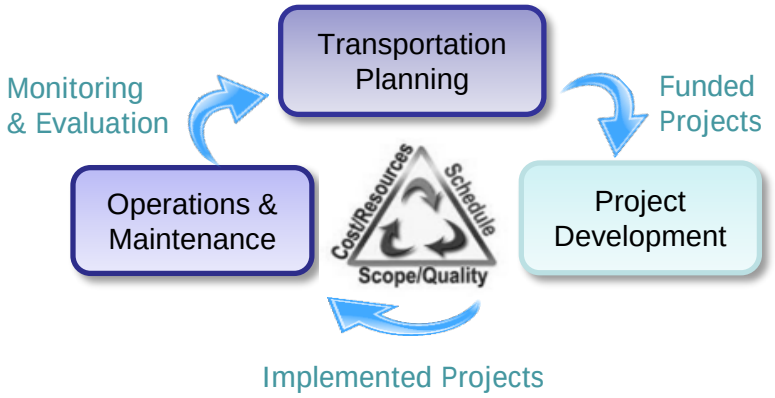
- **Cooperative relationships across Departmental, State, local and industry stakeholders**

- **Access to Standards Development Organizations (SDOs)**
  - Contractual and other relationships with ITE, SAE, IEEE, AASHTO, NEMA to provide financial support to expedite stakeholder consensus standards development
  - Relationships with ETSI, ISO and CEN to facilitate internationally-cooperative standards development, harmonization

- **Federal and contracted access to subject matter experts**
  - ITS Reference Architecture development and deployment support
  - On-Demand training available via USDOT Professional Capacity Building Program. https://www.pcb.its.dot.gov/stds_training.aspx

ITS Architecture Reference: ARC-IT

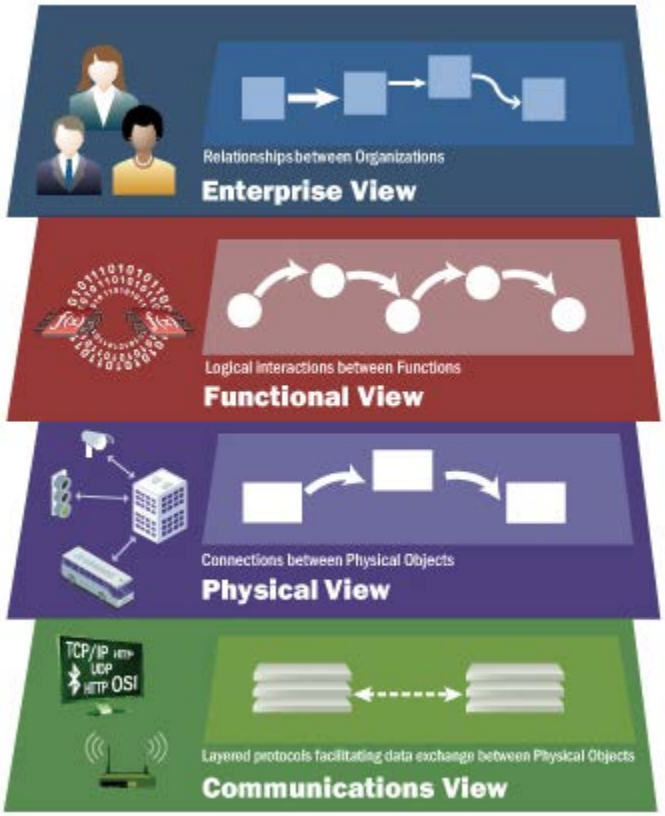
- Architecture Reference for Cooperative and Intelligent Transportation ("ARC-IT", www.arc-it.org) establishes a common language and framework to assist investment decisions**:**
  - **System-wide Planning** • allows investment comparisons; reduces redundancy of systems and costs
  - **Project Development: Planning/Design/Operations/ Maintenance** • Streamlines the lifecycle processes, aiding schedule, and scope
  - **Integration** • applies an interdisciplinary approach and means to enable the realization of successful systems, reducing costs and increasing quality



