UNITED STATES
DEPARTMENT OF TRANSPORTATION

Connected Vehicles: How Wireless Technology can Transform Transportation Safety

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The Problem

Safety

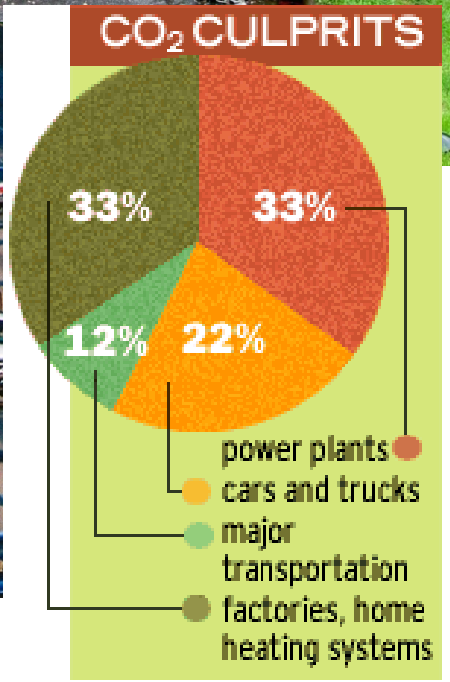
- 32,788 highway deaths in 2010
- 6,000,000 crashes/year
- **Leading cause of death for ages 4 to 34**

Mobility

- 4,200,000,000 hours of travel delay
- $80,000,000,000 cost of urban congestion

Environment

- 2,900,000,000 gallons of wasted fuel



ITS Research = Multimodal and Connected

Drivers / Operators

Vehicles and Fleets

Connectivity

Infrastructure

Wireless Devices

What is the Connected Vehicle Program

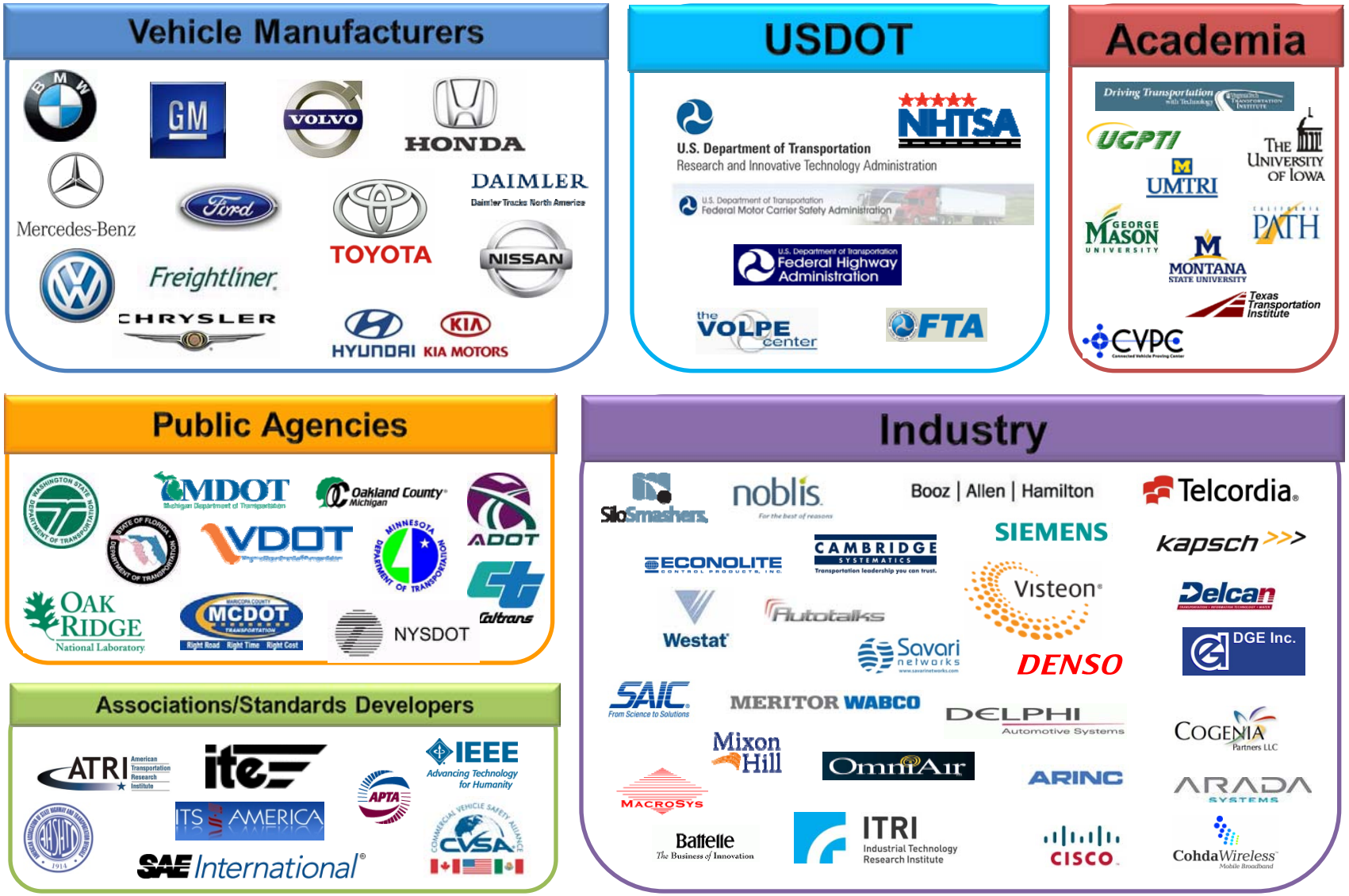
- Vehicle-to-vehicle and vehicle-to-infrastructure wireless communications for:
  - **Crash prevention**
  - **Improved mobility**
  - **Environmental sustainability**
- **Over 80% of unimpaired crash scenarios addressed by connected vehicle capability**

- Encompasses **autos, buses, and trucks**
- Uses wireless communications
  - **Dedicated Short-Range Communications (DSRC)** technology using FCC-dedicated spectrum that is essential for safety applications
  - Other communications types for non-safety applications
- Research is maturing such that NHTSA has committed to an agency decision regarding whether the safety technology is sufficiently developed to support rulemaking

