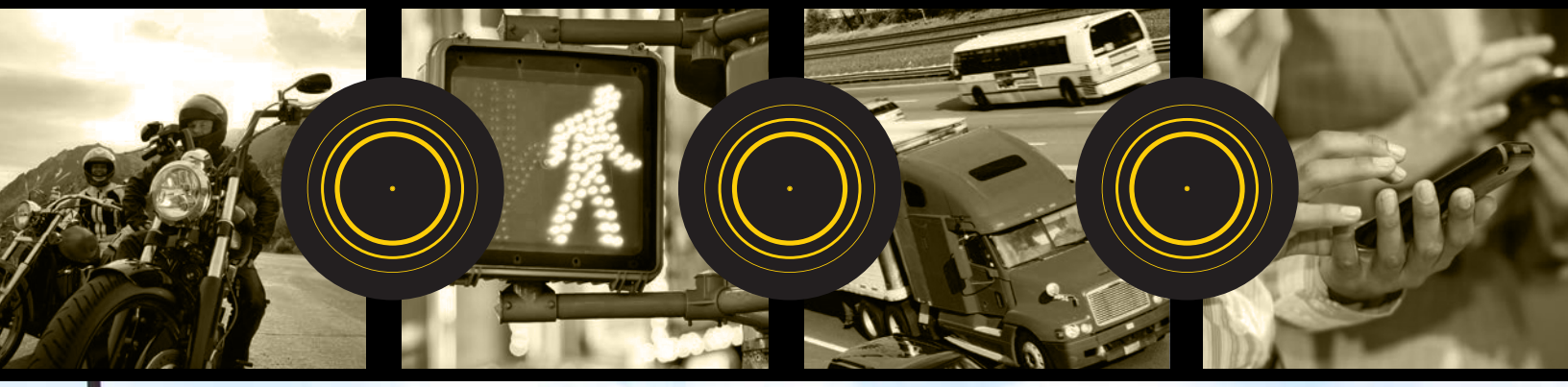

ITS 2015–2019 STRATEGIC PLAN

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

FHWA-JPO-14-145 | **www.its.dot.gov**

U.S. Department of Transportation

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16. Abstract

This document constitutes the Intelligent Transportation Systems Strategic Plan covering the years 2015 to 2019; it builds on the progress of the 2010-2014 plan and presents a wide array of technical, policy, institutional, and organizational concepts. It provides a comprehensive perspective that is based on an inclusive, collaborative, interactive, and iterative process, with a wide mix of stakeholder engagement opportunities that ensured that the Strategic Plan reflects the aspirations of the multi-faceted ITS community across the nation.

This new Plan: identifies a vision – "*Transform the Way Society Moves,*" and the ITS JPO's associated mission of advancing research that cuts across all surface modes; outlines technology lifecycle stages and strategic themes articulating outcomes and performance goals that define six program categories; describes "*Realizing Connected Vehicle Implementation"* and "*Advancing Automation"* as the primary technological drivers of current and future ITS work across many sectors; and, presents enterprise data, interoperability, ITS deployment support, and emerging ITS capabilities as additional program categories that are supplemental and interdependent activities critical to achieving the program's vision. The plan further identifies research questions aligned to every program category in each stage of the technology lifecycle, in addition to cross-cutting organizational and operational disciplines that relate to the program categories.

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Executive Summary

ITS technologies improve transportation safety and mobility, reduce environmental impacts, and enhance productivity through the integration of advanced communications-based information and electronic technologies into the transportation infrastructure and vehicles.

The United States Department of Transportation (USDOT) has long been a leader and strong supporter of research, development, adoption, and deployment of intelligent transportation systems (ITS) around the nation. The *ITS Strategic Plan 2015-2019* presents the next set of priorities, strategic themes, and program categories under which ITS research, development, and adoption activities will take place. The plan was developed with significant stakeholder input from all relevant parties, both within and external to the USDOT. Close collaboration with all surface transportation modes and other agencies within the USDOT helped shape the direction of the *ITS Strategic Plan 2015–2019*.

Strategic Priorities and Themes

Building on the momentum and success of prior and current research, and working on the areas that are at the forefront of ITS research going forward, two primary strategic priorities have been defined. These are: *Realizing Connected Vehicle* (CV) *Implementation* and *Advancing Automation*. The first builds on the substantial progress made in recent years around design, testing, and planning for CVs to be deployed across the nation. The second shapes the *ITS Program* around research, development, and adoption of automation-related technologies as they emerge. The priorities reflect a sense of where the bulk of transportation research and innovation is heading, but are not exclusive of other technologies or research areas.

As our environments become more connected in general, ITS and transportation will play an ever-more important and central role in our cities, towns, suburbs, and rural communities, between regions and across borders. The transportation system as a whole can best serve vital needs when it is using technology to its fullest potential and enabling transportation system managers to effectively "connect the dots" of information from various factors that affect transportation operations (e.g., weather, planned special

events, and response to unanticipated emergencies). The priorities, themes, and program categories presented in this plan provide a structure from which to approach research, development, and adoption of emerging and important technologies.

Photo Courtesy of USDOT

The strategic themes set the direction for the plan, like the priorities, and are meant to focus the attention of the ITS community on intended outcomes of new technologies and systems as they are developed, tested, and eventually adopted. The following themes align with the USDOT strategic priorities and are embedded in the program categories.

- **Enable Safer Vehicles and Roadways** by developing better crash avoidance for all road vehicles, performance measures, and other notification mechanisms; commercial motor vehicle safety considerations; and infrastructure-based and cooperative safety systems.
- **Enhance Mobility** by exploring methods and management strategies that increase system efficiency and improve individual mobility.
- **Limit Environmental Impacts** by better managing traffic flow, speeds, and congestion, and using technology to address other vehicle and roadway operational practices.
- **Promote Innovation** by fostering technological advancement and innovation across the *ITS Program*, continuously pursuing a visionary/exploratory research agenda, and aligning the pace of technology development, adoption, and deployment to meet future transportation needs.
- **Support Transportation System Information Sharing** through the development of standards and systems architectures, and the application of advanced wireless technologies that enable communications among and between vehicles of all types, the infrastructure, and portable devices.

Program Categories

While the priorities and themes provide high-level direction and structure for the *ITS Program*, individual programs perform the work that produces new systems to advance the goals of the USDOT and the ITS community at large. The plan includes program *categories* to provide the necessary structure for research, development, and adoption of ITS technologies. These categories reflect modal and external stakeholder input about the areas where attention, focus, and resources should be devoted. The lines between the program categories are not hard and fast, and it is expected that individual programs within these categories will often overlap or share resources, goals, deliverables, and timelines. Short descriptions of the program categories are included here.

- **Connected Vehicles:** The USDOT will focus much of its CV program activities on adoption and eventual deployment of CV systems. CV research, development, and eventual adoption fall into two areas based on activities in the USDOT, including NHTSA plans to issue a proposal by 2016 on vehicle-to-vehicle (V2V) safety messaging.

- *V2V communications based on dedicated short-range communications (DSRC) technology*. This is the area where NHTSA is continuing to pursue its rulemaking process. DSRC-enabled devices in vehicles that broadcast safety messages may be regulated by the USDOT and thus comprise a certain set of research, development, and adoption questions that are specific to this authority.
- *Other CV technologies and communications that are enabled by either DSRC or other networks, such as cellular, Wi-Fi, or satellite.* Although the USDOT is not researching regulatory decisions related to these other communications technologies, they are very much a part of the overall research and development foci. The *ITS Program* will consider how various technologies and communications media will interact and operate within the anticipated CV environment, including safety and other types of applications and messages.

- **Automation:** The automation program will focus on research about automated road-vehicle systems and related technologies that transfer some amount of vehicle control from the driver to the vehicle. Automation technologies offer tremendous possibilities for enhancing safety, mobility, and the environment, but also pose new technical and policy challenges. The focus of the *ITS Program* in this area will be on the advancement of technology and systems to enable smooth and safe introduction of automated features into the nation's vehicles and transportation systems.

- **Emerging Capabilities:** The USDOT's emerging capabilities program initiatives will focus on future generations of transportation systems. As the scale of CV implementation grows and automation of transportation systems increases, vehicle manufacturers, infrastructure providers, innovators, and entrepreneurs will discover new opportunities to use the technologies and data generated , while also protecting consumer privacy. Technological advances, new functionality, new applications, new operational concepts, and disruptive innovations will result. The USDOT will track technological, market, and demographic trends throughout the globe and across industries to seek and evaluate emerging capabilities that demonstrate the potential to transform transportation, while also protecting consumer privacy.

- **Enterprise Data:** With increased connectivity among vehicles, organizations, systems, and people, unprecedented amounts of data are being generated. New methods to collect, transmit/transport, sort, store, share, aggregate, fuse, analyze, and apply these data will be needed for management and operations of transportation systems. Enterprise data management initiatives focus on enabling effective data capture from ITS-enabled technologies, including CVs (automobiles, transit, and commercial vehicles), mobile devices, and infrastructure in ways that protect the privacy of users. These activities also focus on enhancing the creation of data environments that enable integration of data from multiple sources for use in transportation research, management, and performance measurement.

- **Interoperability:** Interoperability is essential to ensure effective connectivity among devices and systems. Interoperability focuses on enabling ITS elements in vehicles, devices, infrastructure, and applications to effectively communicate with other parts of the system as needed, regardless of where they are built and where or when they are used. Interoperability will be more critical than ever before with the implementation of CV systems and the introduction of automated transportation systems as system interdependencies increase, not only in number but also in

complexity. Standards and architectures must continue to evolve to ensure that technological advancements are reflected, and the required backward compatibility and interoperability are maintained.

- **Accelerating Deployment:** As new ITS technologies and systems evolve into market-ready products, the *ITS Program* must address questions associated with adoption and deployment. As defined in this plan, adoption includes the phase after testing, when technologies are ready for initial implementation in the "real world." As technologies transition from adoption to large-scale deployment, the responsibility of support for operators and deployers shifts from research and development to operations. Ensuring a smooth transition from initial adoption (seen as part of the overall research and development lifecycle) to widespread deployment, and working closely with deployers to understand and manage that transition require special attention and detailed programs.


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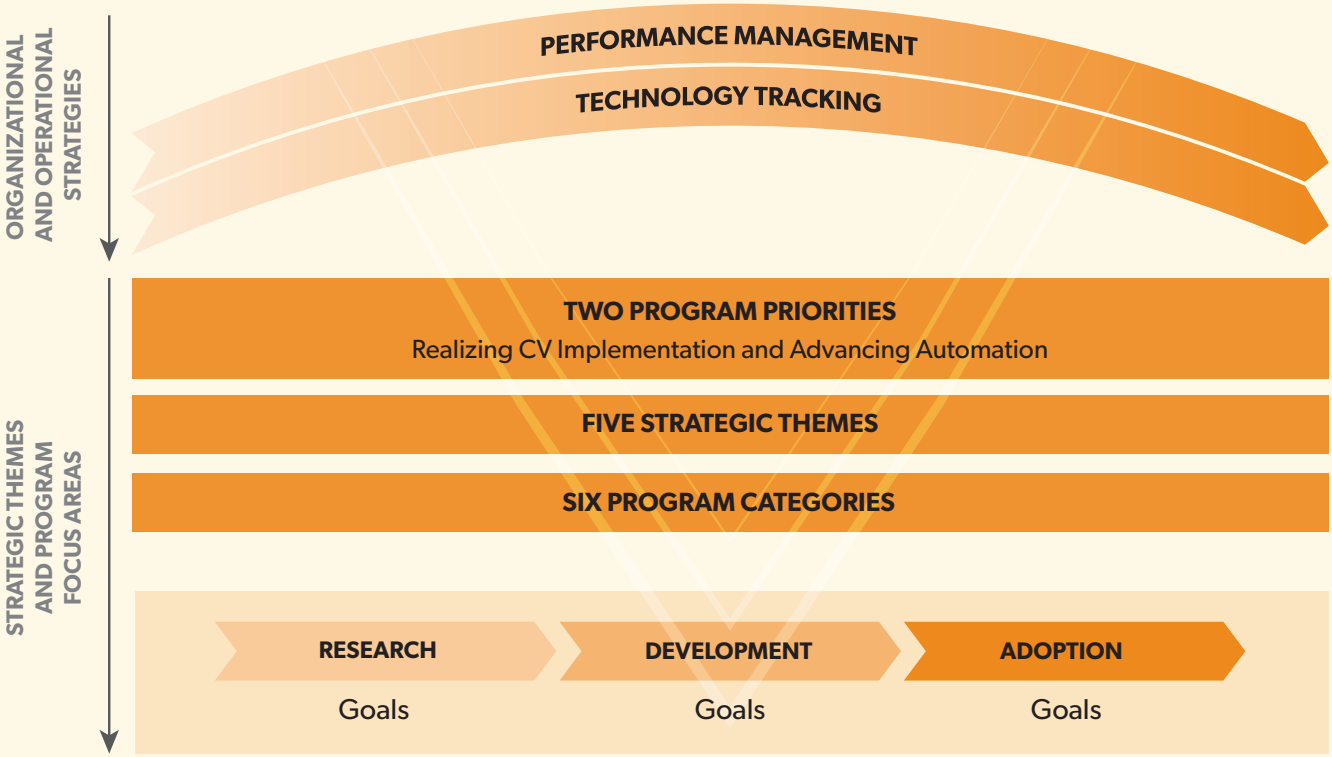
Benefits, focused research questions to guide program charter development and performance measurement, and relevance to stakeholder groups are all included in each program category in the plan. The research questions will be the primary guide to developing specific and actionable program plans that address real needs of various ITS-affected groups and communities.

Plan Layout

This is the first ITS Strategic Plan that includes a comprehensive structure that can be used to develop actionable goals, program milestones and timelines, and outcome measures to determine success. As such, several principles and guiding areas that were incorporated to create this structure and provide direction and focus to ITS research, development, and adoption. Figure 1 shows how the various pieces of the plan fit together and influence each other, as well as how high-level concepts are deconstructed into greater levels of detail with program categories and goals.

This approach is aimed towards execution of the USDOT *ITS Program* that is coordinated to manage the complexity of the total portfolio; applies a holistic approach to program management that delivers measurable results; and balances exploration of the state-of-the-art with elevation of the state-of-the-practice in close coordination with the modal agencies of the USDOT.

FIGURE 1 Holistic View of Organizational and Operational Discipline Components as They Relate to the Strategic Themes and Program Categories



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01

Realizing Connected Vehicle Implementation and Advancing Automation

1.1 Introduction

ITS improves transportation safety and mobility, reduces environmental impact, and enhances productivity through the integration of advanced communications-based information and electronic technologies into the transportation infrastructure and vehicles. For more than two decades, the USDOT has provided leadership of the national *ITS Program*.

During this period, the USDOT, through the work of the ITS Joint Program Office (JPO) in close collaboration with other modal partners in the Department, has responded to new transportation systems and user needs, advances in technologies, and evolving relationships between public and private sector organizations by periodically refining the direction of the federal *ITS Program*.

ITS is a set of tools that facilitates a connected, integrated, and automated transportation system that is information-intensive to better serve the interests of users and be

"*ITS Program*" refers to the entire USDOT portfolio of ITS-related programs, projects, and initiatives.

"ITS JPO programs" refers to the individual programs led and supported by the ITS JPO in support of the broader portfolio.


Photo Courtesy of USDOT

responsive to the needs of travelers and system operators. The USDOT cooperates with other federal agencies, public sector entities, appropriate private sector organizations, and international partners to support the implementation of ITS across the United States and around the world.

American travelers derive a substantial benefit from ITS. One estimate indicates that the societal benefits, from a key subset of ITS technologies, exceed $2.3 billion annually.[1] Yet millions of Americans experience ITS every day without even noticing. The technology tools made possible through ITS increase efficiency throughout transportation systems and increase the value of the transportation infrastructure that was delivered more than a generation ago.

