U.S. DOT Connected & Automated Vehicle Research Update

NSF Cyber Physical Systems Principal Investigators

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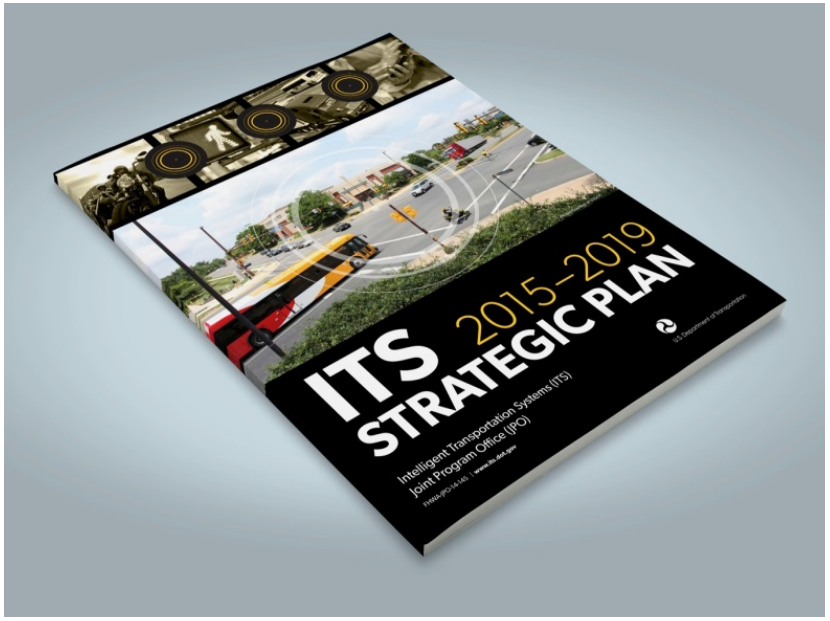
ITS Strategic Plan 2015-19 Strategic Priorities

- **Two Strategic Priorities:**

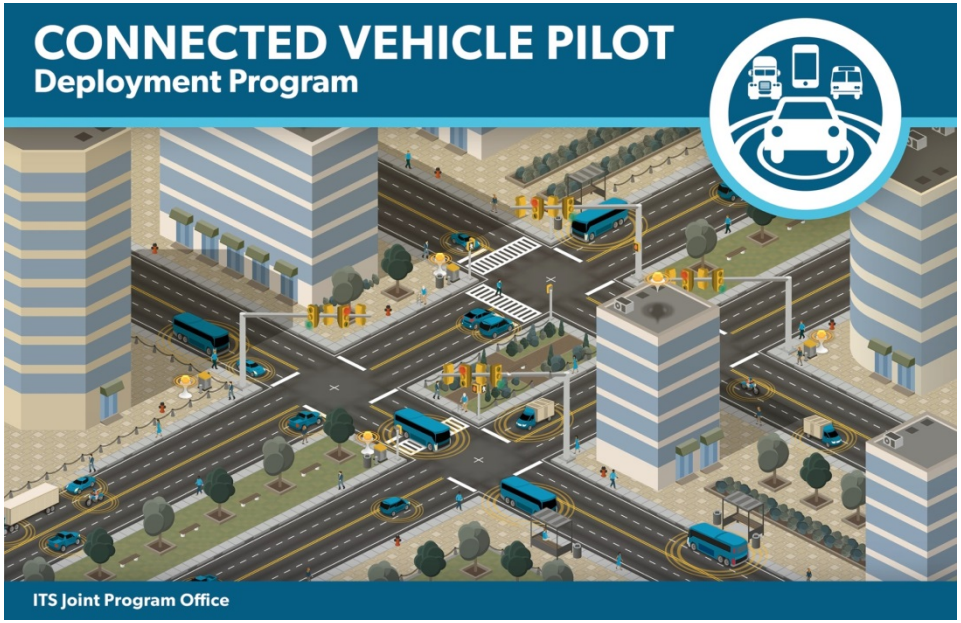
- **Realizing Connected Vehicle Implementation** – Builds on the substantial progress made in recent years around design, testing, and planning for connected vehicles to be deployed across the nation.
- **Advancing Automation** – Shapes the ITS Program around research, development, and adoption of automation related technologies as they emerge.