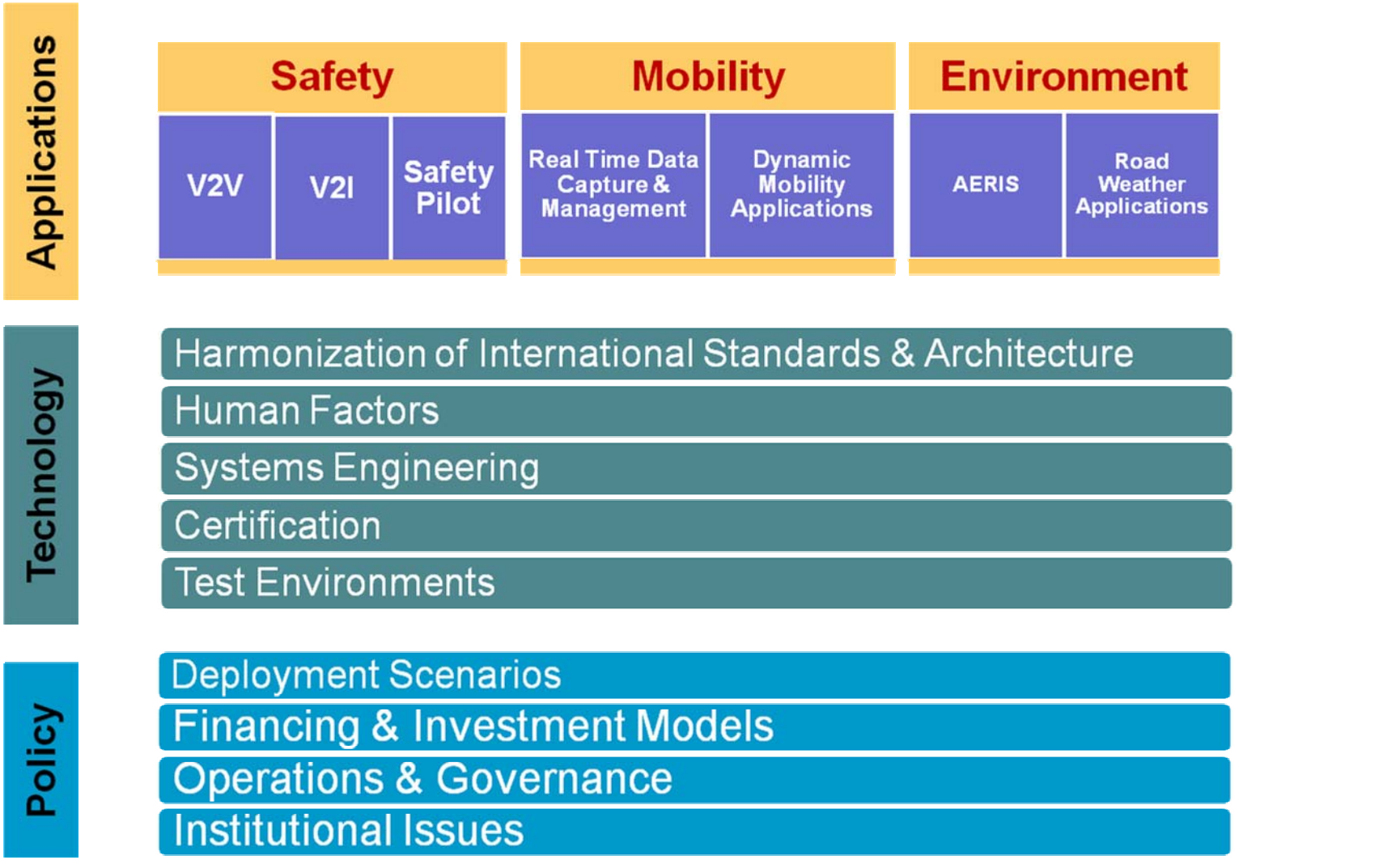
The Connected Vehicle Environment

- Uses wireless communications
  - Dedicated Short-Range Communications (DSRC) technology using FCC-dedicated spectrum that is essential for safety applications
  - Other communications types for non-safety applications

Connected Vehicle Safety Program Partners and Contractors



ITS Research Program Components



Key Program Objectives

- 2013 Decision on Vehicle Communications for Safety (light vehicles)
- 2014 Decision on Vehicle Communications for Safety (heavy vehicles)
- 2015 Infrastructure Implementation Guidance

NHTSA Agency Decision

- Possible decision options include:
  - **Rulemaking** on minimum performance requirements for vehicle communications for safety on new vehicles
  - Inclusion in NHTSA's **New Car Assessment Pro**gram to give car makers credit for voluntary inclusion of safety capability in new vehicles
  - **More research** required
- Data will determine NHTSA's action for the 2013 decision point:
  - Simulation and modeling efforts based upon previous field operational tests
  - Data collection from vehicle-to-vehicle test track testing
  - Empirical data obtained from **Safety Pilot**
    - Driver clinics (user acceptance)
    - Model deployment activities (safety effectiveness)
- A key factor for the NHTSA decision will be the need for, and timing of, necessary infrastructure for communication security (still undefined)

Safety Pilot Objectives

- **Generate empirical data for supporting 2013 & 2014 decisions**
- Show capability of V2V and V2I applications in a real world operating environment using multiple vehicle types
- Determine driver acceptance of vehicle-based safety warning systems
- Assess options for accelerating the safety benefits through aftermarket and retrofit safety devices
- Extend the performance testing of the DSRC technology
- Collect lots of data and make it available for industry wide use
- Let others leverage the live operating environment

Safety Pilot Sites

- **Driver clinics**
  - Assess user acceptance

Six Driver Clinic Sites

- **Large-scale model deployment**
  - Obtain empirical safety data for estimating safety benefits

One Model Deployment Site

User Acceptance - Driver Clinics

- 6 locations across the US beginning in August 2011
- 100 drivers per locations
- Experience Crash Warnings
  - Forward Crash Warning
  - Emergency Brake Light
  - Blind Spot Warning
  - Lane Change Warning
  - Intersection Assist
  - Do Not Pass Warning

Progress - Step Two - Demonstrate Safety

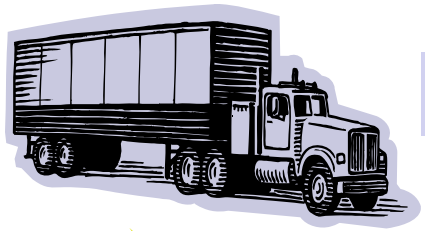
Six Scheduled Driver Clinics

1. Aug'11 – Brooklyn, MI
2. Sep'11 – Minneapolis, MN
3. Oct'11 – Orlando FL
4. Nov' 11 – Blacksburg, VA for DAC and Washington DC for the demo
5. Dec'11 – Dallas, TX
6. Jan'11 – San Francisco, CA

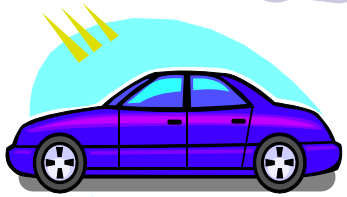
Model Deployment: Ann Arbor, MI

- Major road test and real world implementation taking place 2011 thru 2013, involving:
  - Approximately 3000 vehicles
  - Multiple vehicle types
  - Fully integrated systems and aftermarket devices
  - Roadside infrastructure
  - System wide interoperability testing
- Also to test
  - Prototype security mechanisms
  - Device certification processes