American travelers are increasingly more conscious of their travel decisions, the personal consequences of those decisions, and their societal impact. The framework of the USDOT ITS Strategic Plan is built around the *ITS Program* priorities of *Realizing CV Implementation* and *Advancing Automation*. These priorities guide the development of the *ITS Programs* to harness the personal involvement.

The priorities reflect what many stakeholders noted: the need for the *ITS Program* not only to conduct research, but also to help with deployment and implementation of specific technologies related to both of these areas (CVs and automation). The first priority of *Realizing CV Implementation* builds on the substantial progress made in recent years around design, testing, and planning for CVs to be deployed across the nation. The *ITS Program* will continue to work in this arena and expand its current programs to include planning and support for adopters and deployers.

The second priority of *Advancing Automation* allows the *ITS Program* to delve into this innovative and cutting-edge field to research, develop, and adopt automation-related technologies as they emerge. Close collaboration with current industry and academic leaders in this field will be a cornerstone to this work. In many ways, automation technology builds on or leverages the technology and applications in the CV system, providing a close tie to the research activities associated with *Realizing CV Implementation.*

This document is the result of the latest review of the federal *ITS Program* and establishes the USDOT's ITS priorities for the period 2015 through 2019. Building from the priorities (*Realizing CV Implementation* and *Advancing Automation*), there are six program categories—CVs, automation, enterprise data, interoperability, emerging capabilities, and deployment support—within which the ITS JPO intends to focus its activities. These program areas provide the framework that the USDOT will use to conduct specific activities that advance the research, development, and adoption of ITS solutions toward the achievement of *CV Implementation* and *Advancing Automation.* While this document describes the federal *ITS Program*, it can be expected to influence ITS development and deployment across the broader national landscape.

1 *ITS Technology Adoption and Observed Market Trends from ITS Deployment Tracking,* USDOT Volpe Center, FHWA-JPO-10-066

1.2 The ITS Strategic Planning Process

Broad stakeholder engagement and consultation were essential components of the strategic planning process and provided an opportunity to develop ongoing commitment to ITS implementation activities among the participants. The stakeholders provided technical, organizational, contextual, and policy needs specific to their environments, resulting in a comprehensive transportation sector perspective of the ITS JPO activities moving forward.

Photo Courtesy of USDOT

Over 285 organizations were represented by the stakeholders who attended the various forums to provide input and feedback. Among these groups were representatives from state and local transportation organizations, academia, industry, trade groups, other state and local public organizations, and multiple federal agencies. Automobile manufacturers were represented in multiple forums, conferences, webinars, and questionnaires. State and local transportation organizations spanned the entire nation, and industry representatives were from various industries, such as automobile manufacturing, electronics, logistics, trucking, and consulting, among others. Appendix A includes the full list of stakeholder organizations.

Feedback and insights received from stakeholders such as quotes, questionnaire results, and written input have been integrated throughout this strategic plan in the various relevant sections. Additionally, positive comments were received from various stakeholder groups indicating their appreciation for the process for developing this strategic plan. Please refer to Appendix A for detailed analysis and stakeholder input.

Photo Courtesy of USDOT

02

Vision, Mission, Strategic Themes, and Technology Lifecycle

The vision and mission of the *ITS Program* articulate the long-term and operational foci of the Program. These aspirational and guiding statements provide direction and goals for the *ITS Program* and align to the internal activities of the ITS JPO and the entire USDOT in fulfilling these goals.

As noted in the USDOT ITS charter for the Strategic Planning Group: *"The ITS JPO is responsible for ITS research execution and initial technology transfer activities, such as field testing, though modal staff is involved throughout the research process. Once a technology is considered mature, the modal agencies assume responsibility for its ongoing support in most cases."* This plan outlines both the ITS JPO activities as well as the broader *ITS Program* strategies, which involve many other modal partners and stakeholders, both within and external to the USDOT.

Vision
Transform the way society moves.

2.1 Vision

Nearly every facet of our society is undergoing a shift of connecting the individual to the community. The "Internet of Things" movement is giving great power to the individual,

by personalizing information that is time and location-aware. The "Internet of Things" also allows the broad transportation community (including public agencies and private organizations) to be more equipped to address how individuals experience transportation. The paradigm in which we can balance individual decision making and system-optimal transportation management is within grasp.

The prior ITS Strategic Plan articulated connectivity as a concept for transportation services. The work produced under the aegis of connectivity has laid the foundation for making connectivity in transportation as ubiquitous as the experience of mobile internet access and highly tailored personal services.

The influence of the "Internet of Things" extends far beyond the reaches of transportation. People increasingly regard access to information as critical for sustaining their quality of life. Other societal functions are undergoing similar transformations as is the transportation sector. Public health, labor, commerce, public safety, energy, and other public systems are leveraging the tools of the "Internet of Things" to coordinate resources and optimize the delivery of a range of services to individuals.

In this ITS Strategic Plan, the vision statement of "Transform the Way Society Moves" aims to guide the *ITS Program* and the USDOT in finding the path to integrate transportation services with a range of other public institutions and services. The vision statement also supports the *ITS Program* and the USDOT in working with the private sector to establish new industry and economic opportunities.

The program categories that are described in the following pages outline a pathway for establishing transportation's domain among other information-rich services.

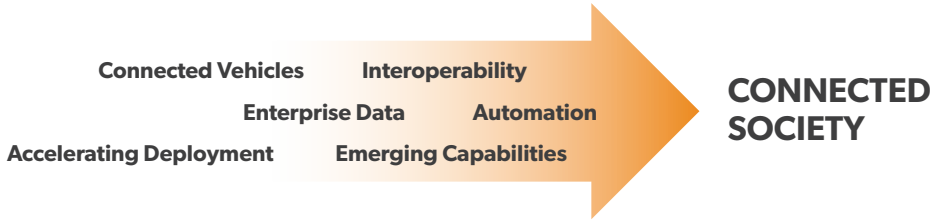


Photo Courtesy of USDOT

2.2 Mission

Figure 2 shows the hierarchy of the strategic plan and reflects the relationships among various components of the plan. All elements of the plan align and sync with each other, providing consistency and coherence to the overall *ITS Program*. The strategies and program categories described in the plan will help the ITS JPO determine its processes and priorities in advancing research, development, and adoption. Furthermore, the ITS JPO will be developing an Operational Plan, which will consist of a suite of program charters.

Mission

Conduct research, development, and education activities to facilitate the adoption of information and communication technology to enable society to move more safely and efficiently.

FIGURE 2 ITS Strategic Plan Hierarchy

STRATEGIC PLAN

The purpose of the **ITS Strategic Plan** is to outline the direction and goals of the *ITS Program* and provide a framework around which the ITS JPO and other DOT agencies will conduct research, development, and adoption activities to achieve the outcomes and goals of the overarching *ITS Program*. The plan will be used to inform interested stakeholders about the activities and priorities of the *ITS Program*.

OPERATIONAL PLAN FOR ITS JPO

The purpose of the **ITS JPO Operational Plan** is to provide a suite of program charters with resource allocations, milestones, responsibilities, and processes that the individual programs will develop. Working within the overarching structure and framework set forth in the Strategic Plan, the Operational Plan will allow the ITS JPO to maintain its focus and momentum along the program categories defined in the Strategic Plan.

2.3 Strategic Themes

Building from the program priorities, mission, and vision, the strategic themes described below reflect the broad areas of impact that the *ITS Program* aims have across all modes within the surface transportation sector. These themes help better define program categories (delineated in the next section of the plan) and reflect stakeholder input. The themes articulate the outcomes and performance goals that should be reflected in defining the *ITS Program* portfolio of activities.

- **Enable Safer Vehicles and Roadways** by developing better crash avoidance for all road vehicles, performance measures, and other notification mechanisms, as well as mechanisms to protect consumer privacy; commercial motor vehicle safety considerations; and infrastructure-based and cooperative safety systems. This strategic theme will include activities within the CV and automation areas, exploring how those technologies can help people avoid crashes through new safety advisories, warnings, messages, and ultimately, automated responses, in addition to exploring ways to enhance traffic incident management and responder safety when a crash does occur.
- **Enhance Mobility** by exploring methods and management strategies that increase system efficiency and improve individual mobility. This will be achieved through a variety of programs and applications, including improved traffic management, work zone and incident management, transit management, freight management, and road weather management, among others. It further leverages the full potential of CVs, travelers, and infrastructure to provide additional information and technologies that better facilitate mobility for all users of surface transportation systems.

- **Limit Environmental Impacts** by better managing traffic flow, speeds, and congestion and using technology to address other vehicle and roadway operational practices. This strategic theme explores how to reduce the environmental impacts of each trip by assisting system users and operators with "green" transportation alternatives and options such as avoiding congested routes, taking alternate routes, using public transit, or rescheduling a trip — all of which can make trips more fuel-efficient and eco-friendly.
- **Promote Innovation** by fostering technological advancement and innovation across the *ITS Program;* continuously pursuing a visionary/exploratory research agenda; and aligning the pace of technology development, adoption, and deployment to meet future transportation needs. This strategic theme further explores leveraging strategic partnerships with public and non-public entities to enable ongoing targeted outreach, engagement, and knowledge/technology transfer efforts. Promoting innovation will necessitate that the *ITS Program* focus on market scanning to increase awareness of new technology developments so that the ITS JPO is always on the cutting edge of current and upcoming innovations developed by others.
- **Support Transportation System Information Sharing** through the development of standards and systems architecture, and the application of advanced wireless technologies that enable communications among and between vehicles of all types, the infrastructure, and portable devices. Those communications break down barriers through shared transportation processes, shared resources, and common rules of operation. This work will support connectivity among vehicles, infrastructure, organizations, systems, and people to support more efficient and effective transportation.

Photo Courtesy of USDOT

Alignment of ITS Strategic Themes with USDOT Goal Areas and Moving Ahead for Progress in the 21st Century Act (MAP-21)

Because the *ITS Program* is embedded in the work of the larger USDOT and is influenced by legislation (MAP-21), it is critical that the plan align with the goals of the Department and Congress, as reflected in Table 1.

TABLE 1 Alignment of ITS Strategic Themes with Strategic Goal Areas and MAP-21[2]

ITS Strategic Plan Strategic Themes	USDOT Strategic Goal Areas						Map-21
	Safety	State of Good Repair	Economic Competitiveness	Livable Communities	Security, Preparedness and Related	Environmental Sustainability	
Enable Safer Vehicles and Roadways	✓	✓	✓	✓	✓		✓
Enhance Mobility	✓	✓	✓	✓	✓	✓	✓
Limit Environmental Impacts			✓	✓		✓	✓
Promote Innovation	✓		✓		✓	✓	✓
Support Transportation System Information Sharing	✓	✓	✓	✓	✓		✓

2 Please note that cells without checks do not indicate a discrete divergence from previously established strategy.

Both the research and development phases are iterative and include measurement and evaluation of the technology along the way. Findings often feed back into previous stages of research or development as new technology breakthroughs and challenges of the technology are discovered.

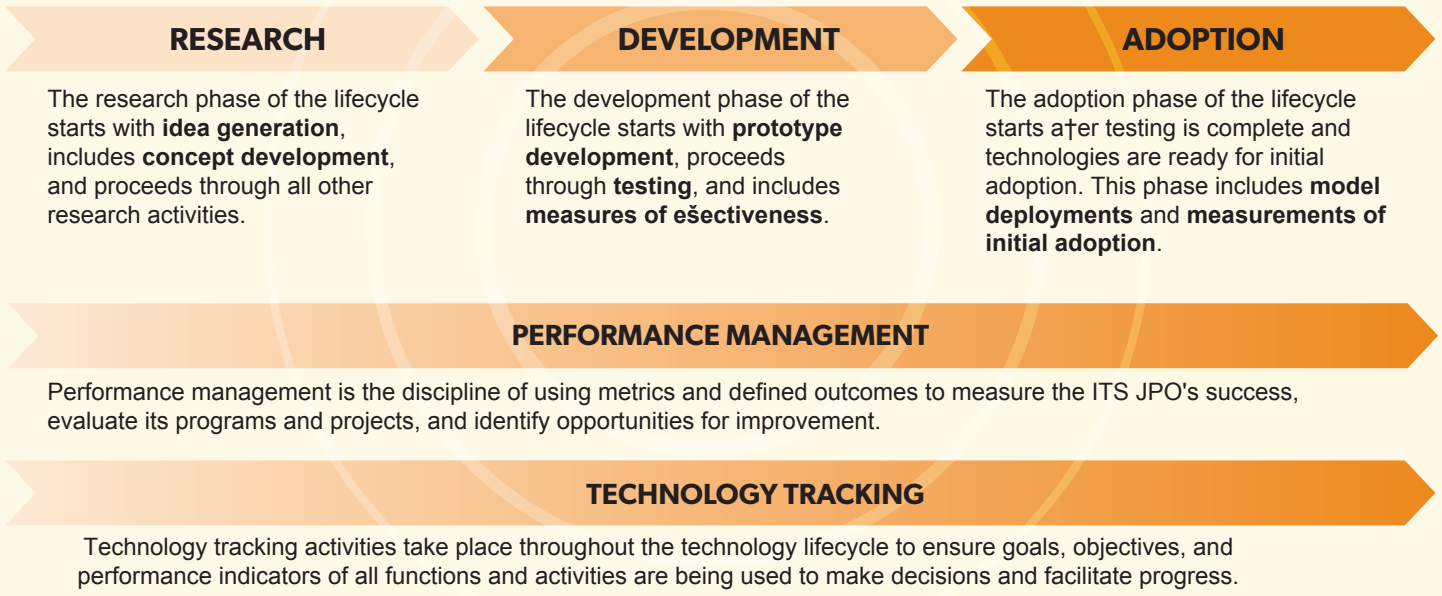
2.4 ITS Technology Lifecycle

The technology lifecycle serves as a framework to guide the focus and activities of the *ITS Program* in an effort to achieve adoption and help facilitate widespread deployment of new ITS technologies.

Figure 3 illustrates the lifecycle and the activities within each phase, as described here:

- Research Phase:
  - Begins with idea generation—the first step toward conducting research activities
  - Includes concept development and research activities
- Development Phase:
  - Transitions from research phase to prototype development
  - Progresses into testing
  - Includes measures of effectiveness development
- Adoption Phase:
  - Is the culmination of the *ITS Program* activities
  - Focuses on bringing new ITS technologies to market, often in a few initial sites with early adopters
  - Includes support of early adopters, and education and training activities, as well as marketing activities to increase awareness and understanding of the technology or system.

FIGURE 3 ITS Technology Lifecycle Process Framework



Throughout this technology lifecycle, the *ITS Program* must integrate strong communication and education activities to solicit partners and input at the research phase, work with testing partners and other agencies during the development phase, and train and educate early adopters during the adoption phase.

Figure 3 presents the lifecycle and the overarching organizational disciplines (identified as performance management and technology tracking) that are applied across and throughout the duration of *ITS Programs*. The following sections provide additional discussion of each phase.

Photo Courtesy of USDOT

Research Phase Characteristics

The role of research within the context of the *ITS Program*'s mission is to help plan, gather information, and test ideas that might eventually be developed into ITS technologies and subsequently be deployed to advance transportation. Research helps validate the development of new technology by supporting the ideas, opinions, beliefs, and findings of a variety of stakeholders. Almost all programs will begin with the research phase.

To be successful, all stages of the lifecycle must follow certain processes and disciplines, across any program or activity. For the research phase, these disciplines include:

1. Organize programs around key areas of interest across stakeholders
2. Determine the outcomes desired for each program
3. Define performance indicators for each program to establish a means for tracking progress.

Development Phase Characteristics

Transforming an ITS technology concept into a usable transportation product must include extensive prototyping and testing, including consideration of security features, minimization of technological risks, standardization, and determination of the appropriate set of technologies to be integrated into a larger system where applicable.