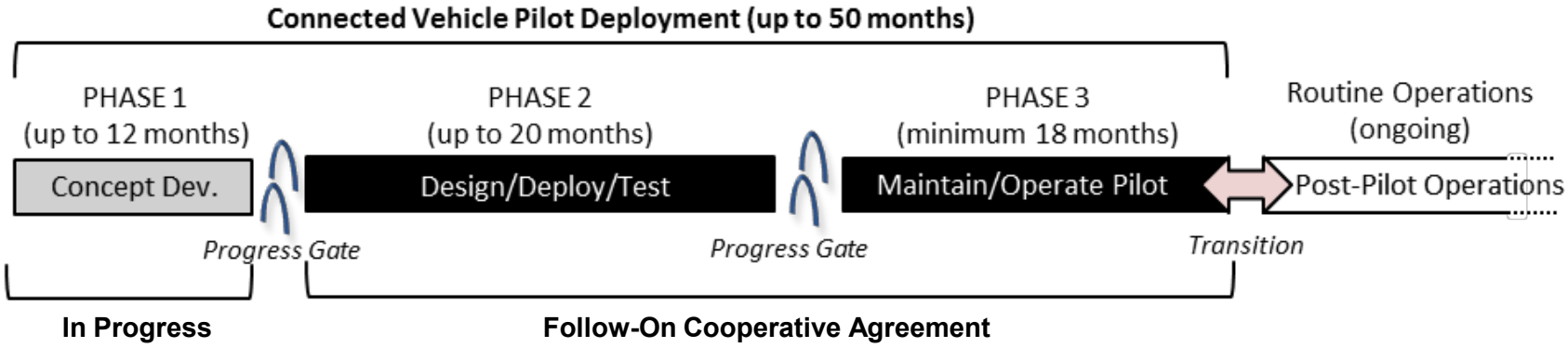
CONNECTED VEHICLES

Connected Vehicle Milestones

- 8/2014: NHTSA ANPRM on vehicle-to-vehicle communications
- 9/2015: First wave of CV Pilots begin
- 12/2015: FHWA V2I guidance document
- 12/2015: V2V NPRM to OMB
- 2016: Publish NPRM



Three Pilots Awarded Phase 1 Contracts



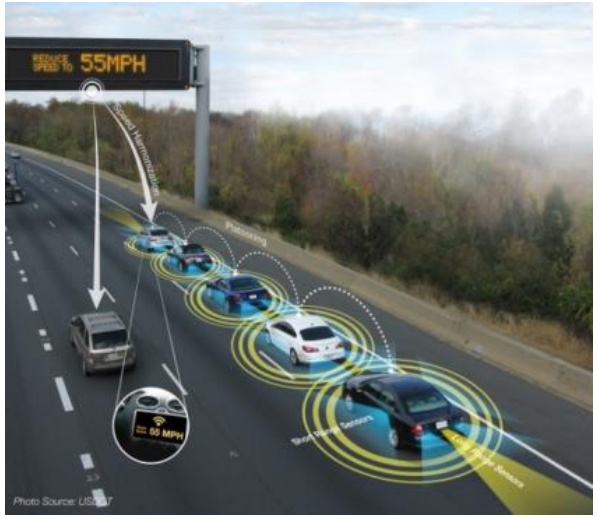
- Tampa, Florida
- New York City, New York
- State of Wyoming

http://www.its.dot.gov/pilots/

CONNECTED AUTOMATION

Automation Can Be a Tool for Solving Transportation Problems

- **Improving safety**
  - Reduce and mitigate crashes
- **Increasing mobility and accessibility**
  - Expand capacity of roadway infrastructure
  - Enhance traffic flow dynamics
  - More personal mobility options for disabled and aging population
- **Reducing energy use and emissions**
  - Aerodynamic “drafting”
  - Improve traffic flow dynamics



…but connectivity is critical to achieving the greatest benefits

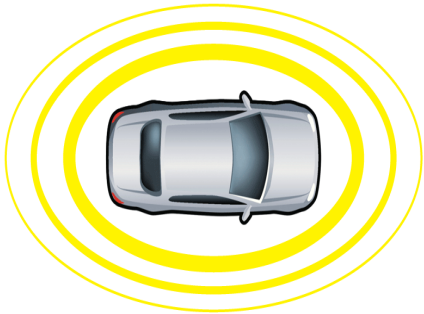
Connected Automation for Greatest Benefits