ARC-IT Views and Toolsets

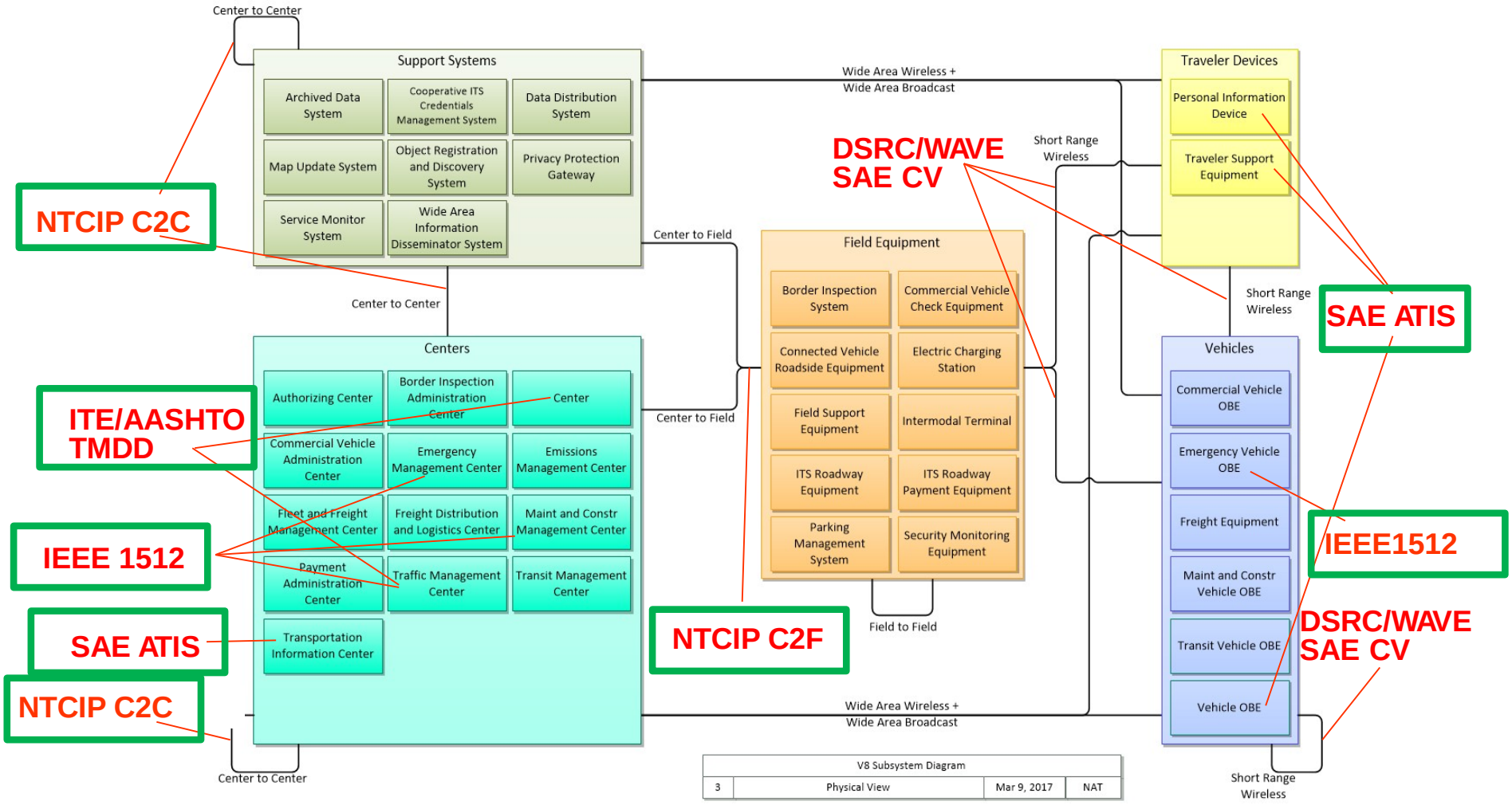
- **ARC-IT structure is defined around four views**
  - Enterprises to carry out services
  - Functions to implement services
  - Physical objects to implement that functionality
  - Communications protocols required for implementation

- **Multiple views address different stakeholders**
  - Business relationships and user expectations
  - Performance measures, user services and system goals
  - Functionality, security, interface characteristics
  - Physical configurations



- **ARC-IT software tools**
  - Regional Architecture Development for Intelligent Transportation (RAD-IT): Turbo Architecture updated with modern interface, ARC-IT database
  - Systems Engineering Tool for Intelligent Transportation (SET-IT): Project architecture functionality tailored to implementation and project specification