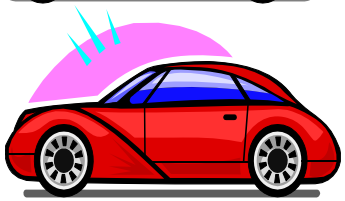
Integrated Vehicles



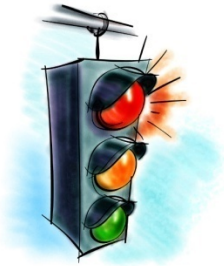
Integrated Trucks



Aftermarket Devices



Here I Am Vehicles



Roadside Infrastructure

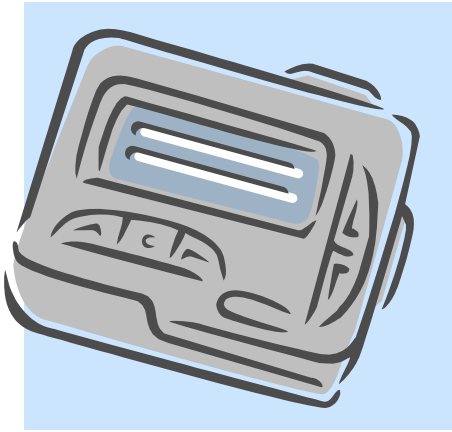
Aftermarket Safety Devices

- Devices that transmit and receive Basic Safety Message
  - Driver interface for safety warnings
  - No integration with vehicle
- 4 vendors currently underway
- Applications include:
  - CICAS-V (red light warning) (V2I)
  - Curve overspeed warning (V2I)
  - Emergency electronic brake light (V2V)
  - Forward collision warning (V2V)
- QPL projected for March 2012

- ***<u>Safety devices must comply with NHTSA driver interface criteria before being released to drivers for model deployment</u>***

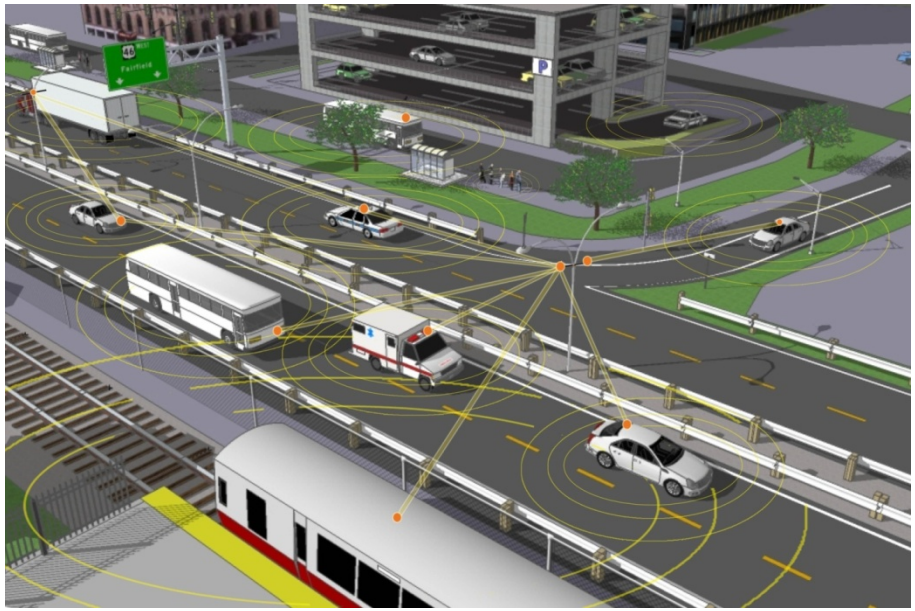
Basic Communication Devices

- Devices that only transmit Basic Safety Message
  - No driver interface
- Initial procurement resulted in 8 awards
  - 6 vendors made it to acceptance testing
  - No vendors fully complied with the tests
  - Specification was considered by DOT as still weak
  - Updated specification and issued 2nd procurement
- 2nd procurement resulted in 4 awards
- Qualified Products List (QPL) estimated to be established later this year



Roadside Equipment for Safety

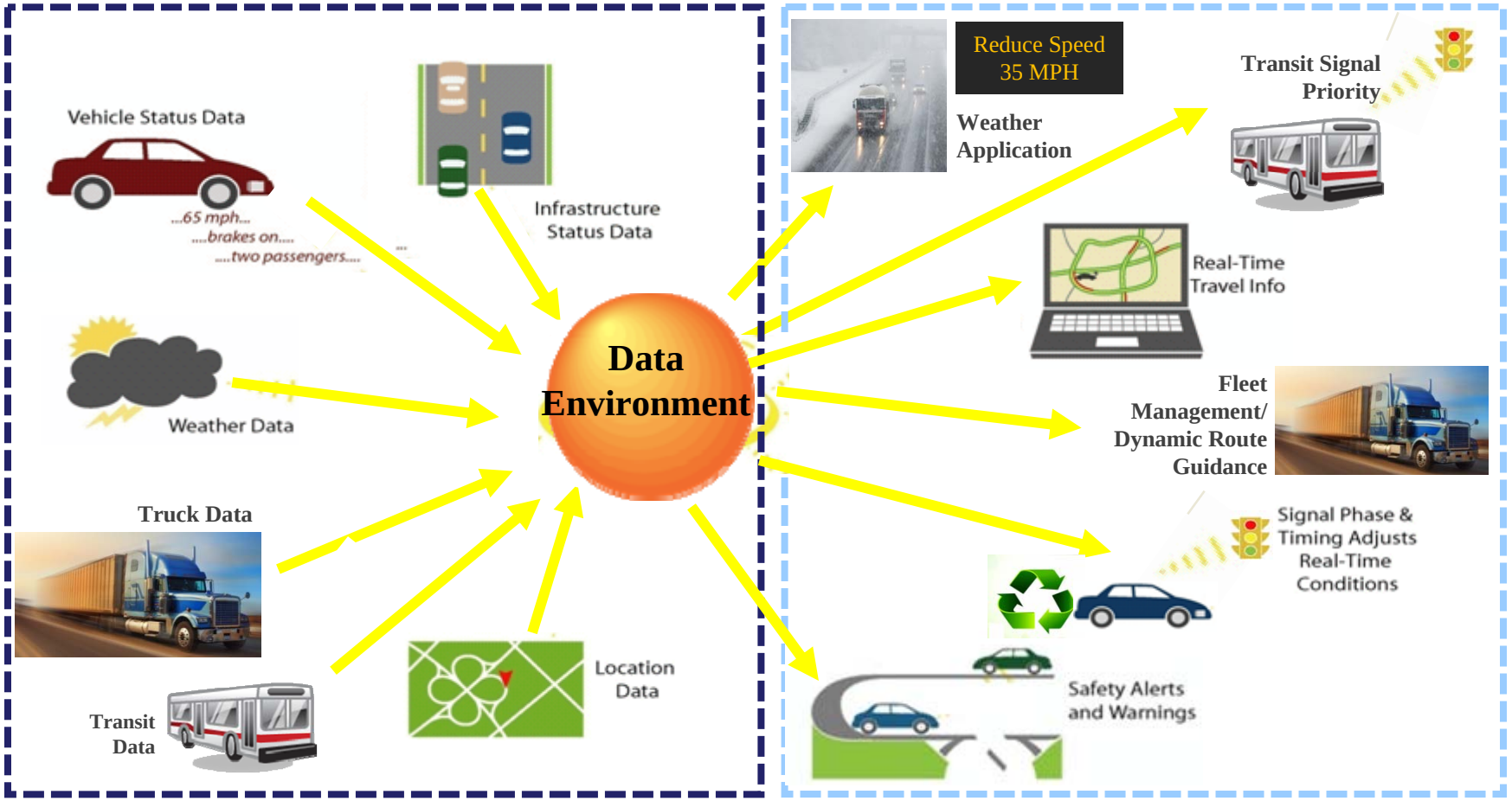
- Transmission and receipt of V2I messages
  - Interfaces with signal controller (at intersections)
  - Supports other dangerous road segment applications
- Applications supported
  - CICAS-V (red light warning)
  - Curve overspeed warning
  - Collection of probe data transmissions
  - Other (tbd)
- 4 vendors currently underway
- QPL projected for January 2012