Autonomous Vehicle

Operates in isolation from other vehicles using internal sensors

Connected Automated Vehicle

Leverages autonomous and connected vehicle capabilities



Connected Vehicle

Communicates with nearby vehicles and infrastructure

Automation Program Research Tracks

Enabling Technologies		
Digital Infrastructure	Communications	Technology Research

Safety Assurance			
Electronic Control Systems	Functional Safety and Electronics Reliability	Cybersecurity	Human Factors

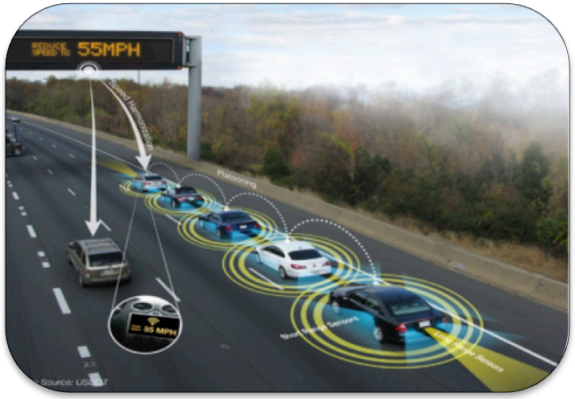
Transportation System Performance		
CACC, Speed Harmonization, and Platooning	Lateral Control	First/Last Mile and Transit Operations

Testing and Evaluation		
Interoperability	Testing Methods	Benefits Assessment

Policy and Planning			
Standards	Federal Policy Analysis	Stakeholder Engagement	Transportation Planning

Enabling Technologies Example

POSITION, NAV & TIMING



MAPPING

SENSORS

COMMUNICATIONS

HUMAN FACTORS

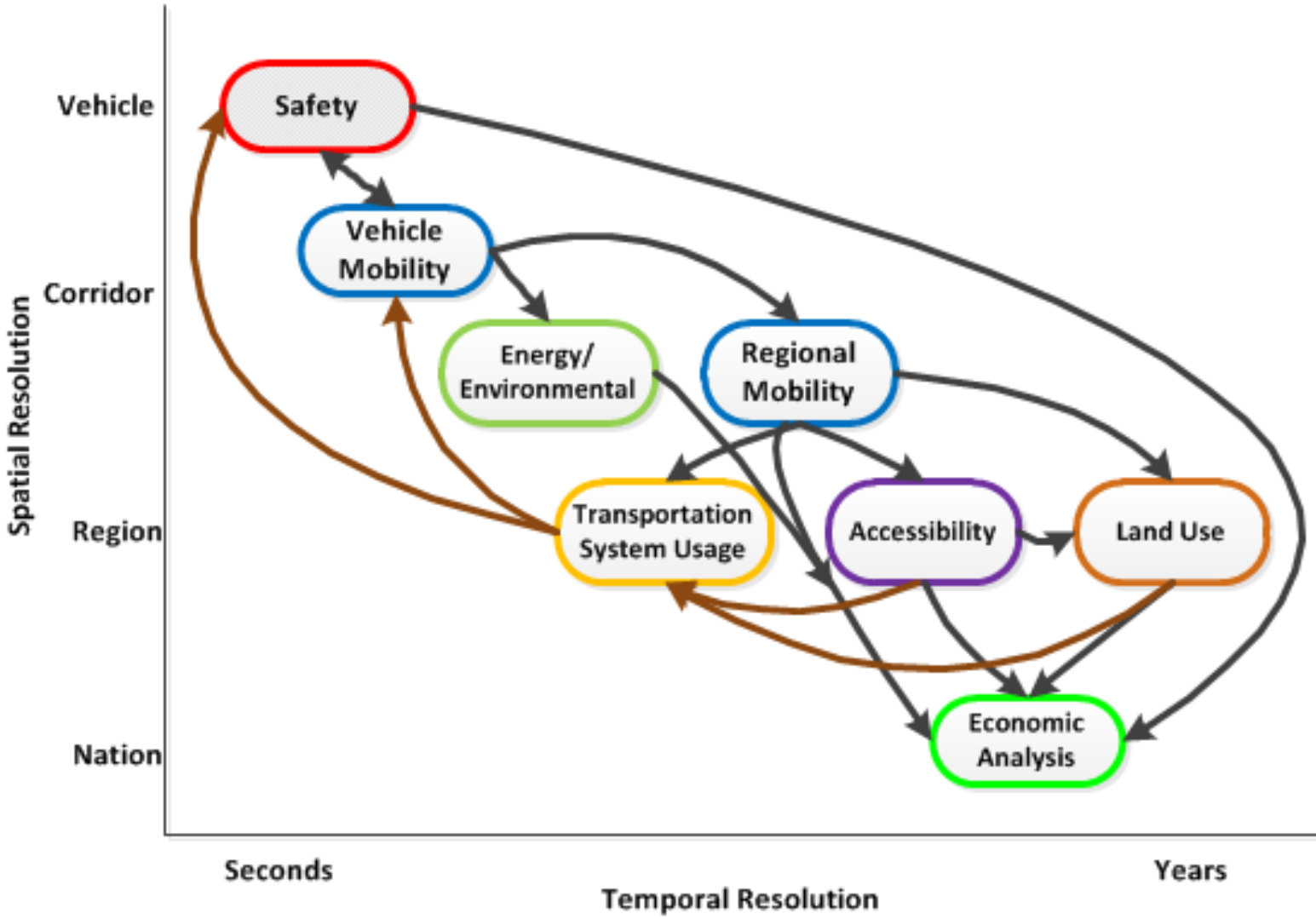
Safety Assurance Example: Human Factors Research