Development disciplines include:

1. Specify outcomes and key performance indicators to maintain focus and track progress over time
2. Establish a regular evaluation process to ensure development efforts maintain the initial intended purpose; adjust accordingly based on evaluation findings
3. Develop and implement prototypes and testbeds to achieve the goals of any program, feeding results back into the research questions and intended outcomes
4. Analyze results in terms of costs and benefits to users and operators to gain a clear perspective of the value of the new technology or system.


Photo Courtesy of USDOT

Adoption Phase Characteristics

The adoption phase is the culmination of the research and development activities within any given area or program. Once tests have been successful and technical challenges have been addressed, the adoption phase can begin and pave the way to deployment. The *ITS Program*'s fundamental role in this phase is to support and help implement the new technologies for the first time, focusing on training, educating, and communicating the value of the technology.

Adoption disciplines include:

1. Provide support to stakeholders in the early adoption of ITS technology using an agreed upon plan that includes timelines and costs
2. Work to embed key adoption success factors into the environment and process prior to the start of the adoption phase
3. Track performance indicators and manage risk factors throughout the research and development stage to reduce adoption risks and increase probability for adoption and implementation
4. Ensure that the right audiences are engaged in order to facilitate and engender buy in for larger-scale deployment.

The adoption phase sets the stage for large-scale deployment. As technologies transition from adoption to large-scale deployment, the responsibility of support for operators and deployers shifts from the ITS JPO to other agencies within the USDOT and even across other government departments and agencies. More about this transition and the movement from adoption to deployment is included later in this plan in the description of the in the Accelerating Deployment program category.

Table 2 presents a set of questions for each phase of the technology lifecycle, from research to deployment. The questions are designed to be applicable to any given ITS technology to ensure a strategic approach, fact-based decisions, and efficient execution throughout the lifecycle to achieve the level of desired success.

TABLE 2 Key Lifecycle Phase Questions

	Research
Key Research Questions	Have the targeted user(s) been identified?
	Could the potential technology fill a gap or enable advancement of another ITS technology?
	Has the research already been started or conducted in this or similar area(s)?
	Is the timing right to begin this research or are there other areas that require attention before this can be successful?
	Is this research area going to become obsolete in the next 5-10 years? And how reliable are the data and/or the study used to draw this conclusion?
	Would prospective users need to invest greatly to adopt the technology?
	How would the value provided by the technology justify their investment?
	What possible outcomes can be defined?
	Development
Key Development Questions	Are there sufficient data and information available to share with prospective users and key stakeholder groups?
	Has a value proposition that aligns directly with the needs of targeted users been developed and generally accepted by these groups?
	Have obstacles and barriers to testing been identified, and have mitigation plans been developed and approved?
	Have the security risks, features, and challenges been defined to the level that action can be taken to address?
	Have technological risks been identified?
	What measures of effectiveness can be developed?
	What sources of data are needed to test the measures of effectiveness?
	Adoption
Pre-Adoption Phase Decisions	Who are the people or groups of people who are actually ready for the technology?
	Who has the infrastructure to support adoption?
	Has the total cost of adoption and/or range of cost been calculated and fully communicated? If so, who can afford the cost of adoption?
	Does the target audience have the necessary processes in place to support the new technology or will their existing processes limit how the technology can be used?
	Does the solution that the technology offers limit the market's willingness to spend?
Key Adoption Questions	Do those being targeted for adoption of the ITS technology have the infrastructure to support the technology?
	Who are the partners for the on-the-ground adoption efforts and how can the JPO work with these agencies/organizations?
	Will an investment in the ITS technology solution require additional investment for those being targeted for adoption?
	Does the *ITS Program* have strategies and plans in place to help prospective adopters overcome the identified limitations?
	Are the necessary enabling technologies at a place where integration into the new technology is possible?
	Is there a need to help facilitate a new process for prospective adopters in order to accommodate the new technology?
	How does empirical measurement of outcomes compare with initial expectations?
	Deployment
Key Deployment Questions	Have specifications for the various roles required to manage the deployment been developed?
	Is there a defined and standardized work plan broken down by deployment functions that can be used and continuously improved upon?
	Have deployment measures around defined deployment functions and roles been established so that effective management can take place, rates of deployment can be continuously tracked and improved, and deployment costs can steadily decrease?
	Are deployment plans and performance data being shared with targeted users in the development and adoption phases so that expected levels of risk can be factored into the go/ no go decisions of targeted users?


Photo Courtesy of USDOT

03

ITS Programs

The program priorities of *Realizing CV Implementation* and *Advancing Automation* address the primary technological drivers of current and future ITS work across many sectors. The priorities have been chosen not to exclude other areas of ITS research and development, but as a reflection of where much of the focus across multiple sectors for advancing transportation technologies and systems is anticipated to be. These areas represent the ambitions and future-looking goals for transforming transportation technologies and the way users engage with the transportation systems.

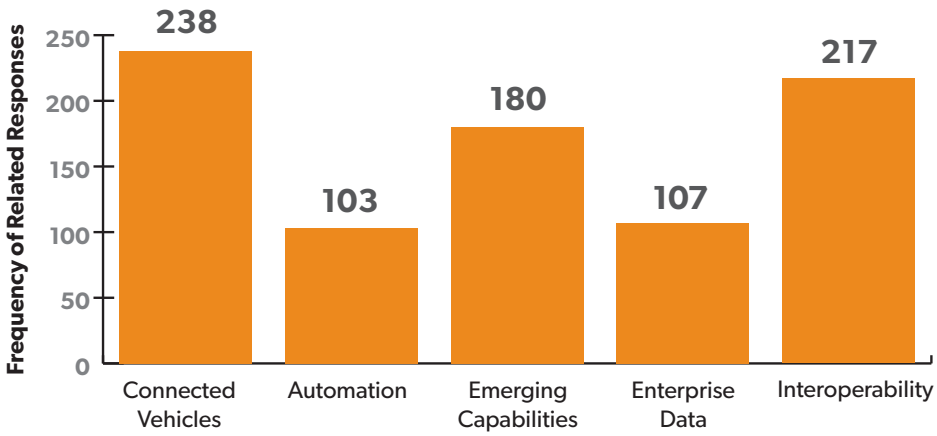
The program priorities are the same focus as the first two program categories. Other program categories include supplemental, interdependent activities surrounding enterprise data, interoperability, emerging ITS capabilities, and accelerating ITS deployment. These categories capture evolving stakeholder needs related to CV implementation and automation, while also providing mechanisms for data management, standards development, and innovation.

A variety of engagement opportunities were held during 2013 to solicit input from a large group of varied stakeholders. These opportunities included webinars, question-

naires, conference sessions, and IdeaScale forums. The input from these sessions was instrumental in developing the program categories, and is comprehensively included in Appendix A.

Figure 4 depicts the frequency with which stakeholder responses highlighted the five most common program areas, reflecting a large majority of responses.

FIGURE 4 Stakeholder Prioritization of Program Categories



845 unique responses were collected from stakeholders representing over 285 organizations across various industries. Representatives from industry, academia, trade organizations, federal agencies, state and local transportation agencies, and nonprofits interacted through a series of six webinars and six in-person meetings.

3.1 Program Categories

Today's *ITS Program* includes a large portfolio of programs that researches diverse systems and technologies based on an evaluation of the kinds of technologies and systems that will make the most impact in achieving significant transportation transformation. Many of these programs are already well into the research, development, or adoption phases. In the next few years, projects and programs that are either related to existing programs, or completely new, will emerge and become core areas of focus for the *ITS Program*. These program categories are not mutually exclusive, and programs may overlap in how they align.

Program categories represent the types of detailed programs that will provide the work needed to advance the mission and vision.

The purpose of defining these program categories is not to place hard boundaries between them. In a complex field, it is natural that program categories have some degree of overlap. These program categories establish a framework for the ITS JPO to focus and prioritize its efforts.

This section describes each program category, its associated benefits, and a set of research questions that will drive the activities of the programs within each category. Current activities will be evaluated within the context of this plan and the program categories. Decisions about potential transition to other agencies or continuation of existing activities within the new structure will be made as program charters are developed and milestones defined within the Operational Plan. Also of note is that many programs will include research and analysis into unintended consequences, including comprehensive cost-benefit analyses and models.


Photo Courtesy of USDOT

Figure 5 illustrates how the program categories relate to each other, with enterprise data and interoperability laying the foundation for the other programs. The pillars of CVs, automation, and emerging capabilities represent the technology and systems-focused programs. The top triangle of accelerating deployment illustrates that all of the programs will eventually arrive at this stage, moving the work from research, development, and adoption, to large-scale deployment, and transition into the elevated state-of-the-practice. This figure is used throughout this section to refer to the relevant categories.

The five strategic themes (enabling safer vehicles and roadways, enhancing mobility, limiting environmental impacts, promoting innovation, and supporting transportation connectivity) are reflected throughout the program categories. All of the categories, and several of the future detailed programs within those categories, will include multiple strategic themes in their goals and activities.

FIGURE 5 Program Categories

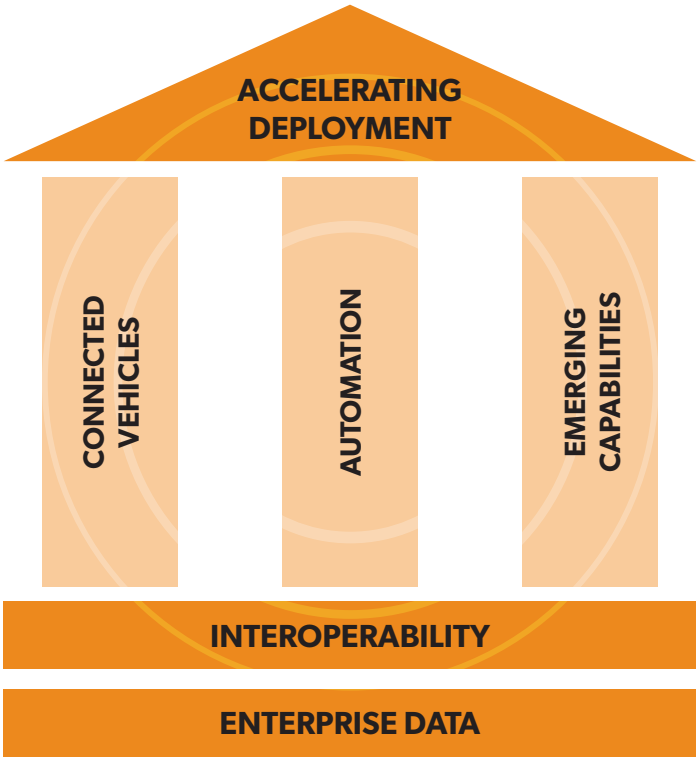
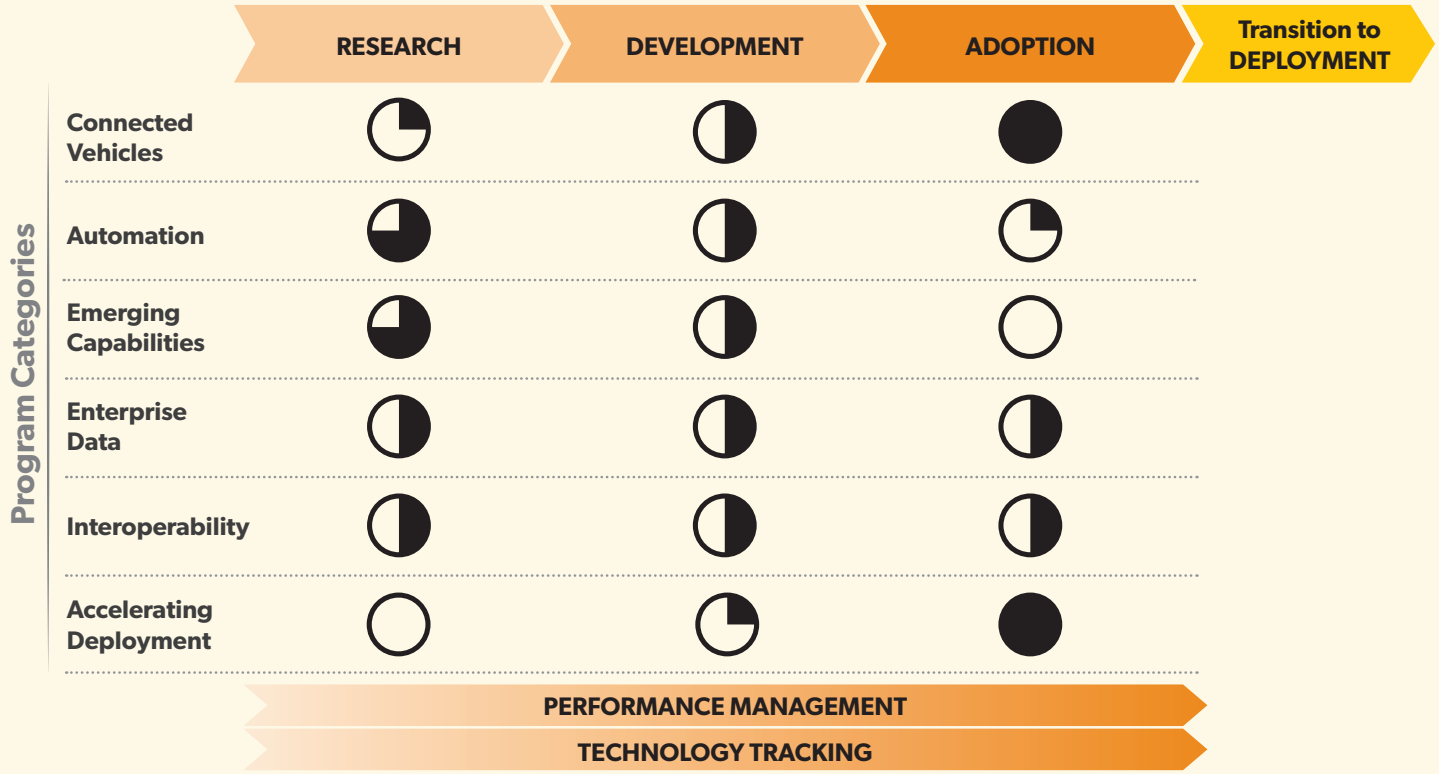


Figure 6 illustrates the *ITS Program*'s technology lifecycle mapped with the program categories. This matrix illustrates how the lifecycle stages apply to all program categories. The intention is that as individual programs (within the categories) develop their detailed plans and charters, within the ITS Operational Plan, various activities within each lifecycle phase will be defined, per the program and technology needs. The different circles within each cell in this figure represent the extent to which that program category's activities are anticipated to fall within the technology lifecycle phase. The more a circle is filled, the higher the degree of activity is anticipated in the particular timeframe of this Strategic Plan (2015–2019).

FIGURE 6 *ITS Program* Emphasis According to Technology Lifecyle Stages

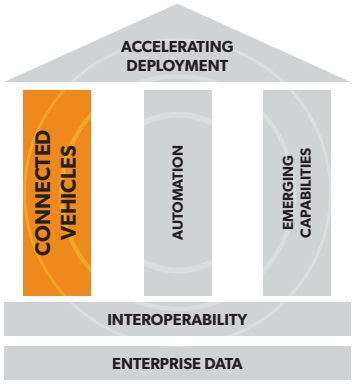


For each program category, a set of research questions has been defined. These questions will guide the individual program charters that will be included in the Operational Plan. In turn, those charters will specify activities that the ITS JPO will undertake in its mission to address the research questions.

Research questions characterize the broad scope of each program category. These questions will shape the program definitions as the ITS JPO creates the work activities.

Program Category: Connected Vehicles

The USDOT will focus much of its CV program activities on adoption and eventual deployment of the system. Future advancements in research and testing of CV technology will not be ignored. In fact, as CV technology is rolled out, added functionality, new applications, and technological enhancements will be investigated under this program in response to user needs and technical issues that arise with scaled deployments supported and informed by the work in the *ITS Program*.