How the ITS System Fits Together …



Potential Challenges…

- Diversity of automation technologies and capabilities likely to be great … how to accommodate all users … automated or not? For example:
- How to provide a speed limit?
  - Assume automation can read the sign? Provide via broadcast also?
    - Then how to synchronize?
    - Can broadcast variable speed limits … then how to assure all vehicle receive the information?
    - More than one technology?
- Manage Minimal Risk Condition (MRC) fallback without disrupting mobility?
  - Might human drivers handle this better than some automated systems?
  - Additional guidance in certain areas?
    - "Avoid stopping on bridge"?
    - "Stop only on the left in this segment"?
- Advance notice of road conditions?
  - "Snow covered road beyond MP ##" – disseminate how?
    - If vehicle automation cannot accommodate, vehicle can refuse trip unless driver agrees to manual control? Preferable to interrupting trip and vehicle stopping …

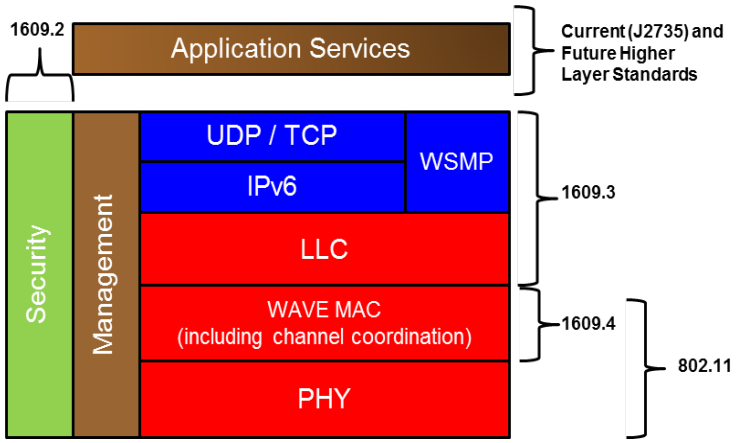
Discussion

- What do vehicle manufacturers, owners and operators want? Expect?
- What do IOO's want that the ITS architecture doesn't currently provide? Expect?
- New architectural elements? New user services? Additional levels of detail? Different information?
- Technical standards?

Available ITS Standards - Examples

Connected Vehicle (CV)

- SAE J2945/0 - DSRC SEP Guidance
- SAE J2945/2 - V2V safety awareness
- SAE J2945/3 - Weather related communication
- IEEE 1609 - Revisions based on experience
- ETSI TS 103097 - Harmonization with 1609.2
- ISO 19091 - Intersection applications



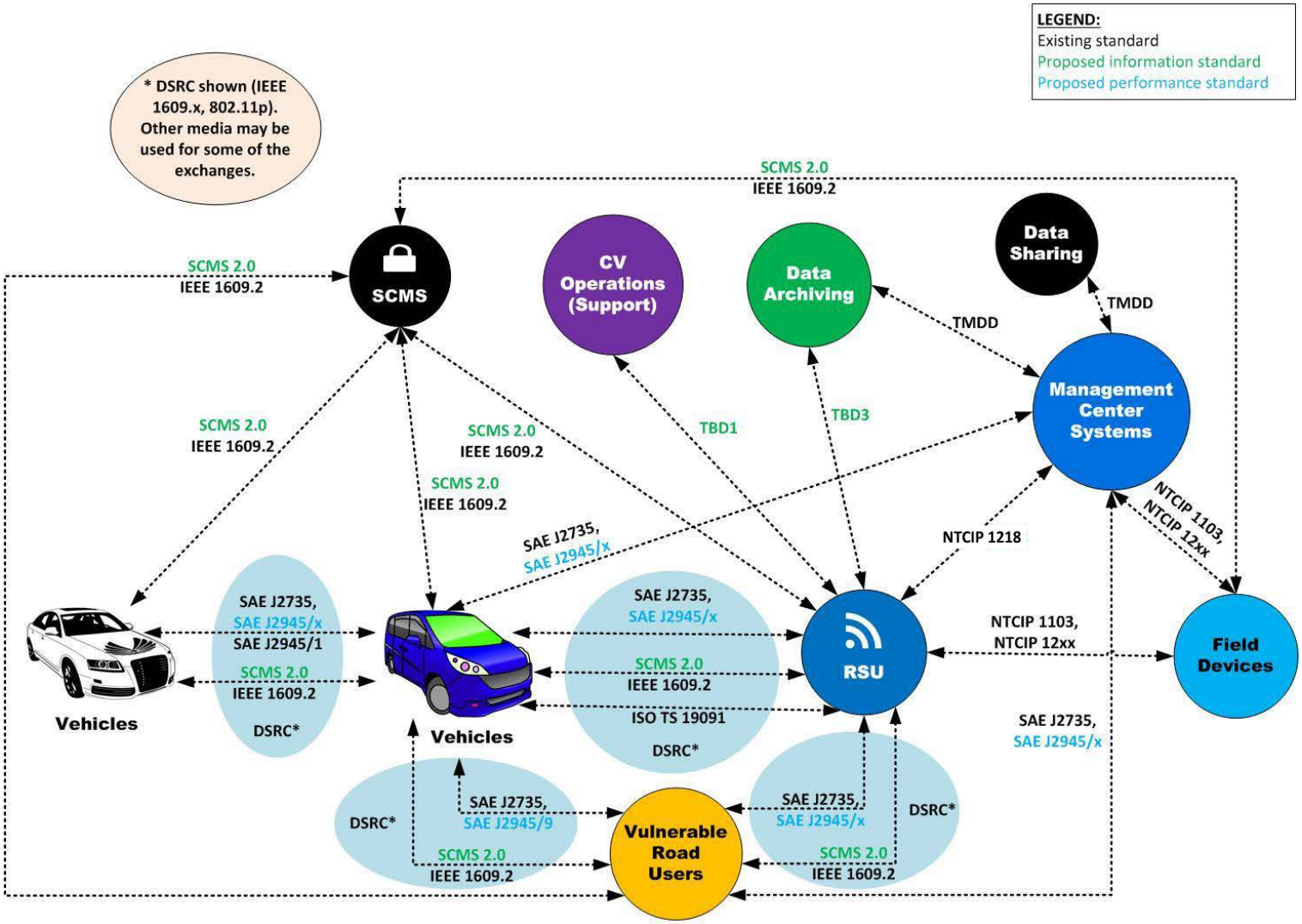
Center-to-Field (C2F)