- Transition between automated and non-automated modes
- Level 2 (2010 Cadillac SRX) and Level 3 (Google-modified 2012 Lexus RX450h)
- Results published; also producing Driver-Vehicle Interface Design Principles
  - http://www.nhtsa.gov/DOT/NHTSA/NVS/Crash Avoidance/Technical Publications/2015/812182_HumanFactorsEval-L2L3-AutomDrivingConcepts.pdf

Transportation System Performance

- Application and prototype development
- Primarily human-in-the-loop level 1 connected automation
- (More details later in presentation)

Evaluation and Testing Example: Benefits Evaluation Framework



Policy and Planning Example: Review of Federal Motor Vehicle Safety Standards

How could highly automated vehicles impact or change the nature of existing Federal Motor Vehicle Safety Standards (FMVSS)?

- Identifying where current FMVSS pose challenges to introduction of AVs
- Ensure NHTSA regulations do not stifle innovation
- NHTSA and ITS JPO coordinated research

NHTSA
www.nhtsa.gov

Image Source: http://www.automotiveaddicts.com/wp-content/uploads/2012/08/IIHS-Crash-Test.jpg

L1 CONNECTED AUTOMATION

Example Systems at Each Automation Level

SAEL evel	Example Systems	Driver Roles
1	Adaptive Cruise Control OR Lane Keeping Assistance	Must drive other functions and monitor driving environment
2	Adaptive Cruise Control AND Lane Keeping Assistance Traffic Jam Assist	Must monitor driving environment (system nags driver to try to ensure it)
3	Traffic Jam Pilot Automated parking Highway Autopilot	May read a book, text, or web surf, but be prepared to intervene when needed
4	Closed campus driverless shuttle Valet parking in garage 'Fully automated' in certain conditions	May sleep, and system can revert to minimum risk condition if needed
5	Automated taxi Car-share repositioning system	No driver needed