Mobility Program

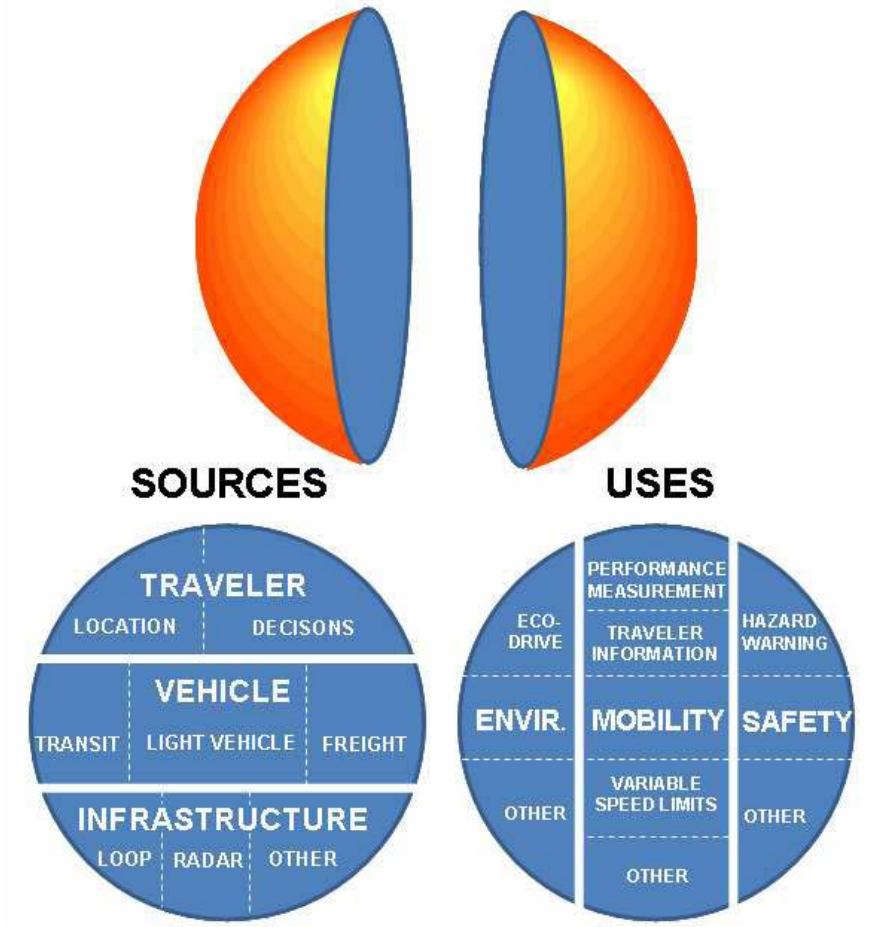
Real-time Data Capture and Management

Mobility Applications



Data Capture and Management

- ITS JPO is developing and collecting well-documented, quality data sets available from recent or ongoing operations, field tests, or simulations of emerging technologies supporting mobility, environment, transit, freight, weather, and other surface transportation research, that can be made broadly available to support dynamic mobility applications development by researchers



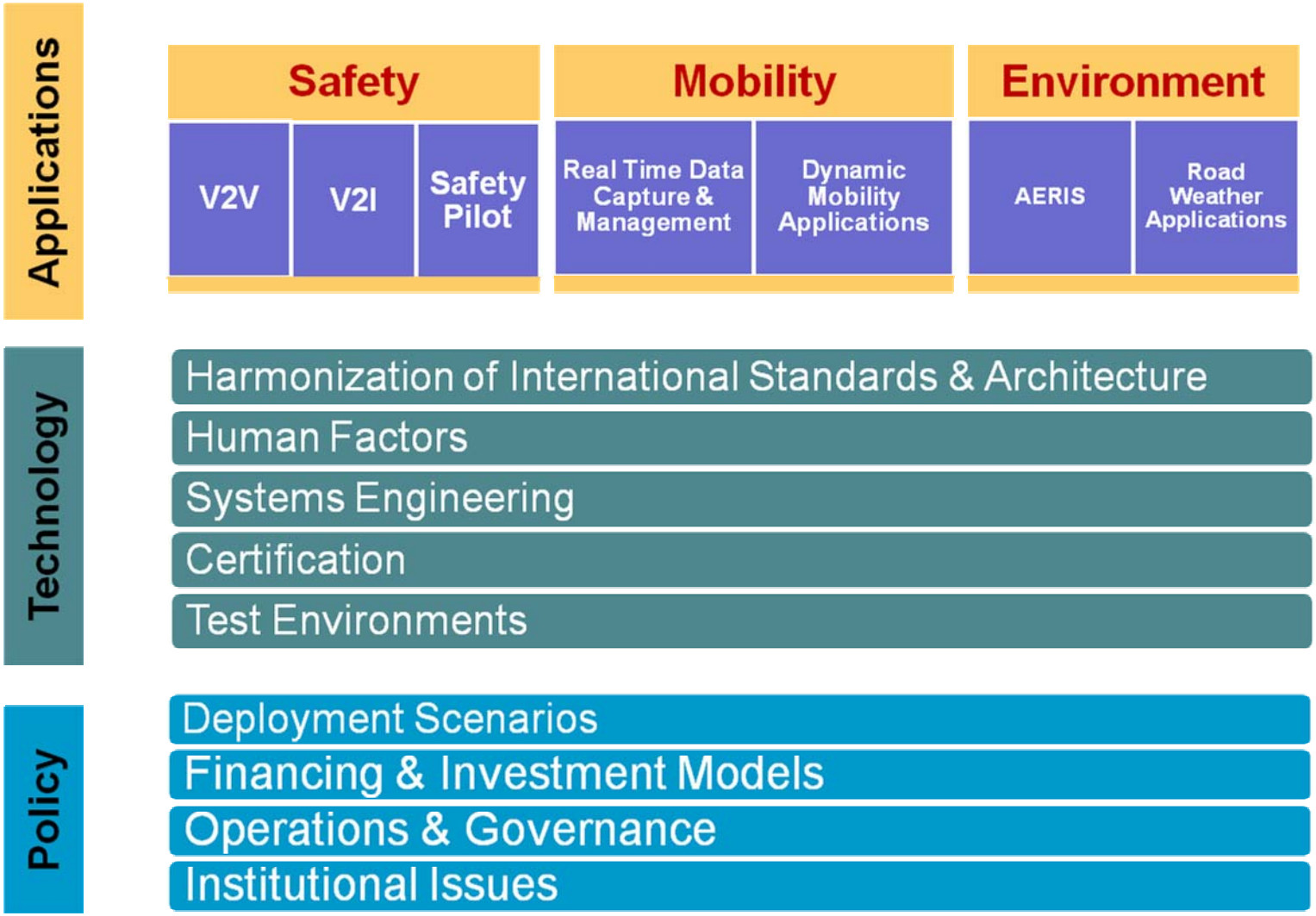
Environmental Program

Applications for the Environment: Real-Time Information Synthesis (AERIS)