CVs will be adopted by different demographic communities at different rates. The continued safety and convenience of those who remain unconnected must be considered.

IdeaScale Submission

As the CV program moves from heavy attention in the research phase to more investment in the development and adoption phases, increased focus on test beds and pilots will be a natural part of the future activities. At the same time, policy and institutional issues


Photo Courtesy of USDOT

The NHTSA Decision

NHTSA announced on February 3, 2014, that it will begin taking steps to enable V2V communication technology for light vehicles. This technology would improve safety by allowing vehicles to "talk" to each other and ultimately avoid many crashes altogether by exchanging basic safety data, such as speed, direction, and relative position, 10 times per second. When cars share this information at such a fast rate, they can "see" all of the vehicles around them, sense the possibility of a crash, and warn drivers to avoid the crash.

http://www.dot.gov/fastlane/v2v-cars-communicating-prevent-crashes-deaths-injuries

involving deployment will be addressed as deployment scenarios and business models are more thoroughly tested in a real-world environment. Technical guidance and support, professional capacity building, and certification requirements will continue to be important elements of the program as the CV system becomes a reality. Evolution and harmonization of standards for the CV system is already underway and will play an increasingly prominent role as the industry approaches implementation.

CV research, development, and eventual adoption fall into two areas, based on activities in the USDOT, including NHTSA plans to issue a proposal by 2016 on V2V safety messaging (refer to call out to the left). The two primary types of communications technologies that drive CV activities are as follows:

- *V2V communications based on DSRC technology*. This is the area where NHTSA is continuing to pursue its rulemaking process. DSRC-enabled devices in vehicles that broadcast safety messages may be regulated by the USDOT and thus comprise a certain set of research, development, and adoption questions that are specific to this authority.
- *Other CV technologies and communications that are enabled by either DSRC or other networks, such as cellular, Wi-Fi, or satellite.* Although the USDOT is not researching regulatory decisions related to these other communications technologies, they are very much a part of the overall research and development foci. The *ITS Program* will consider how various technologies and communications media will interact and operate within the anticipated CV environment, including safety and other types of applications and messages.

Potential Benefits of the CV Program Include:

- Increases in safety, mobility, system efficiency, and access to resources for disadvantaged groups, and decreases in negative environmental impacts such as vehicle emissions, the need for physical expansion, and noise
- Decreases in undesirable transportation impacts to the environment and society
- Increased opportunities to partner with non-government groups, such as private industry and universities
- Real-time and real-world data to help with transportation planning and transportation system operations
- Demonstrations of CV environments that fit into real-world environments of today
- Reduction of fatalities through weather-related, safety, infrastructure-based, and other applications

Research Questions that Guide the Detailed Programs

Research questions associated with the CV program category are presented in Table 3. They are categorized according to each stage of the technology lifecycle.

TABLE 3 CV Research Questions that Guide the Detailed Programs

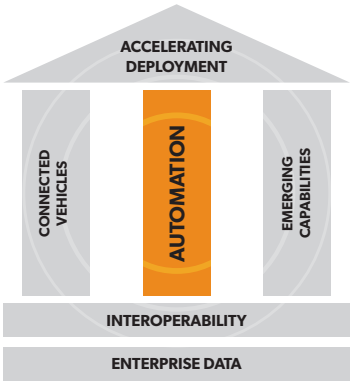
Research
What life cycle benefits can be realized from a CV system?
What are the estimated costs and benefits of CV systems?
How can CV system needs and capabilities be integrated into legacy ITS systems?
How can V2V and V2I security be addressed?
What are viable business models for large scale deployment of the CV system?
What are the elements needed for a complete vulnerability / risk assessment of the CV environment?
How can CV system implementation enable new automation?
Development
Is the security system technically and organizationally representative to support pilot tests and operational deployment?
What are the results of prototypes and tests of the security system (SCMS)?
How will the range of CV apps be integrated with vehicle-based systems?
How will CV systems be accommodated in other roadside systems and technologies?
How can driver distraction be minimized on in-vehicle products, while also maximizing operators' responses?
What are the internal organizational structures in the SCMS that are the best options for deployment?
How will commercial vehicles use the CV environment, and how can they become early adopters?
How can state and local agencies harness CV data, technologies and applications – and leverage these effectively and efficiently to help achieve overall economic, social, and other goals?
How much CV penetration is required to realize benefits from deployment of CV infrastructure?
Adoption
How are state and local agency functions supported in the CV environment deployments, and how to connect CV systems to jurisdictions' current systems and operations?
How are transit agency functions supported in the CV environment deployments?
Are personal devices incorporated into CV product delivery?
How are privacy protections being deployed?
How do transportation services and CV technologies, data, and applications intersect with other sectors of the economy (energy, telecommunications, computing, public safety, public works, public transit, logistics, industry, public health, retail, etc.) and how can these be leveraged together to the overall benefit of a jurisdiction, and to address critical issues and challenges?
Who are the core stakeholders/partners in the public and private sectors to develop strategies and best practices to leverage CVs, data, technologies and applications, and push forward the state of the practice and the state of the art?
How and where is CV training available and are the necessary skills and information disseminated widely enough?
How can CV early adopters (participants in pilots) contribute to technology transfer and training to facilitate enhanced adoption and deployment?
Are public safety officers and emergency responders/personnel included in the CV education/adoption plans?
How can CV data—along with other transportation data—be used to create innovative and informative real-time visualization techniques to support decision making by public agencies and connected travelers?
What institutional barriers may prevent CV data from being accessed and/or integrated with other data sources in urban areas to meet transportation and mobility needs?
How are planning agencies harnessing the potential of CV environments, and supporting smart transportation applications in the traditional transportation planning process?
How can planning, piloting, implementation, and proof of benefits help demonstrate the need for an eventual investment in in national deployment of CV?
How will social equity be impacted by CV technologies?
How will choices be made regarding deployment, and will there be guidance on priority deployment areas?
What funding sources can be used for CV deployment, operation, and maintenance?

The transition to automated vehicles is a key challenge. There is a need to understand the key tipping points as the fleet mix changes, including the diverse levels of automation which will likely exist.

Connected Vehicle Trade Association September 2013 Jam Session Report

Connected Vehicle Trade Association September 2013 Jam Session Report: http://www.connectedvehicle.org/wp-content/uploads/2013/10/2013_Summit_Jams.pdf

Program Category: Automation



Automation focuses on research about automated road-vehicle systems and related technologies that transfer some amount of vehicle control from the driver to the vehicle. Different levels of automation may have a significant impact on driving safety, personal mobility, energy consumption, operating efficiency, environmental impact, and land use. While research into automated vehicles and other aspects of automation are in the early stages, it is fast gaining attention around the world in all sectors of the economy. Developing and adopting varying levels of automation technologies offer tremendous possibilities for enhancing safety, mobility, and the environment, but also pose new technical and policy challenges, and the *ITS Program's* focus in this area will be on the development of technology and systems to enable smooth and safe introduction of automated features into the nation's vehicles and transportation systems. The USDOT is already working closely with stakeholders to address these challenges, but greater focus will be required as automated features are introduced into the nation's vehicles and transportation systems.

In addition to investigating various stand-alone aspects of automation, the USDOT is also researching how connectivity could enhance the potential benefits of vehicle automation systems, in effect bridging the gap between CV research and automation research.

Potential Benefits of Automation Programs Include:

- Reducing the number and severity of crashes caused by drivers or by other conditions (e.g., weather, pedestrians, roadway conditions)
- Reduction of aggressive driving
- Expanding the reach of transportation modes to disabled and older users, as well as providing "last mile" connectivity service for all users
- Increasing the efficiency and effectiveness of existing transportation systems
- Providing guidance to state and local agencies to help them understand the impacts of automated vehicles on the assets that they manage (i.e., roads, bridges, land, etc.)

Research Questions that Guide the Detailed Programs

Research questions associated with the Automation program category are presented in Table 4. They are categorized according to each stage of the technology lifecycle.

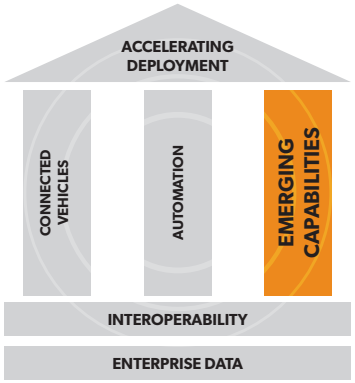
TABLE 4 Automation Research Questions that Guide the Detailed Programs

Research
What should be the role of the Federal government in automation research and development?
What policies are needed to harness benefits from automated vehicles?
What are the benefits from establishing connected automation?
What are users' expectations for automated vehicles?
What are the security needs for various levels of automated environments?
What are the liability issues related to automation?
How to define characteristics for the automation environment?
What are the core elements and the performance criteria for automation?
What are the risks associated with automation applications?
What role will infrastructure play in an automated environment?
Development
What are the non-technical barriers to deployment of automated systems?
What automated vehicle applications can be demonstrated before 2019?
What technical challenges are barriers to deployment of automated systems?
What aspects of automated vehicles impact current law enforcement activities?
How does data produced from "opt in" systems or applications impact policy?
How do vehicle automation systems leverage connectivity to improve their performance and reliability?
What type of naturalistic testing should the USDOT support for automated vehicle systems?
Is there a consolidated focus between CV pilots and automation?
Adoption
What is the appropriate Federal role in facilitating and encouraging deployment of automated systems? Is this different at different levels of automation?
What is the role of early adopters (specialized drivers) in automation adoption and deployment?

There is an evolution we see to accommodate technology and rely on the private sector. We need to look at bridging technologies and enabling technologies to get to goals we want to achieve.

CV Public Meeting
September 2013. Arlington, VA

Program Category: Emerging Capabilities



USDOT emerging capabilities program initiatives will focus on future generations of transportation systems. As the scale of CV implementation grows and as automation of transportation systems increases, vehicle manufacturers, infrastructure providers, innovators, and entrepreneurs will discover new opportunities to use the technologies and the data that will be generated. Technological advances, new functionality, new applications, new operational concepts, and disruptive innovations will result. The USDOT will track technological, market, and demographic trends throughout the globe and across industries to seek and evaluate emerging capabilities that demonstrate the potential to transform transportation. As this happens, the USDOT will be positioned and engaged as a partner to guide research, development, and technology adoption in a systematic manner.

Potential Benefits of Emerging Capabilities Programs Include:

- Forge stronger relationships and partnerships with private industry and universities
- Provide the ITS JPO with the ability to adapt existing or upcoming programs to accommodate new ITS technologies
- Stimulate economic growth through innovation and technological leadership.

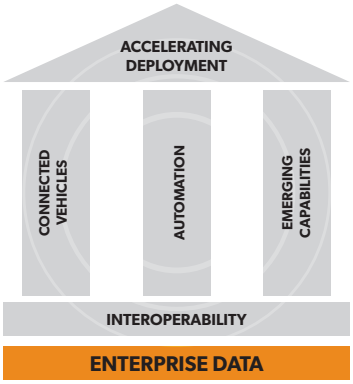
Research Questions that Guide the Detailed Programs

Research questions associated with the Emerging Capabilities program category are presented in Table 5. They are categorized according to each stage of the technology lifecycle.

TABLE 5 Emerging Capabilities Research Questions that Guide the Detailed Programs

Research
Are promising long-range technological advances being developed in the private sector and within research labs/organizations reviewed for application in transportation?
What disruptive forces are likely to change transportation systems and services in the future? What trends will drive innovation and new technologies?
What is the state of the field in terms of electric/non-gas powered vehicles?
How will electric vehicles (EVs) and other alternative-fuel (alt-fuel) vehicles affect mobility in the future (including the economics and purpose of driving), and how might these changes affect the deployment of CV technologies and applications?
How can crowdsourcing, social media, gamification, and incentivization strategies become effective decision support tools – not only for real-time needs, but to meet longer-term public policy objectives and perhaps even instigate social/behavioral change over time?
How will the expanding market for EVs and other alt-fuel vehicles change the mobility landscape in a city, change the expectations of drivers, and affect tax revenues of cities and states?
Development
Are commercial products available today that can be applied for transportation operations?
How will CVs interact with the grid, the cloud, and EVs? How do we better integrate the operational characteristics of EVs into CV applications?

Program Category: Enterprise Data



With increased connectivity among vehicles, organizations, systems, and people, unprecedented amounts of data are being generated. New methods to collect, transmit/transport, sort, store, share, aggregate, fuse, analyze, and apply these data will be needed for management and operations of transportation systems. The USDOT will not only continue its efforts in operational data capture from stationary sensors, mobile devices, and CVs, but will expand its research activities involving the development of mechanisms for housing, sharing, analyzing, transporting, and applying those data for improved safety and mobility across all modes of travel. In addition, a focus on open data sources and access will reflect the current state of the field and a market trend towards consideration of open data code development and storage/access. Large data management organizations, as well as other technology and data-intensive organizations have begun to engage with the USDOT in early discussions of how to integrate open data concepts and approaches as appropriate in various ITS technology research efforts.

Enterprise data initiatives and data management focus on enabling effective operational data capture from ITS-enabled technologies, including CVs (automobiles, transit, commercial vehicles, and connected users contributing situational data via social networking), mobile devices, and infrastructure in ways that protect the privacy of users. It also focuses on enhancing the creation of data environments that enable integration of data from multiple sources for use in transportation research, management, and performance measurement.

Large data sets are also needed as the basis for new applications to support mobility, safety, and greater efficiency of transportation assets. The availability of enterprise data is crucial for continued innovation. A related topic of investigation is also the appropriateness, value, implications, and context for using open source data and applications. As this becomes an increasingly important part of the data management and code development communities, the USDOT will bring the analysis of open source data and code into relevant projects.

Potential Benefits of Enterprise Data Programs Include:

- Providing new revenue opportunities
- Monitoring performance and enabling more efficient responses
- Increasing efficiency of information sharing
- Assuring the public that the privacy of data will be protected
- Improving quality (accuracy and timeliness) of data
- Stimulating innovation in new applications by enabling research
- Efficiently managing large datasets

In research, there is a need to understand how to perform Big Data collections and analysis. In deployment, there is a need to understand how to extract data to enable research topics across broad areas.

Transit Stakeholder

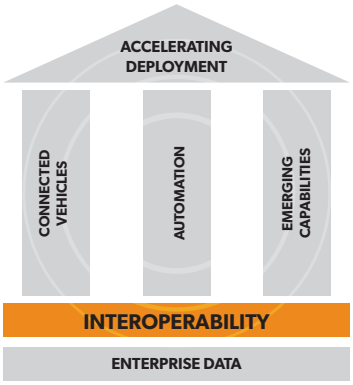
Research Questions that Guide the Detailed Programs

Research questions associated with the Enterprise Data program category are presented in Table 6. They are categorized according to each stage of the technology lifecycle.