Source: California PATH

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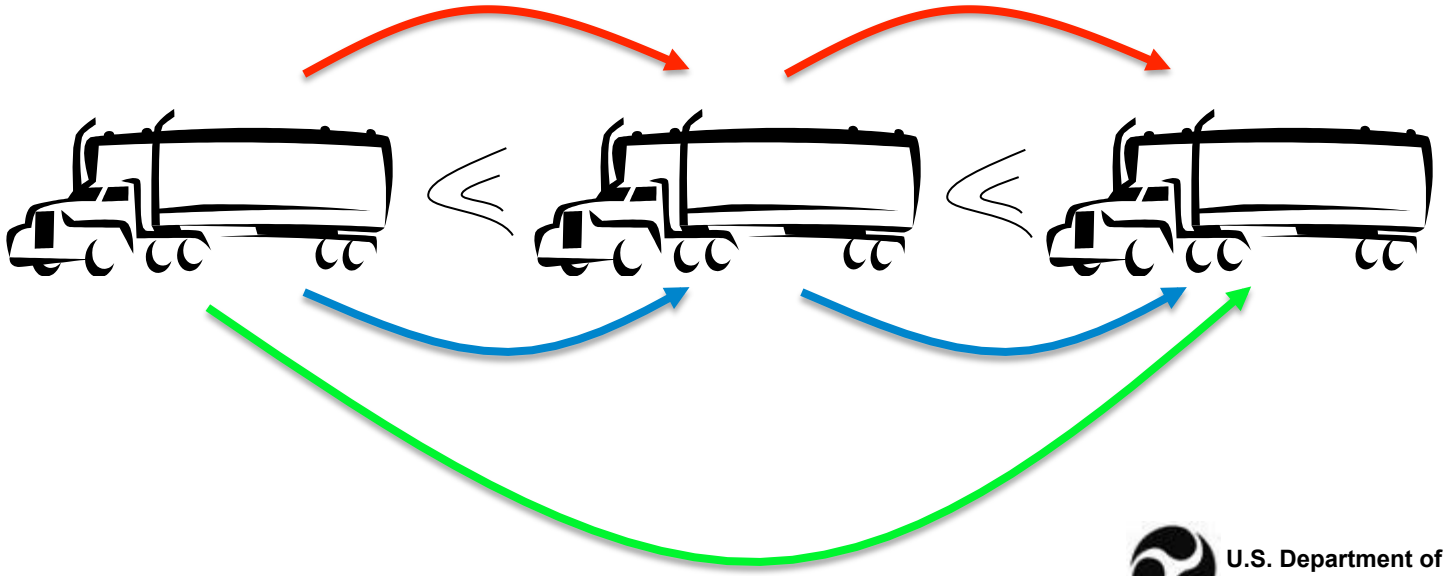
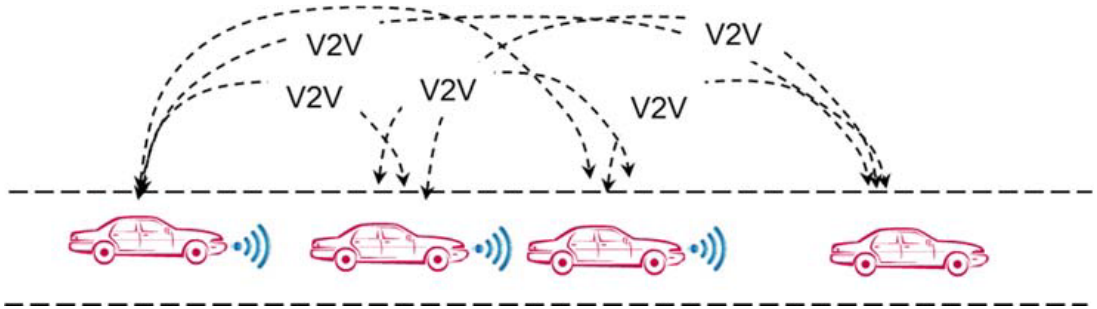
L1 Connected Automation R&D at USDOT

- Cooperative Adaptive Cruise Control (CACC) development
- Freeway Operations Applications
- Eco-Approach and Departure from Signals
- Truck Platooning