- Recently made 7 awards to further innovative applications and concepts building on existing outside research
- Initial research results available this fall

- 2011 Plans to complete State of the Practice Scans:
  - Research of ITS and the Environment
  - Evaluation Techniques for ITS and the Environment
  - Activity-Based Travel Models
  - Environmental Models
  - Data Acquisition Technologies
- Develop Research and Analysis Framework
- Start analytics and modeling research

ITS Research Program Components



Dedicated Short Range Communications

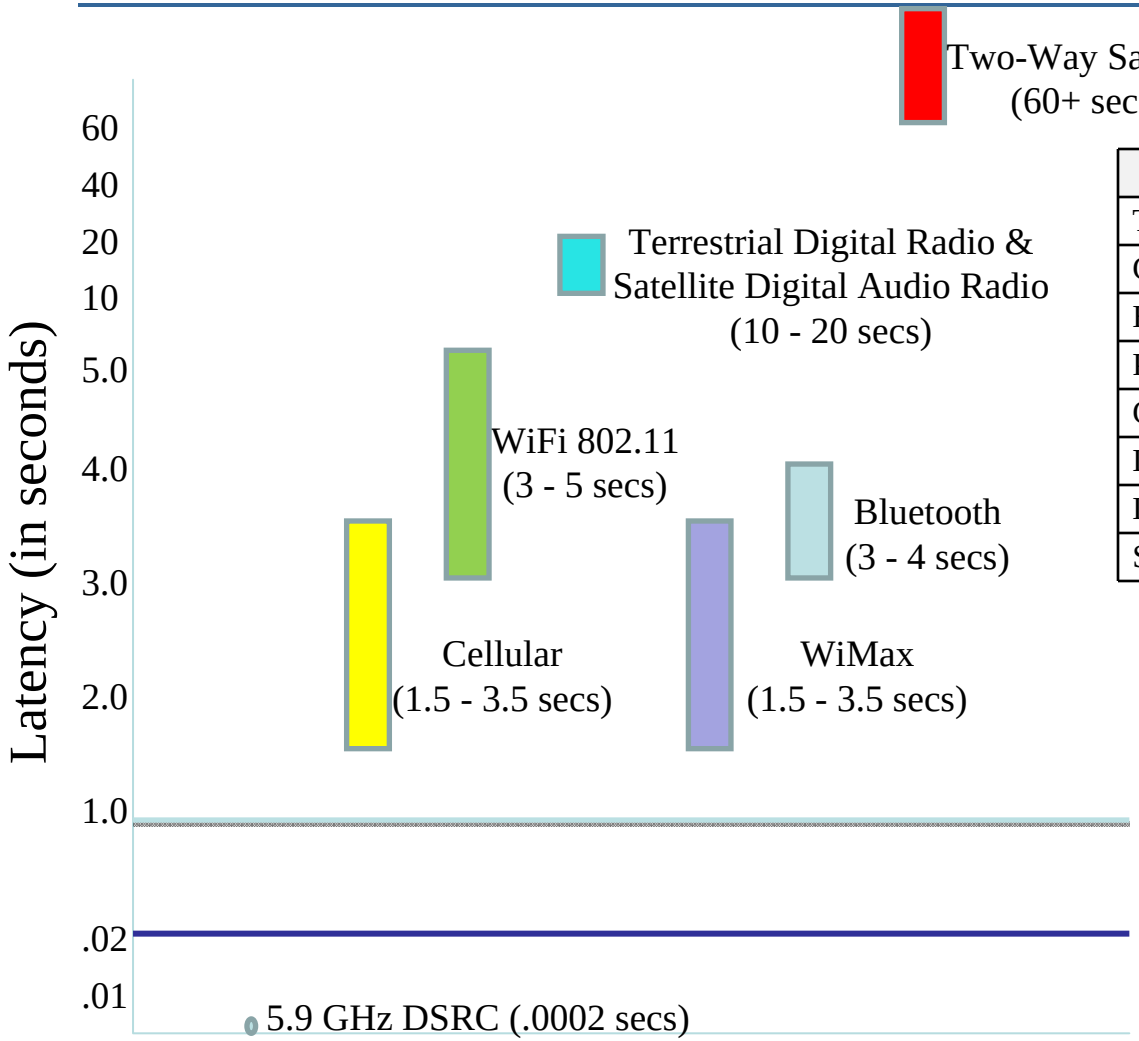
- **Replaces Expensive Onboard Sensors**
- **Dedicated Short Range Communications (DSRC)**
  - 5.9 GHz
  - Low Latency
  - ~300m Range
- **Positioning**
  - GPS
  - Relative Positioning (V2V)
  - Absolute Positioning (V2I)
  - High Accuracy DGPS not required
- **No Digital Map Required**

- **Cost**
- **Effectiveness**
- **Interoperability**
- **Security**
- **Privacy**

Communications Requirements

Communications Requirements	Safety (V2V and intersection crash avoidance)	Mobility and Environment
Range	• Short range is a requirement • Very high update rate (e.g., 10x per second)	• Short range for intersection messages and toll tags, otherwise no requirement
Latency	• Very low latency (≤0.1 seconds) for V2V crash warning	• Low (tolling) to high (traveler information)
Message Size	• Small (100-few thousand bytes)	• Small (tolling, probe) to large (navigation updates)
Update Rate	• High (10x per second or higher)	• Low
Reliability	Very high (safety of life)	• High for tolling (accurate billing), moderate otherwise

Communications Technologies



Active Safety Latency Requirements (secs)	
Traffic Signal Violation Warning	0.1
Curve Speed Warning	1.0
Emergency Electronic Brake Lights	0.1
Pre-Crash Sensing	0.02
Cooperative Forward Collision Warning	0.1
Left Turn Assistant	0.1
Lane Change Warning	0.1
Stop Sign Movement Assistance	0.1

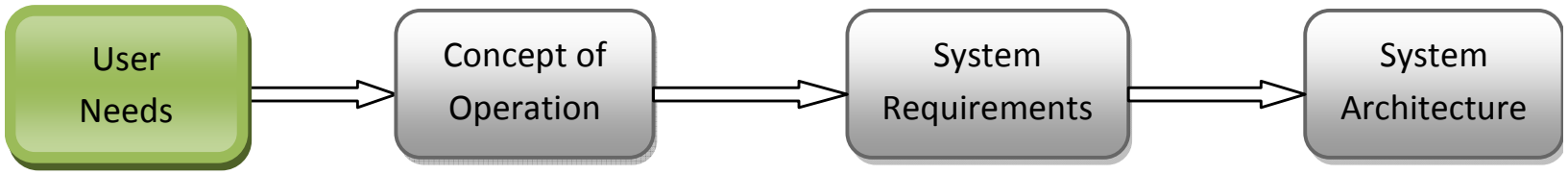
Note: Y-axis not to scale for illustration purposes