TABLE 6 Enterprise Data Research Questions that Guide the Detailed Programs

Research
What additional data from EVs might be usable for various applications/uses?
Can data from vehicles be used to determine liability in various crash scenarios?
To whom does value flow from CV data?
Who owns data in various application scenarios, and how are data rights protected or shared?
What is the Federal role in managing large data sets that are produced in the CV environment?
What data are most useful to different users and operators?
How can various data sets be used?
How can new data sets be integrated with other legacy data management systems?
How to develop communications designs (specs, min standards for design) that can be readily replicated?
What are the data needs of public agencies and are they being fully addressed with current standards?
From what variety of sources can transportation data be collected? What technologies and methodologies are most useful for doing so?
Development
What will be needed in the transportation management center (TMC) of the future to use and leverage information and output alerts?
What are appropriate data sharing schema?
Are guidelines needed to filter and manage CV-generated data?
How can CV data be integrated with a wide variety of other data in order to create the most effective, innovative and informative real time (and predictive) data visualizations to support effective and efficient decision-making by a variety of public agencies and also by connected travelers?
What communications media impact messages in and out of the vehicle?
Do devices perceive the data that are of value? What can be done to prioritize messages? (establish a message prioritization scheme to avoid distracted driving)?
Is automation leveraging the CV environment and enterprise data?
How will operational data environments enable more open access to data that enables the widest opportunity for application creation?
How do CV data management systems contribute to market stimulation and sustainment?
Adoption
How to provide education to support data use and development?
How can cities and agencies leverage the opportunities presented by internet-connected mobile communications technologies — and the data they collect and generate — to connect to citizens, influence traveler behavior in the short and long term, and affect public policy and decision-making?
Is the (contextual and time sensitive) economic value of data understood?
Is the needed technical data expertise available to optimize data structures?
How does opt in of enterprise data expose policy and safety issues?
How to enable new business relationships between the public and private sector to ensure privacy protection?
Are partnerships with State/local DOTs capturing best practices that pinpoint the value enterprise data?
What other sectors might benefit from CV data?

Program Category: Interoperability



The USDOT will continue to focus on interoperability to ensure effective connectivity among devices and systems. Interoperability will be more critical than ever before with the implementation of CV systems and the introduction of automated transportation systems as system interdependencies increase, not only in number but also in complexity. Standards and architectures must continue to evolve to ensure that technological advancements are reflected, and the required backward compatibility and interoperability are maintained. Testing and certification will become more important as CV systems are implemented on a broader scale. Interoperability is especially important on a national basis to ensure that transportation system users and travelers, regardless of the vehicles they drive, transportation mode they use, or the road they travel, are provided consistent, reliable performance from their transportation systems.

You have to consider that the vehicle systems are also connected to safety systems. We have to be careful in a heavily regulated industry so we need to have things that fit into the lifecycle of a vehicle – to standardize vehicles.

CV Public Meeting
September 2013. Arlington, VA

Interoperability focuses on enabling ITS elements in vehicles, devices, infrastructure, and applications to effectively communicate with other parts of the system as needed, regardless of where they are built and where or when they are used. This focus area includes the development of architectures and standards intended to move many ITS-related technologies, agencies, and operations away from distinct silos or legacy systems and institutions that do not communicate and coordinate with each other. Increasing the Nation's ITS interoperability will increase the ability of distinct technologies to work together and will help transportation agencies and users communicate and share information more seamlessly. These developments will facilitate effective planning and deployment, and operationally increase efficiencies, reduce costs, and provide more real-time and effective information to transportation system users, operators, planners, and the industry as a whole.

Standards: As new technologies and ITS-based solutions evolve, new standards or refinement of existing standards is a necessary activity. Whether the standards are regulated or adopted as part of industry evolution and practice, there almost always will be a focus on research, analysis, and development of new standards to accommodate the uses and outcomes of new technologies. Having these standards documented and disseminated prior to adoption is often critical for successful adoption and eventual wide-scale deployment. Several stakeholder groups noted that the ITS JPO is in the best position to coordinate work around new standards and can help its partners understand and adjust to standards as they evolve.

Potential Benefits of Interoperability Programs Include:

- Increased efficiency in communications and information sharing between transportation agencies and users
- Nationwide interoperability for vehicles and other participants in the ITS system

- Maintenance of the forward and backward interoperability of ITS equipment and reduced need for re-investment over time
- Greater adoption rates with reduced anxiety over obsolescence
- More efficient transportation usage based on innovations and new commercial applications
- Transportation solutions that resolve interoperability among developers, users, agencies, and modes to increase efficiencies, reduce costs, and provide real-time and effective information
- Increased efficiencies in the economic enterprise.

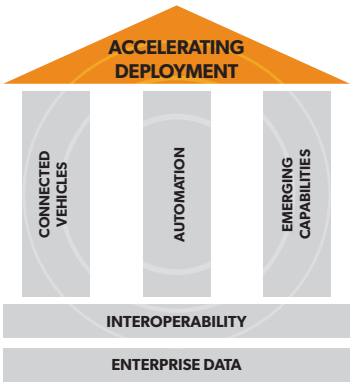
Research Questions that Guide the Detailed Programs

Research questions associated with the Interoperability program category are presented in Table 7. They are categorized according to each stage of the technology lifecycle.

TABLE 7 Interoperability Research Questions that Guide the Detailed Programs

Research
Which standards are needed to support required interoperability of ITS technologies?
What testing and certification procedures and processes are required to ensure compliance with applicable standards?
How are similar interfaces most efficiently grouped into a National Architecture to facilitate interoperable ITS deployments while maximizing flexibilities?
When is it in the public interest to seek international harmonization of architecture and standards and what are the most effective means of facilitating this harmonization?
Development
How is the National Architecture evolved to accommodate CV and automated vehicle technologies?
How is the standards life cycle best managed to efficiently ensure that needed standards remain available to the stakeholder community?
How are standards efficiently evolved to a level of maturity sufficient to support regulatory mandates when needed?
Adoption
How is appropriate technology, standards, and architecture deployment support efficiently provided to the stakeholder community?
How are testing and certification capabilities efficiently made available to the stakeholder community to ensure required interoperability and regulatory compliance?

Program Category: Accelerating Deployment



As new ITS technologies and systems evolve into market-ready products, the *ITS Program* must address questions associated with adoption and deployment. As defined in this plan, adoption includes the phase after testing, when technologies are ready for initial implementation in the "real world." Full-scale deployments are not possible at the outset of this phase, and so the adoption phase is seen as the critical nascent stage of getting technologies into the market. This stage includes the need for solicitation of early adopters, support and training of the adopters, marketing and communications to encourage and increase awareness and understanding of the value of the new technologies, and of course, the actual initial implementation of the new technology. Interaction with adopters needs to be strong in order to become familiar with the challenges that local agencies and other transportation organizations face.

The adoption phase evolves over time into full deployment. Many discussions about the critical transition from adoption to deployment have centered on how to determine when that phase emerges. Some of the criteria identified thus far include:

- Early adopters articulate positive feedback about technology benefits
- Understanding of the technology is broader than just initial adopter community
- Value of the technology is clear and has been realized
- Tactical deployment plans exist and can be shared with additional operators
- Training for the technology exists and is accessible to future operators
- Actual pilot implementation is feasible – which is an indication of the maturity of the technology.

As technologies transition from adoption to large-scale deployment, the responsibility of support for operators and deployers shifts from the ITS JPO to other agencies within the USDOT and even across other government departments and agencies. Although adoption will also be carried out by state, local, and commercial organizations, the ITS JPO will play a support, training, communications, and outreach role during this phase. The main goal of the adoption phase is to gain market support, understanding, and commitment to the new technologies.

Potential Benefits of Deployment Support Programs Include:

Having a structured and standardized process in place for transitioning between adoption and deployment will increase the consistency and performance of a given transition, establishing the trust necessary to build effective partnerships. The transition process will include several components that work together, most notably:

Generally the handoff from JPO to modal responsibilities happens after a new ITS research product has been tested in the field and technology transfer materials (such as documentation of benefits, costs, and lessons learned and training materials) have been developed and delivered to an initial audience of potential deployers. Ongoing ITS JPO funding support for technology transfer activities may continue for some time.

From the Strategic Planning Group Charter

ITS JPO Strategic Planning Group Charter: http://www.its.dot.gov/spg/

Photo Courtesy of USDOT

- **Transition Planning:** A brief overview of the transition goals, any assumptions that the transition is based on, and any risks that have been identified that could severely limit the ability to complete the transition on schedule
- **Training:** Identification of the training needs of each deployer and a list of recommended knowledge transfer activities and specific training offered
- **Transition Plan:** A plan that includes a list of tasks that must be accomplished during the transition process organized in an action table that includes tasks, roles, responsibilities, and timeframes for completion
- **Timelines and Milestones:** Estimated length of the transition period and the milestones to be set as goals throughout the transition, and the extent of overlap with development and adoption phases; there should also be a formal transition when transition activities are expected to be complete.

Below are key elements of the Accelerating Deployment program category, grouped into different overarching areas.

Communication and Education

Communication and education, including training, are important elements that contribute to deployment acceleration. The purpose of a strong communication and education plans is to facilitate awareness, understanding, acceptance, adoption, and deployment of ITS technologies across all stakeholder groups.

Key activities for the communication and education effort include:

- Identification and analysis of stakeholders and their needs
- Development of core messaging for internal and external stakeholders
- Identification of communication tools and methods
- Development and design of communication products
- Development and design of training, knowledge resources, and technology transfer programs.

An effective communication and education effort raises stakeholder awareness and understanding for the ITS JPO's mission and capabilities, strategic direction, and initiatives and priorities. It will establish and use two-way communication channels to engage stakeholders and partner organizations in the research, development, and adoption of ITS technologies.

Communication and education also support and facilitate Professional Capacity Building (PCB), an established priority and program areas for the ITS JPO.

PCB is one area where the ITS JPO maintains joint responsibility with the modes beyond the research implementation phase. The USDOT is required under the current transportation authorization legislation "to develop a workforce capable of developing, operating, and maintaining intelligent transportation systems." The PCB program provides training

and learning resources across a spectrum of ITS subject-matters from fundamental ITS building blocks, such as ITS architecture and standards application and systems engineering processes, to currently available and emerging ITS systems, particularly those that have been the subject of Federal ITS research. The ITS PCB program maintains a strategic plan that guides its investment priorities, developed with stakeholder input, including from the USDOT modal administrations. Potential for duplication of efforts among the ITS PCB program and other PCB programs in the modal administrations is minimized by regular coordination among the PCB program managers.


Photo Courtesy of USDOT

The program uses an internal website and also works with various ITS industry partners to deliver these training resources. Various delivery approaches are used including e-learning, archived webinars, e-books and on-site delivery.

The four strategic goals of the ITS PCB program are professional growth, leadership outreach, knowledge exchange, and technology transfer— they provide the framework to equip transportation professionals with knowledge and skills; create a network of champions; facilitate the sharing of best practices; and ensure that proven ITS solutions are brought to the broader user community.

- **Professional Growth:** The PCB program's mission is to expand the knowledge, skills, and abilities of the ITS workforce. Users of the program desire to see new training methods and techniques. An emerging priority for the program is to strengthen and update existing course offerings, while identifying the requirements for competence in ITS.
- **Leadership outreach:** The PCB program offers support to decision makers and emerging leaders in ITS are seek innovative solutions to the nation's transportation challenges. The outcome of leadership outreach will be decision makers in transportation agencies and other public sector organizations that are knowledgeable about the benefits and challenges of ITS, and are motivated to implement ITS solutions.
- **Knowledge Exchange:** The PCB program is evolving into a new role as a catalyst for knowledge exchange and learning—leveraging its knowledge assets by connecting user needs with its network of trainers and educators, but also facilitating the exchange of knowledge and innovative solutions among experienced policymakers and professionals. In response to customer needs, the program intends to draw more on 'real-world experience from the source' in its learning programs.
- **Technology Transfer:** The ITS PCB program is moving to accelerate new research and prototypes into market-ready technologies that can be adopted by agencies. This goal uses digital technology as an enabler to bring the most current ITS research and solutions to the ITS user community. Leading-edge technological innovations such as social media, mobile application devices, and new learning practices such as interactive games and video will be harnessed to encourage fast and successful adoption of ITS technologies.

Established and Effective Partnerships

Partnerships are a key element that contributes to deployment acceleration. Research collaboration brings partners onboard to ensure user needs are reflected in technology development—this ultimately achieves higher acceptability and adoption rates. The *ITS Program* will strategically leverage current partnerships and actively work on establishing new ones to create an extended national and international network that furthers the advancement of ITS by testing and developing new ideas. In addition, healthy partnerships can foster a competitive and innovative environment and thus address current or emerging market failures.

Partnerships can be made at various levels—executive level, program level, or project level. The partnerships will encompass a wide range of public and private partners, such as:

- Federal agencies (e.g., the Federal Highway Administration, Federal Transit Administration, National Highway Traffic Safety Administration, Federal Motor Carrier Safety Administration, Federal Railroad Administration)
- Policy makers and the national, state, and local levels
- State DOTs
- Regional planning organizations and metropolitan planning organizations
- Local transportation agencies (county, city, or municipality levels)
- Specialty agencies (e.g., police departments, sheriff offices, emergency responders, fire marshals, transit operators, port/airport authorities)
- Private sector (e.g., auto manufacturers and suppliers, railroads, dray carriers, roadside technology vendors, wireless technology vendors, software developers, data providers)
- Academia (universities and research centers)
- Professional associations and organizations (e.g., Transportation Research Board; American Association of State Highway and Transportation Officials; Institute of Transportation Engineers; International Bridge, Tunnel and Turnpike Association; Institute of Electrical and Electronics Engineers; American Society of Civil Engineers; Intelligent Transportation Society of America; CV Trade Association; American Public Transportation Association; Association for Unmanned Vehicle Systems International; Society of Automotive Engineers; Specialty Equipment Market Association; CTIA – The Wireless Association; and AAR – Association of American Railroads)
- Advocacy and focus groups (e.g., the Crash Avoidance Metrics Partnership).

International partnerships[3] (such as the current ITS partnerships with the European Commission, Canada, Japan, Korea, and Mexico[4]) are key to bringing ITS experiences from around the world to capture best practices and lessons learned and standardize practices toward more efficient use of ITS.

3 While Standards Harmonization programs are discussed under the "Interoperability" focus area, a more detailed discussion of international programs is embedded in the international strategic plan developed by the USDOT

4 *http://www.its.dot.gov/connected_vehicle/international_research.htm*

Historically, the ITS JPO has not had significant involvement with foreign private organizations or international agencies or organizations. In recent years, there have been great efforts to move away from a parochial focus and move toward participation in cooperative partnership agreements with both private industry and internal organizations. It will continue to be a focus for the ITS JPO to reach out to and collaborate in a number of ways with private industry groups and international partners. The pace of technology change and investment is such that all actors and invested parties in any field of development must engage in substantive ways to advance adoption of ITS technologies in all possible ways. The ITS JPO is committed to leading this collaborative relationship approach.

The USDOT has always maintained contact and healthy relationships with similar organizations in other countries. However, as new technologies evolve, the nature of cross-border management and cooperation changes and the need for more direct international engagements increases. As the *ITS Program* looks to the future, it will employ an approach where the USDOT can enter into agreements and engagements with a number of international partners, as the need and the bilateral agreements contribute to both parties' needs.

Deployment Challenges in Rural Environments: While rural ITS is not a new area, there is a need to pinpoint whether ITS applications that are being developed can be implemented on the rural level and whether they exhibit benefits for rural communities. Stakeholders from the transit sector, state and local agencies, trade organizations, and other groups noted that contextual analysis must be part of implementation of new technologies to consider the nuanced and specific needs of rural environments.

ITS Applications for those with Disabilities: Disability-oriented ITS aims to improve mobility and services for disabled/special needs users, making ITS products and applications available to everyone, and using ITS applications to enhance accessibility to transportation alternatives. Many of the next-generation ITS technologies, such as automated vehicles, are well suited to help address the needs of the often under-served disabled community. Several stakeholders, most notably those from the transit community, identified the opportunities that may be made available to these communities with new ITS technologies.


Photo Courtesy of USDOT

Research Questions that Guide the Detailed Programs

Research questions associated with the Deployment Support program category are presented in Table 8. They are categorized according to each stage of the technology lifecycle.