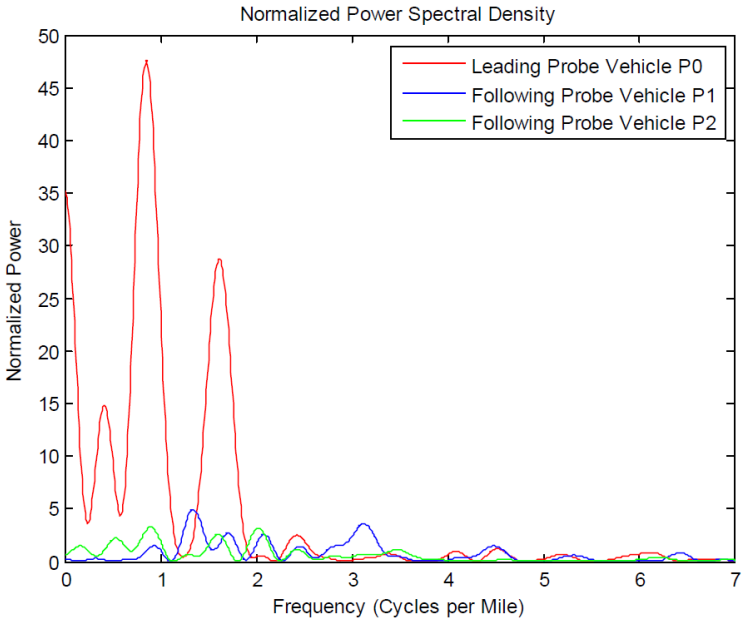
CACC Development Projects

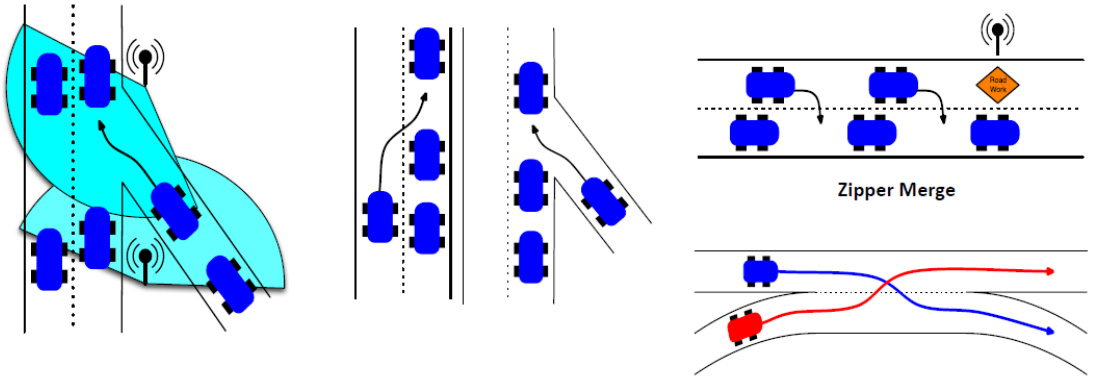
- Enabling CACC High Performance Vehicle Streams
- CACC Field Tests
- OEM Assessment of CACC Concepts and Prototype
- Driver Acceptance of L1 Applications



Freeway Traffic Operations Applications

- Freeway Speed Harmonization
- Lane Change/Merge Operations





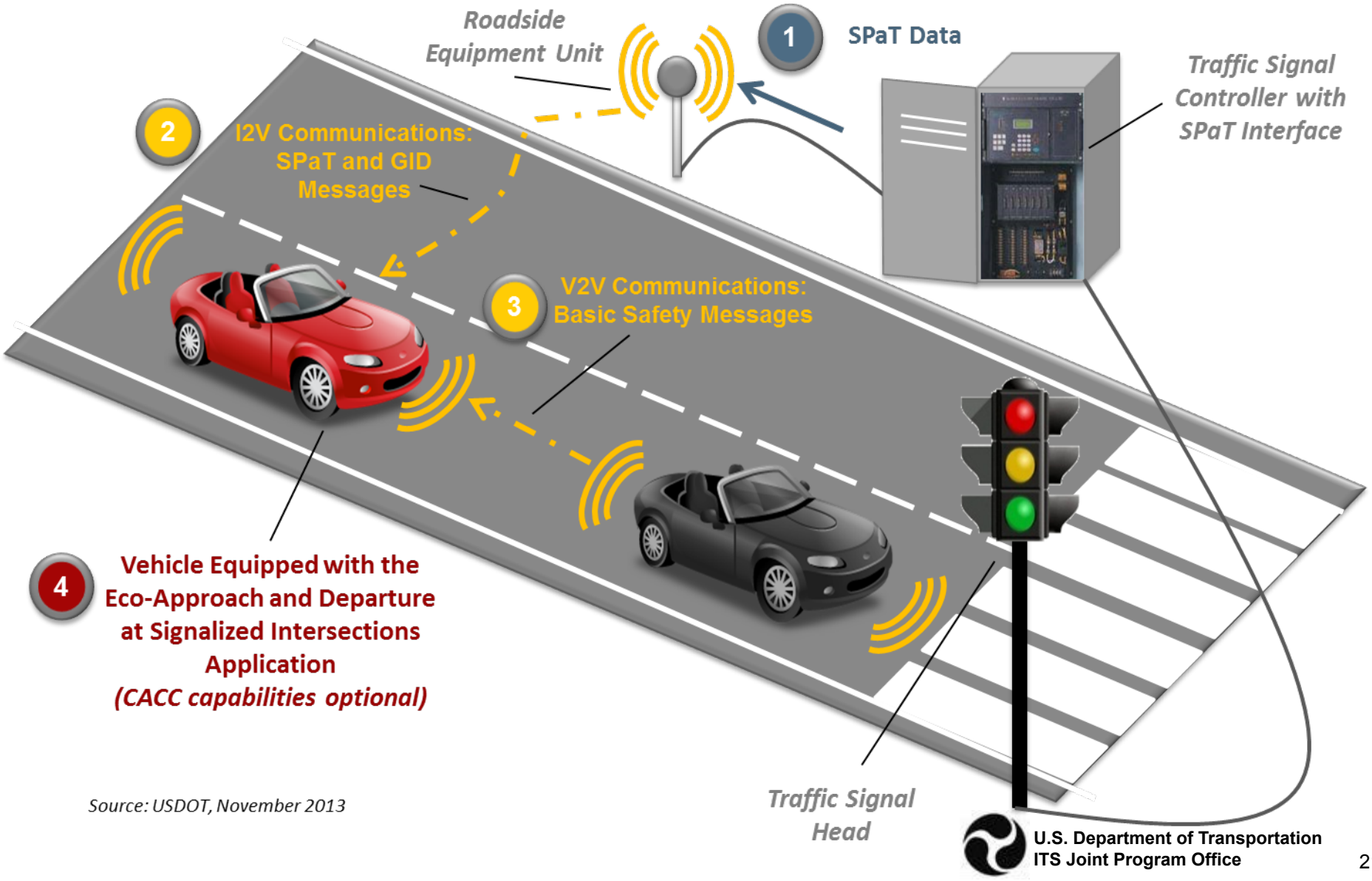
Freeway Entrance with Infrastructure Support