Data source: Vehicle Safety Communications Project – Final Report

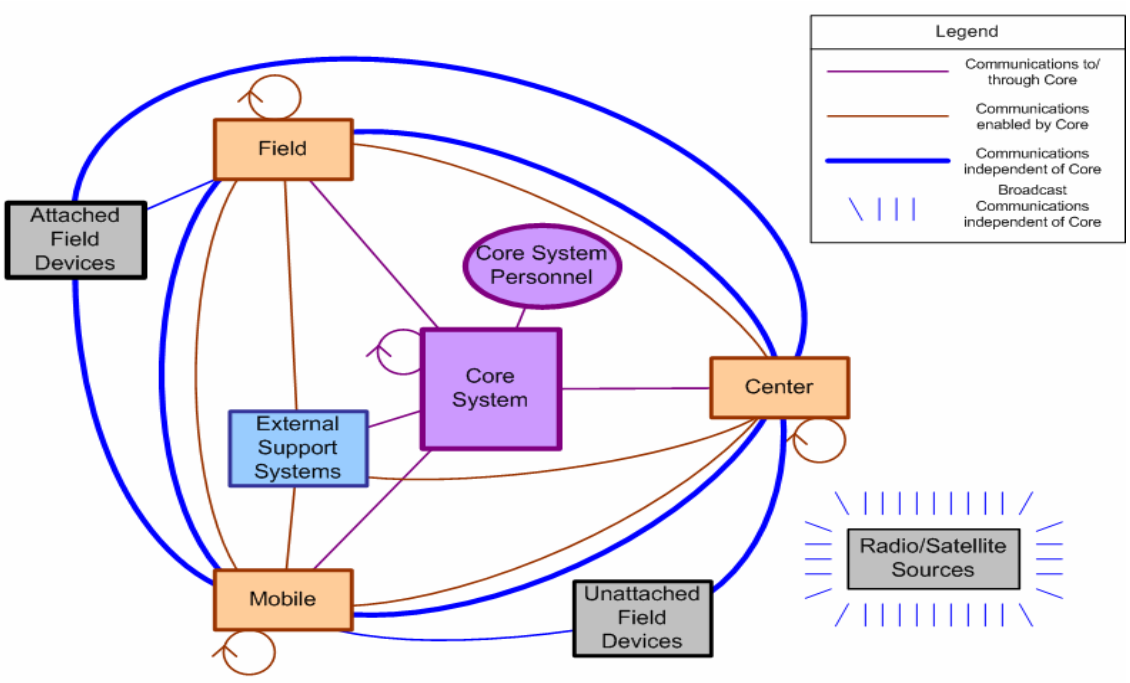
Allocation and Band Plan

- DSRC allocation is 75 MHz in the 5.9 GHz band
- Band is for low power, short-range vehicle to vehicle and vehicle to roadside applications; shared by the public and private sector
- Six Service Channels and one control channel
- One service channel reserved for safety of life and public safety use
  - Not restricted to vehicle-to-vehicle or low latency applications
- One service channel reserved for high power (2x low power) public safety, safety of life and property applications
  - Not restricted to long range applications

Define the System and Establish a Testing Environment



Aug./Sept. 2010 May 2011 September 2011 Oct 2011



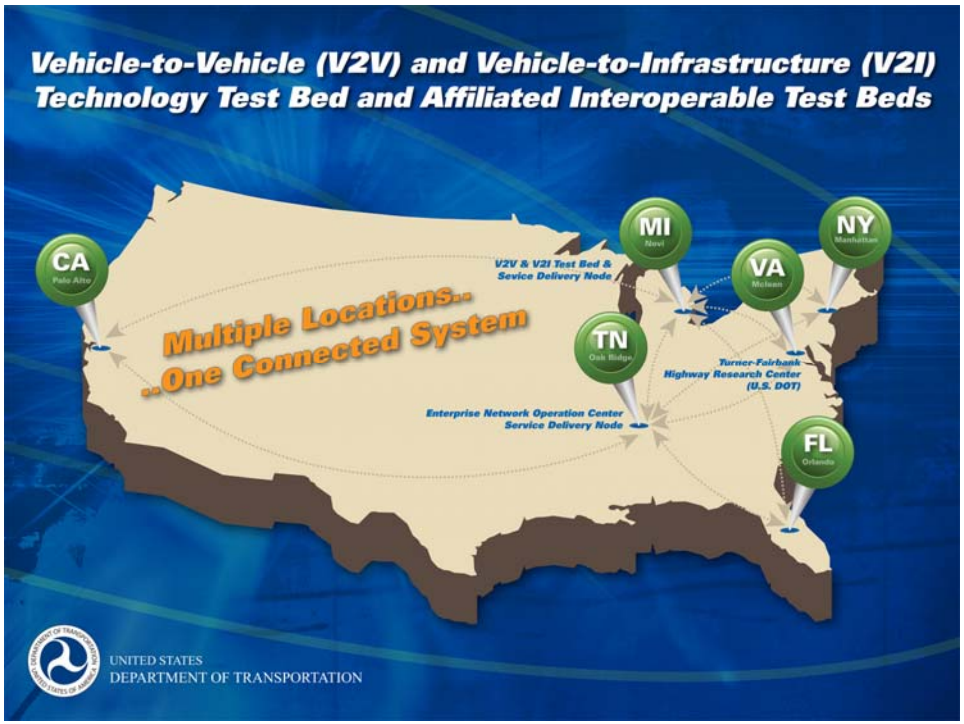
connected vehicle environment

Open Workshops
June 2011 (DC)
Sep (San Jose, CA)

Build a Reference Implementation

2011

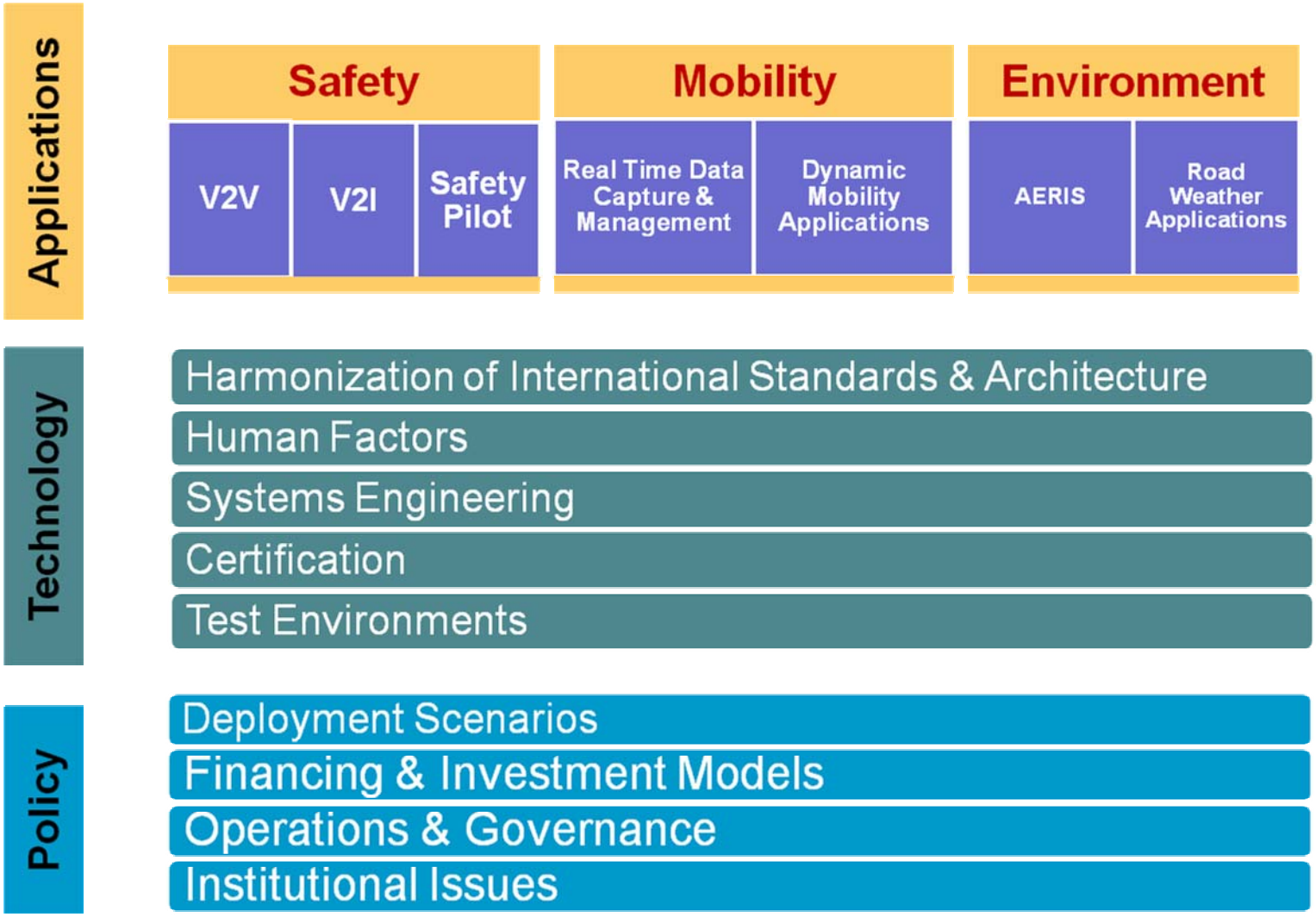
- Test bed is Up and Running. Interoperable equipment in California, Florida, New York, Michigan, Virginia, and Network Operations in Tennessee