TABLE 8 Accelerating Deployment Research Questions that Guide the Detailed Programs

Research
What collaboration and communication mechanisms and targets are needed to encourage public investment?
What personal motivations can be leveraged to encourage adoption that yield societal benefits?
What is the model for international collaboration in the areas of connectivity and automation?
Development
Are opt-in services clearly defined?
Can opt-in services be developed for delivery by the private sector?
Are security and privacy sensitivities addressed so that these do not impede CV environments?
Is CV deployment guidance aligned with the varied levels of decision-making?
Can alignment be achieved in location-specific perspective of safety improvements and CV environments?
What is being done to specifically encourage deployment?
Are the benefits and costs of deployment clearly articulated for public agencies to determine their return?
Adoption
What CV environment targets can be defined?
What metrics should be created to measure CV environments?
Is guidance available to support funding decisions on CV environments?
What is needed to further streamline CV environment acquisition into the planning process?
What is needed to further streamline CV environment acquisition into the Transportation Safety (4E) process?
Are needed standards mature?
What are the guidelines that are needed (e.g., technical, policy, funding)?
Is regulatory action needed?

Centerfold Graphics

Two centerfold graphics were developed to help illustrate how certain elements of the plan fit together, and how the stakeholder feedback was used to inform and validate each element.

The first graphic depicts the relationship between the Strategic and the Operational Plan elements. The Program Categories serve as the foundation, helping to frame the various Research Questions that represent a 'boundary' for the broad *ITS Program*. Those Research Questions are then used to formulate a set of Goals for each Program Category, with various supporting Objectives. The next step is for individual Program Charters to be drafted, which will describe the discrete activities that will help achieve the previously established Goals and Objectives.

The second centerfold graphic represents the stakeholder feedback that was gathered during the data collection phase of the strategic planning effort. The word cloud illustrates the most popular topics discussed by stakeholders from across the country. The larger and more bold the font type, the more frequently that topic was raised. This input validated the Strategic Themes and Program Categories set forth in this plan.

STRATEGIC PLAN

OPERATIONAL PLAN

PROGRAM CATEGORIES	RESEARCH QUESTIONS	GOALS (notional)	OBJECTIVES	PROGRAM CHARTERS
Describe a set of programs related to tech or system	Provide direction for the programs	Translate questions into outcomes	Deconstruct goals into measurable pieces	Describe focus, timeline, budget, and activities
CONNECTED VEHICLES	CV Research Questions	• Integrate CV system needs into legacy ITS systems *(Research)* • Collect benefits and costs and implementation lessons learned information on high priority CV applications *(Development)* • Support state and local, and transit agency functions in the CV environment deployments *(Adoption)*	CV Goals will be split into multiple objectives	The number and scope of programs will vary
AUTOMATION	Automation Research Questions	• Define the core elements and the performance criteria for automation *(Research)* • Test automation components in the CV Pilots, as well as in other test situations as available *(Development)* • Define the federal role in facilitating and encouraging deployment of automated systems *(Adoption)*	Automation Goals will be split into multiple objectives	The number and scope of programs will vary
EMERGING CAPABILITIES	Emerging Capabilities Research Questions	• Establish ways to use new technologies and decision support tools for real-time needs, and to meet longer-term public policy objectives *(Research)* • Integrate the operational characteristics of new technologies into CV and legacy systems and applications *(Development)*	Emerging Capabilities Goals will be split into multiple objectives	The number and scope of programs will vary
ENTERPRISE DATA	Enterprise Data Research Questions	• Integrate new data sets with other legacy data management systems *(Research)* • Identify a model for data management and ownership *(Development)* • Enable new business relationships between the public and private sector to ensure data privacy protection *(Adoption)*	Enterprise Data Goals will be split into multiple objectives	The number and scope of programs will vary
INTEROPERABILITY	Interoperability Research Questions	• Develop and maintain a National ITS Architecture sufficient to ensure required nationwide interoperability while maximizing flexibilities *(Development)* • Develop and maintain an inventory of candidate interfaces for standardization and support standards development efforts for interfaces where there is greatest public interest including those required to support regulatory activity *(Development)* • Internationally harmonize standards and architectures in line with the public interest *(Adoption)* • Facilitate availability of testing and certification processes and procedures to ensure required interoperability and regulatory compliance *(Adoption)*	Interoperability Goals will be split into multiple objectives	The number and scope of programs will vary
ACCELERATING DEPLOYMENT	Accelerating Deployment Research Questions	• Define collaboration and communication mechanisms and targets to encourage public and private investment *(Research)* • Develop comprehensive cost-benefit analytic tools that allow deployers to understand the financial and operational benefits of new technologies and systems *(Development)* • Establish the tools that support the new user base (that had less interaction in the past) *(Adoption)*	Accelerating Deployment Goals will be split into multiple objectives	The number and scope of programs will vary

WE HAVE HEARD YOU...

Over **700 stakeholders** representing states and localities from across the country participated in development of the 2015–2019 ITS Strategic Plan

AUTOMATION was a recurring topic of interest, being discussed by over

100
stakeholders

285 different organizations
contributed inputs to the ITS Strategic Plan 2015–2019

INTEROPERABILITY as an ITS program focus was raised over

200
times

Over **100 inputs**
regarding **ENTERPRISE DATA**
were received

Over **55%**
of participating stakeholders
claimed they are currently ready for and would be receptive to new CV or similar technology, such as what has been described under **ACCELERATING DEPLOYMENT**.

Over
75%
of stakeholders
agreed that technology developers (**EMERGING CAPABILITIES**, not currently associated with CVs) will have an impact on the future of the CV environment.

Nearly
100%
of stakeholders that participated in the surveys indicated they were satisfied with the current level of emphasis on **CV** research

Data collection efforts yielded
845
unique ITS Stakeholder
responses

Photo Courtesy of USDOT

04

ITS Program Goals

The following section presents some initial notional goals that establish the direction that will guide the *ITS Program*'s operational focus and decisions. These goals are forward-looking targets for the programs, projects, and activities.

The research questions associated with each program category represent a 'boundary' for the broad *ITS Program* and frame the strategic plan. Based on those questions, goals can be developed for each of the six defined program categories. On the following page are sample goals associated with every program category: each goal represents a course of action necessary to achieve the *ITS Program*'s mission and progress toward the vision.

If one refers back to the research questions for a particular program category, the link between a question and a goal should be clear. For example, the first CV sample goal below, "Integrate CV system needs into legacy ITS systems" is a direct result of the research question: "How can CV system needs and capabilities be integrated into legacy ITS systems?" Rather than repeat each question and its comparable goal in the plan, we include a centerfold information graphic that illustrates the connections between various parts of program categories, including research questions and goals.

Photo Courtesy of USDOT

Connected Vehicles

- Integrate CV system needs into legacy ITS systems (*Research*)
- Collect benefits and costs and implementation lessons learned information on high priority CV applications (*Development*)
- Support state and local, and transit agency functions in the CV environment deployments (*Adoption*)

Automation

- Define the core elements and the performance criteria for automation (*Research*)
- Test automation components in the CV Pilots, as well as in other test situations as available (*Development*)
- Define the Federal role in facilitating and encouraging deployment of automated systems (*Adoption*)

Emerging Capabilities

- Establish ways to use new technologies and decision support tools for real-time needs, and to meet longer-term public policy objectives (*Research*)
- Integrate the operational characteristics of new technologies into CV and legacy systems and applications (*Development*)

Enterprise Data

- Integrate new data sets with other legacy data management systems (*Research*)
- Identify a model for data management and ownership (*Development*)
- Enable new business relationships between the public and private sector to ensure data privacy protection (*Adoption*)

Interoperability

- Develop and maintain a National ITS Architecture sufficient to ensure required nationwide interoperability while maximizing flexibilities (*Development*)
- Develop and maintain an inventory of candidate interfaces for standardization and support standards development efforts for interfaces where there is greatest public interest including those required to support regulatory activity (*Development*)
- Internationally harmonize standards and architectures in line with the public interest (*Adoption*)
- Facilitate availability of testing and certification processes and procedures to ensure required interoperability and regulatory compliance (*Adoption*)

Accelerating Deployment

- Define collaboration and communication mechanisms and targets to encourage public and private investment (*Research*)
- Develop comprehensive cost-benefit analytic tools that allow deployers to understand the financial and operational benefits of new technologies and systems (*Development*)
- Establish the tools that support the new user base (that had less interaction in the past) (*Adoption*)


Photo Courtesy of USDOT

Photo Courtesy of USDOT

05

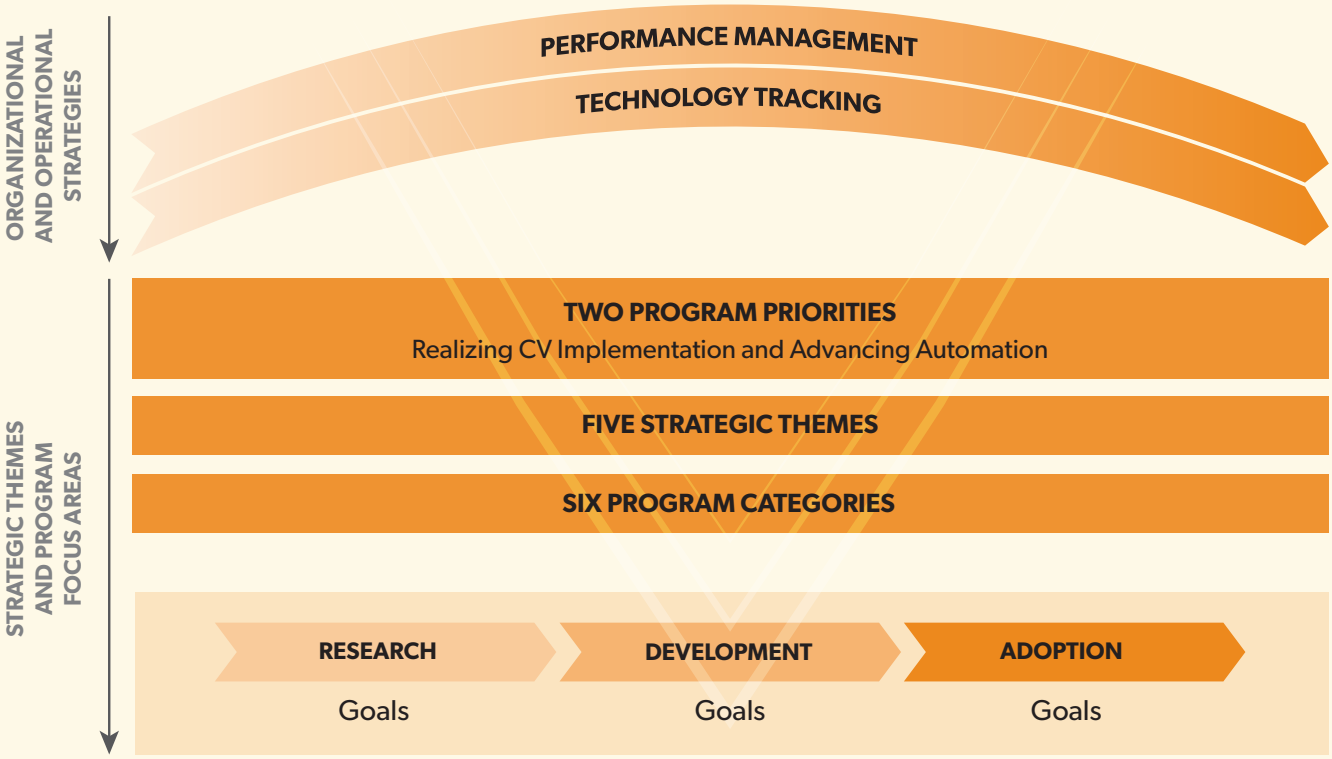
Successful Execution: Employing Operational and Organizational Disciplines

The disciplines outlined in this section represent the processes the ITS JPO will employ internally to help ensure successful execution of the plan. The organizational disciplines (performance management, technology tracking) enable the ITS JPO to react to current and emerging trends, address findings from stakeholder engagements, and stay ahead of a changing environment. They establish a structure and framework that provide guidance for decision making and actions, and at the same time are shaped by the actions taken.

The use of performance management and tracking of the programs will provide the ITS JPO with the information and data needed to protect its focus, ensure relevance of ITS investments, and optimize the allocation of resources.

Figure 7 provides a holistic view of the organizational and operational disciplines outlined in this section as they relate to the strategic themes and program categories introduced earlier in the plan.

FIGURE 7 Holistic View of Organizational and Operational Discipline Components as They Relate to the Strategic Themes and Program Categories



5.1 Organizational Disciplines and Desired Outcomes

This section defines the organizational disciplines that bring focus and accountability to the work performed within the *ITS Program*. These disciplines reflect feedback gathered from stakeholders at various conferences and webinars. There were several statements from transit, state, rural, and goods movement stakeholders that indicated a desire to see the ITS JPO increase its efforts around performance management and technology tracking.

The organizational disciplines are interdependent and will be most effective with articulated and clear outcomes. By nature, these disciplines are outcome-focused and pursuing them implies the need for articulated success indicators. The establishment of the organizational disciplines produces the desired outcomes for the entire *ITS Program*.

Performance Management

Performance management provides the tools and structure needed to implement the strategy and is essential to delivering on the mission and vision. It is the discipline of using metrics and defined outcomes to measure the ITS JPO's success, evaluate *ITS Programs* and projects, and identify opportunities for improvement.

Photo Courtesy of USDOT

Standardized prioritization and selection processes will enable more effective management of programs and activities with respect to tracking and managing process metrics, communication activities, and stakeholder management.

As programs evolve, the ITS JPO will develop a process framework with milestones and associated performance measures that together will help the *ITS Program* understand what is working, what is not working, what needs adjustment and improvement on a continual program-by-program basis, and what should be rolled up.

Implementing end-to-end process and performance management practices across all functions and associated initiatives is necessary to build an organizational capability to:

- Enable alignment of agency goals and desired outputs
- Enable strategic, transparent decisions around program and research efforts
- Bring increased accountability, productivity, and capacity building
- Provide data to inform necessary adjustments, improvements, or changes
- Make it possible to accurately report progress, milestones, and obstacles to internal and external stakeholders
- Better enable the agency to demonstrate its value in multiple areas
- Enable management of the inter-dependencies between education, communication, research, development, and adoption
- Optimize allocation of resources.

Technology Tracking

Technology tracking is an overarching process that accompanies the various stages of the technology lifecycle. The primary purpose of tracking is to identify opportunities and make necessary adjustments or changes within the research and development phases so that any given ITS technology has a higher chance for adoption and successful deployment. Additionally, the identification of areas for improvement initiates an iterative process to modify plans and programs.

Technology tracking focuses on monitoring the progress of research, development, and adoption of ITS technologies to gain greater knowledge and understanding of how to adapt and improve *ITS Programs* and processes to further advance overall deployment. Several processes are needed for monitoring, reviewing, and controlling project outcomes and program activities, and each process would be broken down into a range of tasks and activities to be performed by the relevant assigned individuals at appropriate times throughout a program's existence.

06

Acknowledgements

This *ITS Strategic Plan 2015–2019* includes a comprehensive and interdependent set of technologies, systems, priorities, and strategic themes that will be the focus of ITS research, development, and adoption during this time period. The process of developing the plan was critical to including significant stakeholder demands, focus areas, and needs for ITS support and research.

Throughout the effort, the team engaged a diverse group of stakeholders in an effort to be inclusive, collaborative, and interactive through a broad range of outreach opportunities that ensured the ITS Strategic Plan reflects the aspirations of the multi-faceted ITS community.

The ITS Strategic Plan development team would like to extend our appreciation and thanks to the following groups that were instrumental in both providing input and allowing us to present and hold sessions at their conferences, meetings, workshops, or webinars:

- Federal Highway Administration (FHWA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railroad Administration (FRA)
- Federal Transit Administration (FTA)
- National Highway Traffic Safety Administration (NHTSA)
- Maritime Administration (MARAD)
- *ITS Program* Advisory Committee
- Institute of Transportation Engineers (ITE) CV Task Force


Photo Courtesy of USDOT

- American Meteorological Society (AMS)
- National Rural ITS Conference (NRITS)
- Institute of Electrical and Electronics Engineers (IEEE)
- CV Trade Association (CVTA)
- Intelligent Transportation Society of America
- The public and private sector participants of webinars for transit, tolling and pricing, safety and traffic signals, environment and weather, and goods movement
- International Bridge, Tunnel and Turnpike Association
- Submitters to the IdeaScale forum.