Joining into Car Convoy - Lane Change/Merge

Weaving (Cloverleaf Enter/Exit Lane)

Lane change, merge, and weave maneuvers

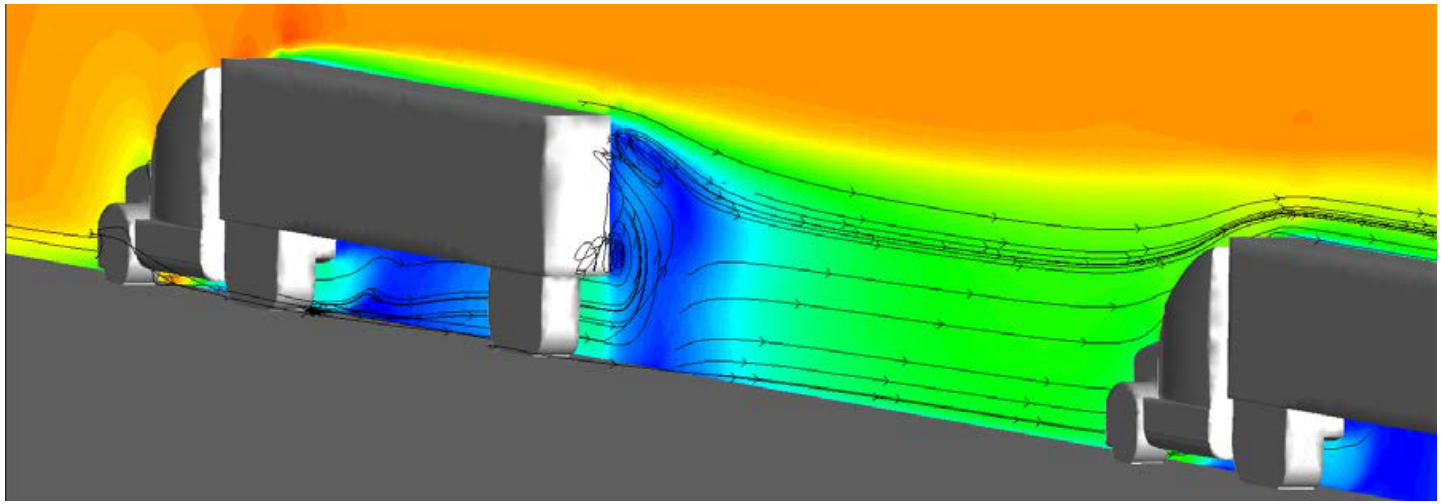
Eco GlidePath at Signalized Intersections



Source: USDOT, November 2013

Truck Platooning

- Two projects underway
  - Auburn U/Peterbilt (2-truck platoons)
  - Caltrans/UC Berkeley/Volvo (3-truck platoons)
- Concept: longitudinal control only; all drivers steer



Conclusion – Technical and Policy Challenges

- Public expectations and understanding
- Human factors
- Data ownership, privacy, and cybersecurity
- Testing and certification complexity
- Harmonizing state and local regulations

For More Information

http://www.dot.gov/

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