2012 to 2013

- Reflect the System Architecture
- Utilize Harmonized International Standards
- Implement a Certification Process
- Implement a Governance Process
- Implement a Security Process

ITS Research Program Components



Deployment Scenarios

V2V Security Network

- DSRC for security: Estimated at 40,000 RSEs; not necessarily owned/operated by Federal/State/local governments
- Cellular or WiFi: Infrastructure exists; must address privacy
- No infrastructure: Unlikely to meet our needs but worthy of consideration

No easy option

All require a sustainable funding stream & governance structure

All under study

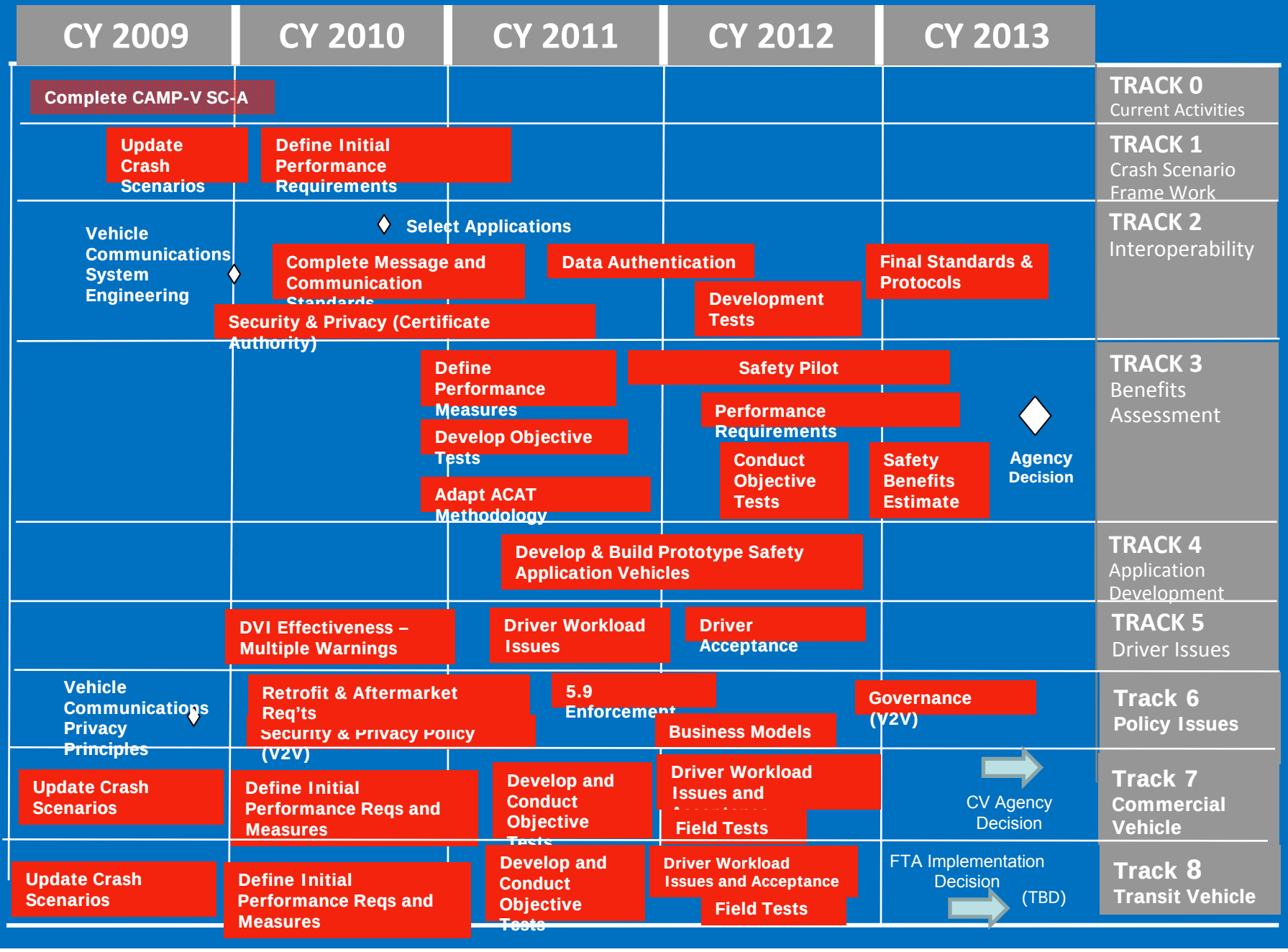
V2I Infrastructure could be implemented for spot locations