Without this vast amount of input and perspectives, the plan would not be a robust representation of the kind of work the *ITS Program* needs to focus on. Great appreciation is extended to all who took the time to listen, provide input, respond to questions, and send materials, ideas, and requests.

The facilitated sessions that these groups made possible explored and refined the plan's fundamental themes, research questions, and programmatic goals. The unique perspectives shared during these sessions made the *ITS Strategic Plan 2015–2019* exponentially stronger, and will enable the ITS JPO and USDOT to better prioritize operational activities. Thank you to all who have contributed.

A

Appendix A

Summary of Results for Stakeholder Engagements

The following appendix contains data gathered from various stakeholders throughout the development of the ITS Strategic Plan. A variety of engagement opportunities were provided to stakeholders including webinars, questionnaires, conference sessions, IdeaScale, etc.

1. Webinars

Three series of webinars were held, each targeting at least three stakeholder groups. The format for the webinars was intended to generate maximum stakeholder input that would help shape and validate the direction of the ITS Strategic Plan.

1.1 Participating Organizations

Efforts were made to engage stakeholders from a variety of disciplines and areas of interest to provide a comprehensive view of current and potential future efforts. Figure 1 shows the distribution of the stakeholders participating in the webinars.

FIGURE 1. Webinar Stakeholder Categories and Distribution of Participants

Category	Participants
Academia	33
Federal Agency	10
Industry	143
International	5
Non-Profit	4
State or Local Transport Agency	72
Trade Group	19
Total	286

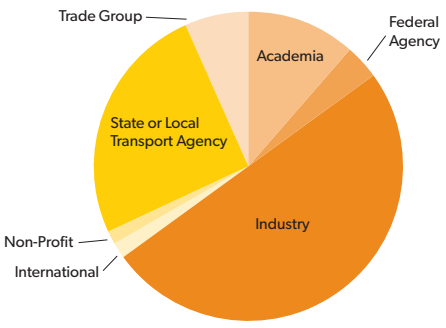


Table 1 shows specific organizations that participated in the webinars, along with their alignment to one of the specific categories identified.

TABLE 1. List of Participating Organizations

Organizations that Participated in the USDOT ITS Strategic Plan Webinar Series	Category
American Transportation Research Institute (ATRI)	Academia
California Partners for Advanced Transportation Technology (PATH), University of California-Berkeley (UCB)	Academia
Carnegie Mellon University	Academia
Center for Automotive Research (CAR)	Academia
Clemson University	Academia
George Mason University	Academia
Georgia Institute of Technology	Academia
Michigan Technological University - Michigan Technological Research Institute (MTRI)	Academia
Michigan Technological University	Academia
North Dakota State University (NDSU) / Upper Great Plains Transportation Institute (UGPTI)	Academia
Northeastern University	Academia
Oak Ridge National Laboratory	Academia
Plymouth State University	Academia
Purdue University	Academia
Southern Illinois University Edwardsville (SIUE)	Academia
Southwest Research Institute (SwRI)	Academia
Stevens Institute of Technology	Academia
Texas A&M Transportation Institute (TTI)	Academia
The National Center for Atmospheric Research (NCAR)	Academia
University at Buffalo, The State University of New York (SUNY Buffalo)	Academia
University of Alberta	Academia
University of Applied Sciences Technikum Wien (FH-Technikum)	Academia
University of California-Berkeley (UC-Berkeley)	Academia
University of Kansas, Transportation Research Institute	Academia
University of Michigan Transportation Research Institute (UMTRI)	Academia
University of Minnesota	Academia
University of Nevada, Reno	Academia
University of Texas	Academia
University of Utah	Academia
University of Wisconsin Transportation Operations and Safety (TOPS) Laboratory	Academia
University of Virginia Center for Transportation Studies	Academia
Virginia Polytechnic Institute and State University (Virginia Tech)	Academia
Virginia Tech Transportation Institute (VTTI)	Academia
Federal Highway Administration (FHWA)	Federal Agency
Federal Motor Carrier Safety Administration (FMCSA)	Federal Agency
Federal Transit Administration	Federal Agency
Intelligent Transportation Systems Joint Program Office (ITS JPO)	Federal Agency
National Renewable Energy Laboratory (NREL)	Federal Agency
National Transportation Safety Board (NTSB)	Federal Agency
Office of the Federal Coordinator for Meteorology (OFCM) / National Weather Service (NWS)	Federal Agency
United States Department of Transportation (USDOT)	Federal Agency
United States Environmental Protection Agency (US EPA)	Federal Agency

Organizations that Participated in the USDOT ITS Strategic Plan Webinar Series	Category
John A. Volpe National Transportation Systems Center	Federal Agency
3M	Industry
A Arnold Relocation	Industry
Accenture	Industry
AECOM	Industry
Al Naif Consulting and Engineering	Industry
Alcatel-Lucent	Industry
ALK Technologies	Industry
Alpine Electronics	Industry
Amdocs	Industry
AMSchoka Consulting LLC	Industry
Appian Strategic Advisors	Industry
Arellano Associates	Industry
Assurant	Industry
Atkins	Industry
Ave Solutions	Industry
Avego	Industry
Battelle	Industry
Belden	Industry
Bendix Commercial Vehicle Systems	Industry
blueRover	Industry
Booz Allen Hamilton	Industry
Bosch	Industry
Brigade Electronics	Industry
Brunett Consulting	Industry
Bulkmatic	Industry
Cambridge Systematics	Industry
Cardinal Logistics	Industry
CBB Traffic and Transportation Engineers	Industry
CDM Smith	Industry
Certusoft	Industry
CH2M HILL	Industry
Cheval Research Inc.	Industry
Cisco	Industry
Civil Transformations Inc.	Industry
Continental AG	Industry
Contrans Flatbed Group	Industry
Con-way Freight	Industry
Cubic Transportation Systems	Industry
Daktronics Inc.	Industry
DBi Services	Industry
Delcan Corporation	Industry
Delphi	Industry
DENSO International America	Industry
Drive Engineering	Industry

Organizations that Participated in the USDOT ITS Strategic Plan Webinar Series	Category
DTL Transportation, Inc.	Industry
ECDRIVING	Industry
Econolite	Industry
Ellen Solar	Industry
England Logistics	Industry
Epoch Microelectronics, Inc.	Industry
E-Squared Engineering	Industry
FedEx Ground	Industry
Ford Motor Company	Industry
Future Impact, Inc.	Industry
Gannett Fleming Inc.	Industry
General Motors	Industry
GeoToll, Inc.	Industry
GEWI North America	Industry
Gresham Smith and Partners	Industry
Gridaptive Technologies	Industry
H. R. Ewell, Inc.	Industry
Harris Corp.	Industry
HERE	Industry
High Sierra Electronics	Industry
Highlight Motor Freight Inc.	Industry
HNTB Corporation	Industry
Honda	Industry
HopeRun Technology	Industry
Hyundai-Kia America Technical Center, Inc.	Industry
IHS Global Inc.	Industry
Image Sensing Systems	Industry
Immersed Technologies, Inc.	Industry
Independent Consultants	Industry
INRIX Inc.	Industry
Institute for Creative Integration	Industry
Insurance Institute for Highway Safety	Industry
Integrated Risk Solutions	Industry
Intel	Industry
Intelligent Imaging Systems	Industry
Intelligent Infrastructure Systems	Industry
Irving Oil Terminals Inc.	Industry
Iteris Inc.	Industry
J. J. Keller & Associates, Inc.	Industry
Jacobs Engineering Group	Industry
Jacoby Consulting	Industry
John Walker Consultancy	Industry
Kapsch TrafficCom AG	Industry
Kimley-Horn	Industry
KMJ Consulting, Inc.	Industry

Organizations that Participated in the USDOT ITS Strategic Plan Webinar Series	Category
Landstar	Industry
M&G Polymers USA	Industry
McNulty Group	Industry
Mentor Graphics	Industry
Metric Engineering	Industry
MetroTech Net, Inc.	Industry
Mountain States Insurance Group	Industry
Narwhal Met	Industry
Neel-Schaffer, Inc.	Industry
NextEnergy	Industry
Noblis	Industry
North River Consulting Group	Industry
Olsson Associates	Industry
Open Roads Consulting	Industry
Panasonic	Industry
Parsons Brinckerhoff	Industry
PDP Associates Inc. (PDP Smart Work Zones)	Industry
Phillips	Industry
Pioneer Advanced Solutions Inc.	Industry
Powersource Transportation	Industry
RK&K Engineers	Industry
RouteMatch Software	Industry
Sakura Associates LLC	Industry
Savari	Industry
Schneider Electric	Industry
Schneider National Bulk Carriers	Industry
Shelley Row Associates LLC	Industry
Siemens	Industry
SiloSmashers	Industry
Skytoll	Industry
Synthetic Services of Arizona	Industry
Tech-I-M	Industry
Telvent/Schneider Electric	Industry
TransBLS	Industry
TransCore	Industry
Transdyn, Inc.	Industry
Transmart Technologies	Industry
TranSystems	Industry
Trimble Navigation Ltd.	Industry
Trinity Infrastructure, LLC	Industry
Triple G Express, Inc.	Industry
TRW	Industry
TUV Rheinland	Industry
Ulteig	Industry
Universal Global Scientific Industrial Co., Ltd.	Industry

Organizations that Participated in the USDOT ITS Strategic Plan Webinar Series	Category
Vaisala Inc.	Industry
Vanasse Hangen Brustlin, Inc. (VHB)	Industry
Verizon	Industry
Viewnyx	Industry
Virtuelements	Industry
Volvo Trucks	Industry
Xerox	Industry
XRS Corporation	Industry
YAG Consulting Del. LLC	Industry
Agence Metropolitaine de Transport (AMT)	International
Intelligent Transport Systems Australia	International
Korea Institute of Construction Technology	International
Ministry of Transport, Maritime Affairs and Communications	International
Transport Canada	International
Advocates for Highway and Auto Safety	Non-Profit
Council of State Governments (CSG)	Non-Profit
Metropolitan Washington Council of Governments (MWCOG)	Non-Profit
Southern California Regional Transit Training Consortium (SCRTTC)	Non-Profit
Alabama Department of Transportation	State or Local Transport Agency
Alaska Department of Transportation and Public Facilities	State or Local Transport Agency
Alberta Transportation	State or Local Transport Agency
Anne Arundel County, Maryland	State or Local Transport Agency
Arkansas Department of Transportation	State or Local Transport Agency
Atlanta Regional Commission	State or Local Transport Agency
Blacksburg Transit	State or Local Transport Agency
California Department of Transportation (Caltrans)	State or Local Transport Agency
Capital Metro Transportation Authority	State or Local Transport Agency
Capital District Transportation Committee (CDTC)	State or Local Transport Agency
Chattanooga Area Regional Transportation Authority (CARTA)	State or Local Transport Agency
Chicago Metropolitan Agency for Planning	State or Local Transport Agency
City of Burbank, California	State or Local Transport Agency
City of Kansas City, Missouri	State or Local Transport Agency
City of Ottawa	State or Local Transport Agency
City of San Jose	State or Local Transport Agency
Colorado Department of Transportation	State or Local Transport Agency
Detroit Transit Agency (SMARTbus)	State or Local Transport Agency
Florida Department of Transportation	State or Local Transport Agency
Genesee Transportation Council	State or Local Transport Agency
Georgia Department of Transportation	State or Local Transport Agency
Greater Buffalo-Niagara Regional Transportation Council (GBNRTC)	State or Local Transport Agency
Illinois Department of Transportation	State or Local Transport Agency
Illinois State Toll Highway Authority	State or Local Transport Agency
Indiana Department of Transportation	State or Local Transport Agency
Indianapolis Metropolitan Planning Organization	State or Local Transport Agency
Iowa Department of Transportation	State or Local Transport Agency

Organizations that Participated in the USDOT ITS Strategic Plan Webinar Series	Category
Johns Creek, Georgia	State or Local Transport Agency
Kansas Department of Transportation	State or Local Transport Agency
Kentucky Transportation Center	State or Local Transport Agency
Kings County Association of Governments	State or Local Transport Agency
Los Angeles (LA) Metro	State or Local Transport Agency
Los Angeles County Service Authority for Freeway Emergencies (LA SAFE)	State or Local Transport Agency
Maryland DOT	State or Local Transport Agency
Massachusetts Department of Transportation	State or Local Transport Agency
Metro Transit - St. Louis: Research and Development	State or Local Transport Agency
Metropolitan Transportation Authority (MTA) Bridges and Tunnels	State or Local Transport Agency
Metropolitan Transportation Commission (MTC)	State or Local Transport Agency
Miami-Dade Expressway Authority (MDX)	State or Local Transport Agency
Michigan Department of Transportation	State or Local Transport Agency
Minnesota Department of Transportation	State or Local Transport Agency
Missouri Department of Transportation	State or Local Transport Agency
Montana Department of Transportation	State or Local Transport Agency
Nevada Department of Transportation	State or Local Transport Agency
New Jersey Department of Transportation	State or Local Transport Agency
New York Metropolitan Transportation Council (NYMTC)	State or Local Transport Agency
North Carolina Department of Transportation	State or Local Transport Agency
North Dakota Department of Transportation	State or Local Transport Agency
North Florida Transportation Planning Organization	State or Local Transport Agency
North Texas Tollway Authority (NTTA)	State or Local Transport Agency
Orange County Transportation Authority (OCTA)	State or Local Transport Agency
Puget Sound Regional Council (PSRC)	State or Local Transport Agency
San Diego Association of Governments (SANDAG)	State or Local Transport Agency
San Mateo County Transit District	State or Local Transport Agency
Seattle Department of Transportation	State or Local Transport Agency
Southeast Michigan Council of Governments (SEMCOG)	State or Local Transport Agency
South Carolina Department of Transportation	State or Local Transport Agency
Southeastern Pennsylvania Transportation Authority (SEPTA)	State or Local Transport Agency
Southern California Association of Governments (SCAG)	State or Local Transport Agency
Southwestern Pennsylvania Commission	State or Local Transport Agency
Texas Department of Transportation	State or Local Transport Agency
The Port Authority of New York and New Jersey	State or Local Transport Agency
Transportation Commission of Southern Nevada	State or Local Transport Agency
Utah Department of Transportation	State or Local Transport Agency
Utah Transit Authority (UTA)	State or Local Transport Agency
Vermont Agency of Transportation	State or Local Transport Agency
Virginia Department of Transportation	State or Local Transport Agency
Washington State Department of Transportation	State or Local Transport Agency
West Virginia Department of Motor Vehicles	State or Local Transport Agency
Wisconsin Department of Transportation	State or Local Transport Agency
Wyoming Department of Transportation	State or Local Transport Agency
American Association of Motor Vehicle Administrators (AAMVA)	Trade Group

Organizations that Participated in the USDOT ITS Strategic Plan Webinar Series	Category
American Association of State Highway and Transportation Officials (AASHTO)	Trade Group
American Motorcyclist Association	Trade Group
American Trucking Associations (ATA)	Trade Group
Association for Commuter Transportation	Trade Group
Automotive Aftermarket Industry Association (AAIA)	Trade Group
Automotive Recyclers Association	Trade Group
Coalition for America's Gateways and Trade Corridors	Trade Group
Global Automakers	Trade Group
I-95 Corridor Coalition	Trade Group
Intelligent Transportation Society of America (ITS America)	Trade Group
Intelligent Transportation Society of California (ITS California)	Trade Group
Intelligent Transportation Society of Maryland (ITS Maryland)	Trade Group
International Bridge, Tunnel and Turnpike Association (IBTTA)	Trade Group
Kentucky Motor Transport Association (KMTA)	Trade Group
Telecommunications Industry Association	Trade Group
The League of American Bicyclists	Trade Group
Transportation Intermediaries Association (TIA)	Trade Group
Vehicle Infrastructure Integration Consortium (VIIC)	Trade Group

1.2 Quantitative Data

Both quantitative and qualitative data were acquired through the webinar engagements. This section contains the quantitative data, organized by topic area. The questions found in Tables 2 and 3 were asked of stakeholders to quantify perceptions of progress to date, as well as to gauge areas of interest for the future. Figures 2 through 4 show the distribution of the responses.