- ITE-SAE RSU – Backhaul to center, distribution

C2F / Center-to-Center (C2C)

- NTCIP 1202 Actuated Signal Controller - Controls intersection signals (SPaT, MAP)
- NTCIP 1204 Environmental Sensor Systems – Roadway weather, air quality sensors
- NTCIP 1213 Electrical and Lighting Management Systems
- C2C Reference Implementation - Tool verifies conformance to C2C standards
- Test Procedure Generator (TPG) - Automates the development of test procedures for NTCIP standards

Examples of Connectivity Interfaces



Vehicles include freight, transit, etc.
Communications network neutral except as indicated.

Discussion: Defining the *Automated* Vehicle – Infrastructure Interface

- What is the same and what is different compared to human operated vehicles?
  - Architecture tools can describe the interface
  - Standards can define sufficiently for interoperability
- Are there information flows that are essential for integrating automation but only beneficial for connectivity? The converse?
- Need broad stakeholder consensus …
  - A small initial set of core information flows?
    - Standardized at what level?
  - Should all participation be optional?
  - When should there be multiple communications means available?
    - Options for IOOs? Options for vehicles?
- How to gain maximum benefit to the system from automation?

National Dialogue Goals

1. Focus attention on highway automation readiness.
2. Catalyze nationwide engagement.
3. Evolve the national highway automation community.
4. Complement related USDOT summits.

National Dialogue Objectives

1. **LISTEN: Gather input** from a broad group of stakeholders on key issues, challenges, and concerns in highway automation.

2. **ENGAGE: Facilitate information sharing** among industry, public agencies, and others.

3. **EVOLVE: Update institutional structures** for working with existing and new stakeholders.

4. **INFORM: Raise awareness** of FHWA and USDOT activities in automation and emerging technologies.

National Dialogue Tentative Schedule

Month	Event	Location
June 7	**National Dialogue Launch Workshop**	Cobo Center, Detroit, MI
June 26-27	**National Workshop 1** Planning and Policy Considerations for Highway Automation	Science History Institute Philadelphia, PA
July 12	**Automated Vehicle Symposium** FMCSA-FHWA Truck Automation Listening Session	San Francisco, CA
August 1-2	**National Workshop 2** Digital Infrastructure and Data Considerations for Highway Automation	DoubleTree Hilton Seattle Airport Seattle, WA
Early September	**National Workshop 3** Freight Considerations for Highway Automation	Chicago, IL
October 24-25	**National Workshop 4** Operations Considerations for Highway Automation	Phoenix, AZ
Week of Nov. 12	**National Workshop 5** Infrastructure Design and Safety Considerations for Highway Automation	Austin, TX

Discussion

- What else should USDOT be doing to build consensus with the stakeholder community?
- What other forums and stakeholders should USDOT be targeting?

Questions/Discussion?

www.its.dot.gov

Steve Sill
ITS Architecture and Standards Program Manager
US DOT / ITS JPO
steve.sill@dot.gov