- Intersections
- Curves

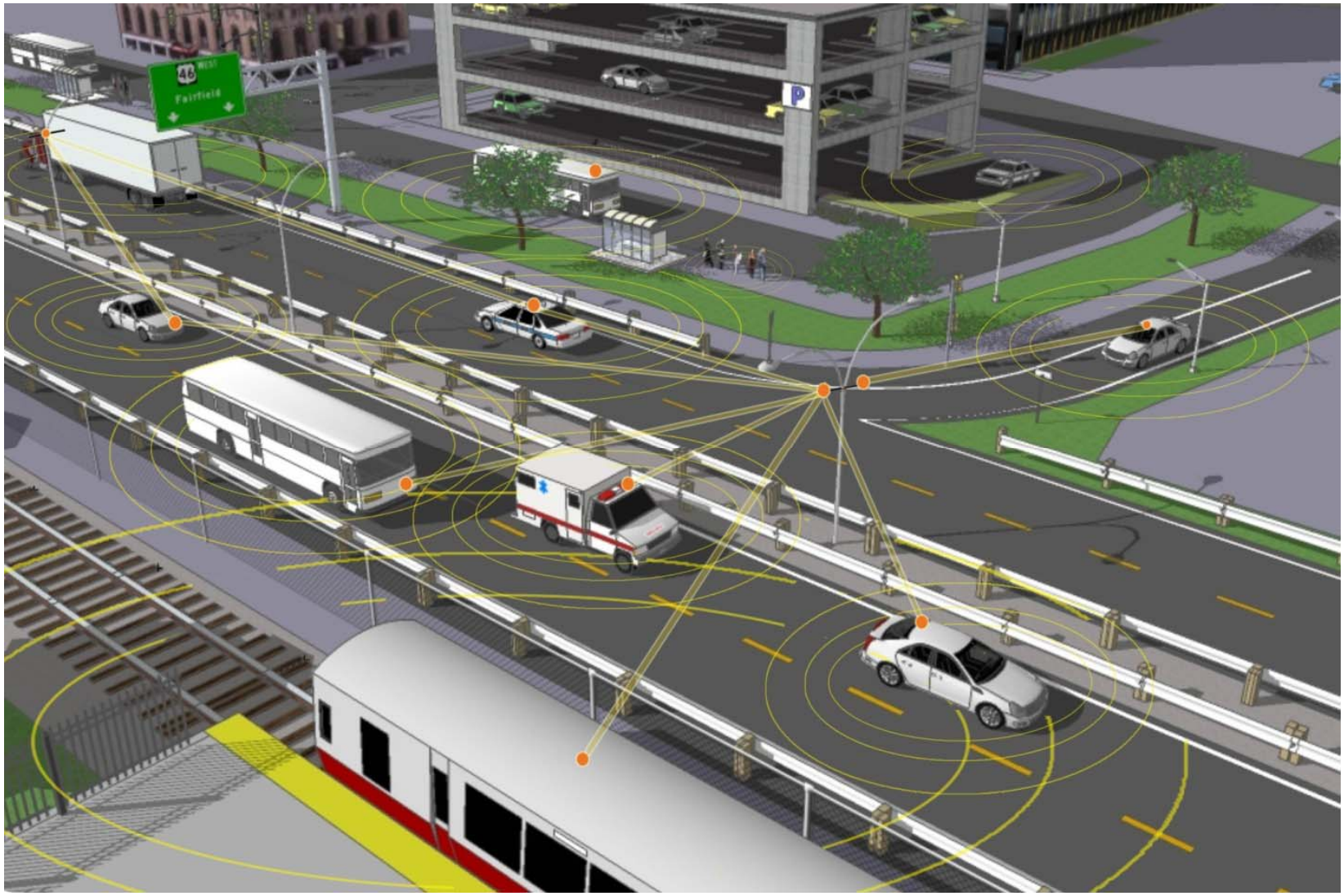
Privacy

- **A key concern from program beginning!**
- Privacy principles and policy framework developed with privacy experts, interest groups and primary program stakeholders early in program
- Addresses collection, storage and use of personal information
- Consistent with Fair Information Practices Principles used in federal government
- Basis for program decision-making and architecture development
- Continuing to engage privacy experts and interest groups in review of program architecture and plans throughout

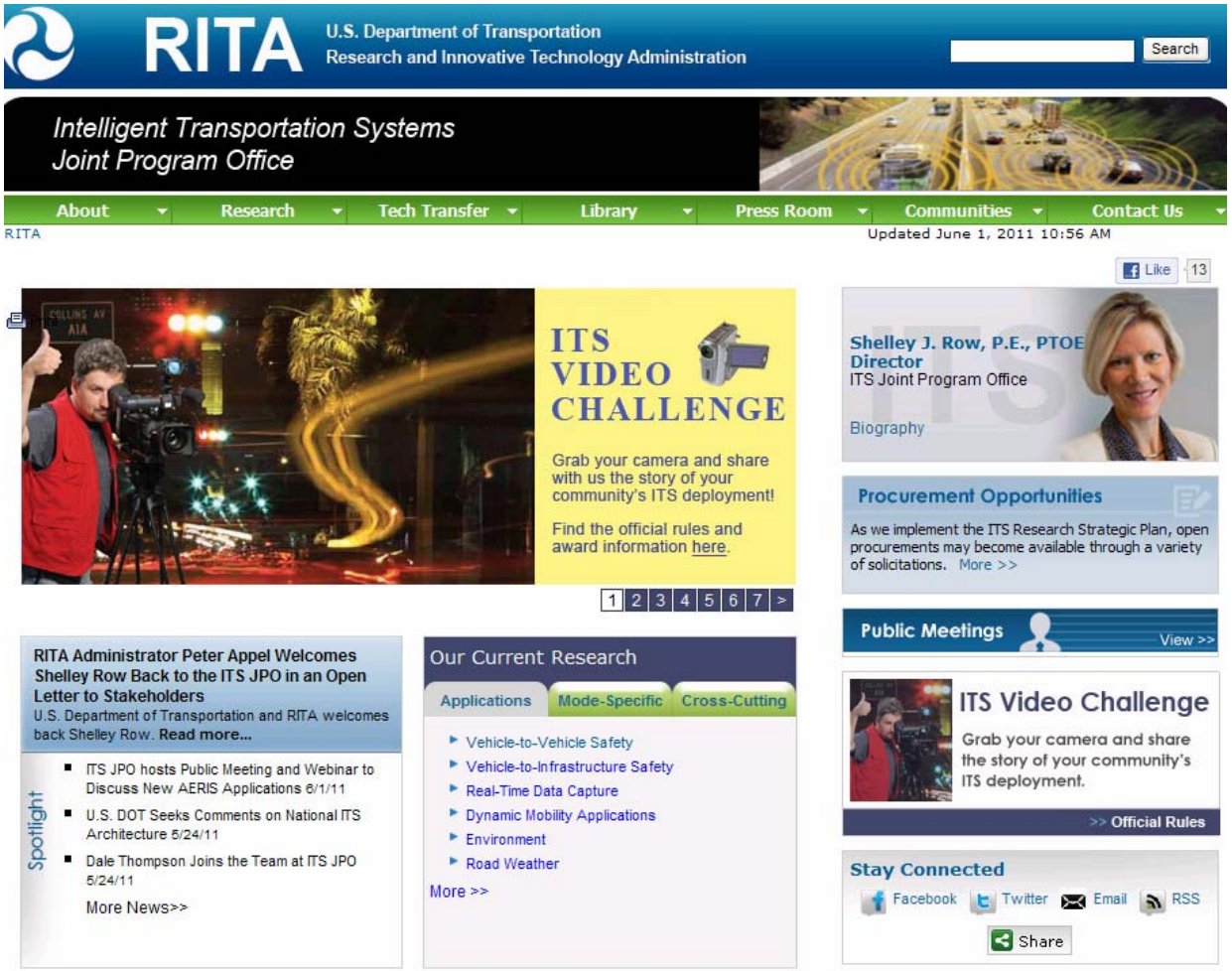
Vehicle to Vehicle Safety Application Research Plan



Connected Transportation



For More Information



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