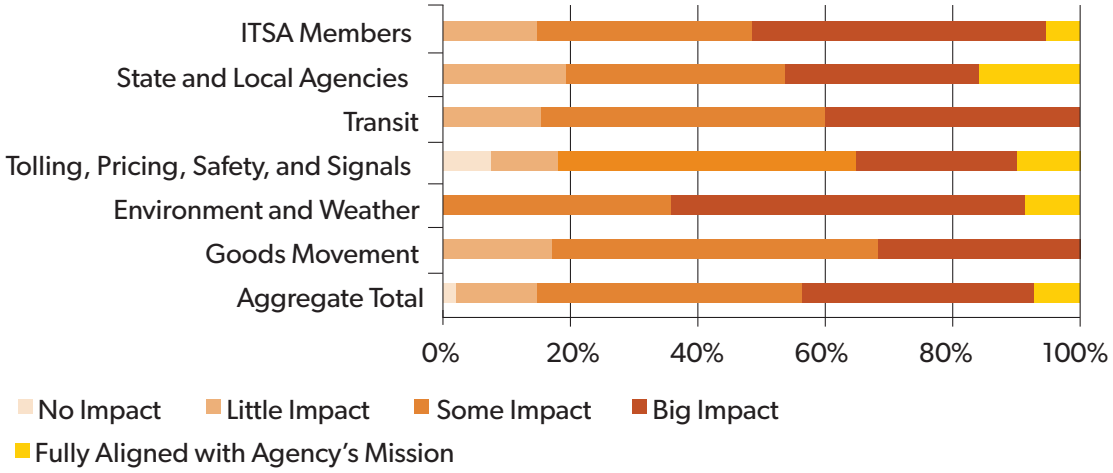
1.2.1 ITS Programs – Level of Impact

TABLE 2. ITS Programs – Level of Impact Perceived by Stakeholders

1. What would you say is the level of impact the ITS Programs have on your organization's mission?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
No Impact	0	0.00%	0	0.00%	0	0.00%
Little Impact	6	14.63%	5	19.23%	3	15.00%
Some Impact	14	34.15%	9	34.62%	9	45.00%
Big Impact	19	46.34%	8	30.77%	8	40.00%
Fully Aligned with Agency's Mission	2	4.88%	4	15.38%	0	0.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
No Impact	4	7.27%	0	0.00%	0	0.00%
Little Impact	6	10.91%	0	0.00%	5	17.24%
Some Impact	26	47.27%	9	36.00%	15	51.72%
Big Impact	14	25.45%	14	56.00%	9	31.03%
Fully Aligned with Agency's Mission	5	9.09%	2	8.00%	0	0.00%

Aggregate	Total	
No Impact	4	2.04%
Little Impact	25	12.76%
Some Impact	82	41.84%
Big Impact	72	36.73%
Fully Aligned with Agency's Mission	13	6.63%

FIGURE 2. ITS Programs – Level of Impact Perceived by Stakeholders – Distribution



1.2.2 Connected Vehicle Research

TABLE 3. Level of Emphasis on Connected Vehicle Research

2. Should the level of emphasis on connected vehicle research be more, less, or the same?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
More	26	63.41%	20	64.52%	16	80.00%
Less	4	9.76%	2	6.45%	2	10.00%
Same	11	26.83%	9	29.03%	2	10.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
More	43	81.13%	10	38.46%	17	51.52%
Less	3	5.66%	7	26.92%	1	3.03%
Same	7	13.21%	9	34.62%	15	45.45%
Aggregate	Total					
More	132	64.71%				
Less	19	9.31%				
Same	53	25.98%				

FIGURE 3. Level of Emphasis on Connected Vehicle Research – Distribution

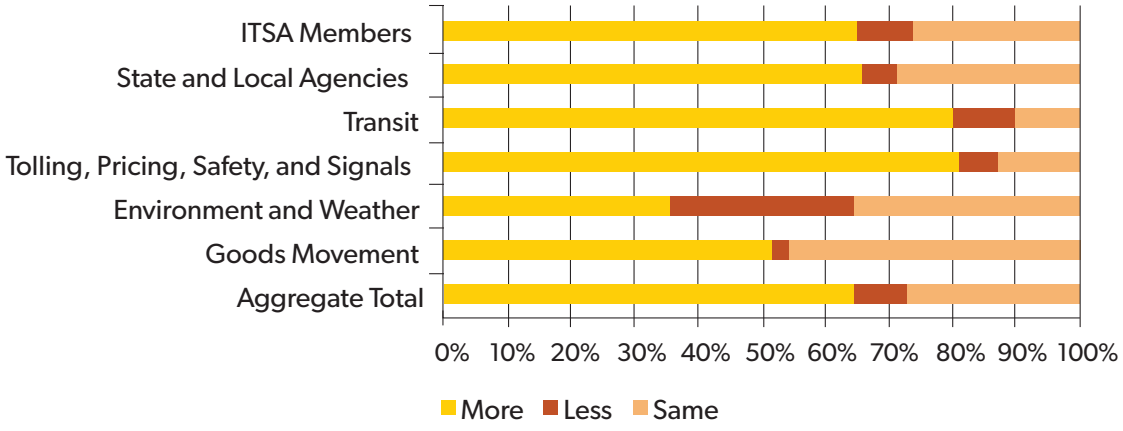
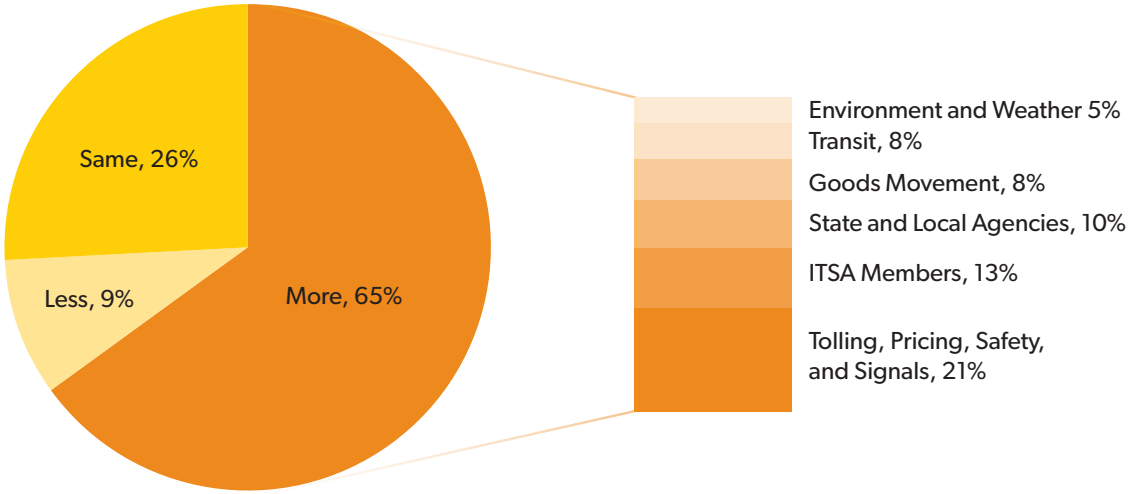


FIGURE 4. Aggregate Level of Emphasis on Connected Vehicle Research – Distribution

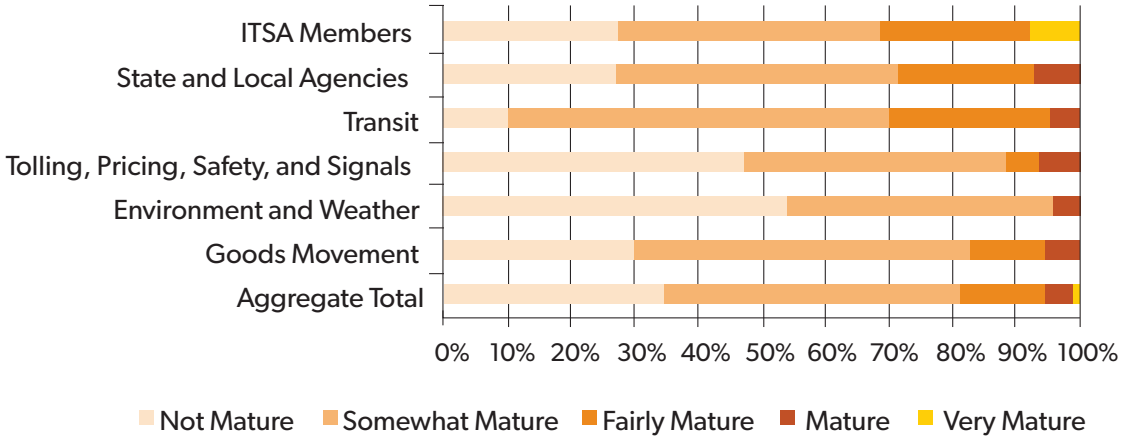


1.2.3 Vehicle-Based Technology

TABLE 4. Maturity Level of Vehicle-Based Technology

3. How would you define the level of maturity of vehicle-based technology?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Not Mature	11	28.21%	9	28.13%	2	10.00%
Somewhat Mature	16	41.03%	14	43.75%	12	60.00%
Fairly Mature	9	23.08%	7	21.88%	5	25.00%
Mature	0	0.00%	2	6.25%	1	5.00%
Very Mature	3	7.69%	0	0.00%	0	0.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Not Mature	26	48.15%	14	53.85%	11	29.73%
Somewhat Mature	22	40.74%	11	42.31%	20	54.05%
Fairly Mature	3	5.56%	1	3.85%	4	10.81%
Mature	3	5.56%	0	0.00%	2	5.41%
Very Mature	0	0.00%	0	0.00%	0	0.00%
Aggregate	Total					
Not Mature	73	35.10%				
Somewhat Mature	95	45.67%				
Fairly Mature	29	13.94%				
Mature	8	3.85%				
Very Mature	3	1.44%				

FIGURE 5. Maturity Level of Vehicle-Based Technology – Distribution

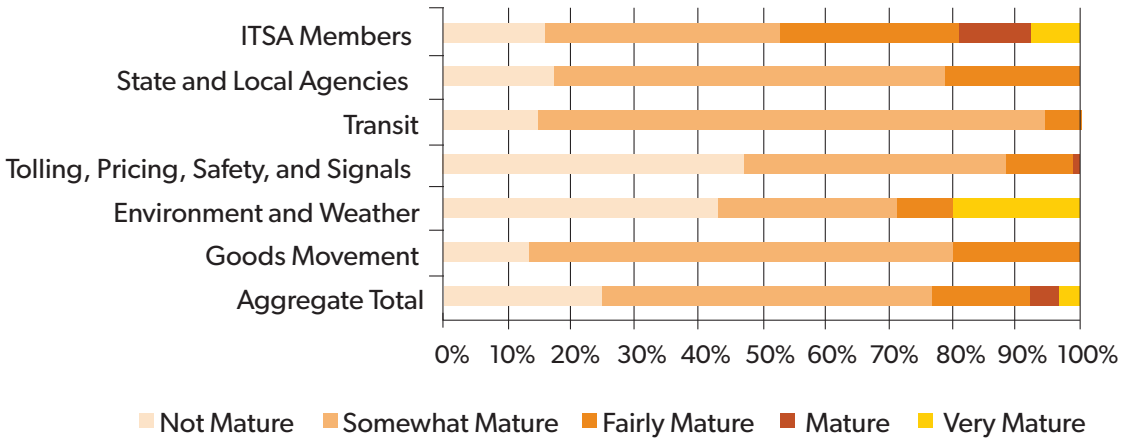


1.2.4 Road Side Technology

TABLE 5. Maturity Level of Road Side Technology

4. How would you define the level of maturity of road side technology?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Not Mature	6	15.38%	6	18.75%	3	15.79%
Somewhat Mature	15	38.46%	19	59.38%	15	78.95%
Fairly Mature	10	25.64%	7	21.88%	1	5.26%
Mature	7	17.95%	0	0.00%	0	0.00%
Very Mature	1	2.56%	0	0.00%	0	0.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Not Mature	26	46.43%	11	44.00%	5	13.89%
Somewhat Mature	23	41.07%	7	28.00%	24	66.67%
Fairly Mature	6	10.71%	2	8.00%	7	19.44%
Mature	1	1.79%	0	0.00%	0	0.00%
Very Mature	0	0.00%	5	20.00%	0	0.00%
Aggregate	Total					
Not Mature	57	27.54%				
Somewhat Mature	103	49.76%				
Fairly Mature	33	15.94%				
Mature	8	3.86%				
Very Mature	6	2.90%				

FIGURE 6. Maturity Level of Road Side Technology – Distribution



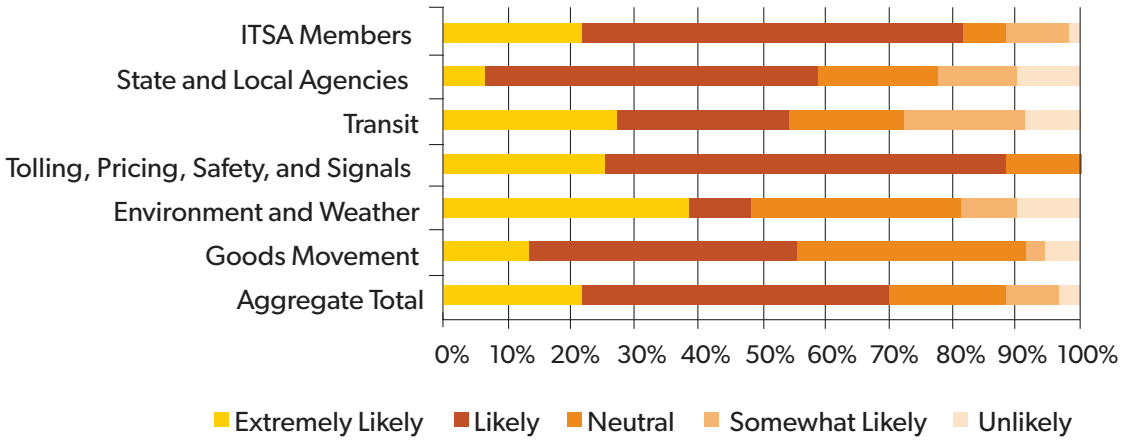
1.2.5 Disruptive Technology

TABLE 6. Impact of Other Disruptive Technology

5. Likelihood that OTHER DISRUPTIVE TECHNOLOGY will have an impact?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Extremely Likely	11	22.92%	2	6.45%	3	27.27%
Likely	28	58.33%	16	51.61%	3	27.27%
Neutral	4	8.33%	6	19.35%	2	18.18%
Somewhat Likely	4	8.33%	4	12.90%	2	18.18%
Unlikely	1	2.08%	3	9.68%	1	9.09%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Extremely Likely	15	25.86%	8	38.10%	5	14.29%
Likely	36	62.07%	2	9.52%	14	40.00%
Neutral	7	12.07%	7	33.33%	13	37.14%
Somewhat Likely	0	0.00%	2	9.52%	1	2.86%
Unlikely	0	0.00%	2	9.52%	2	5.71%

Aggregate	Total	
Extremely Likely	44	21.57%
Likely	99	48.53%
Neutral	39	19.12%
Somewhat Likely	13	6.37%
Unlikely	9	4.41%

FIGURE 7. Impact of Other Disruptive Technology – Distribution

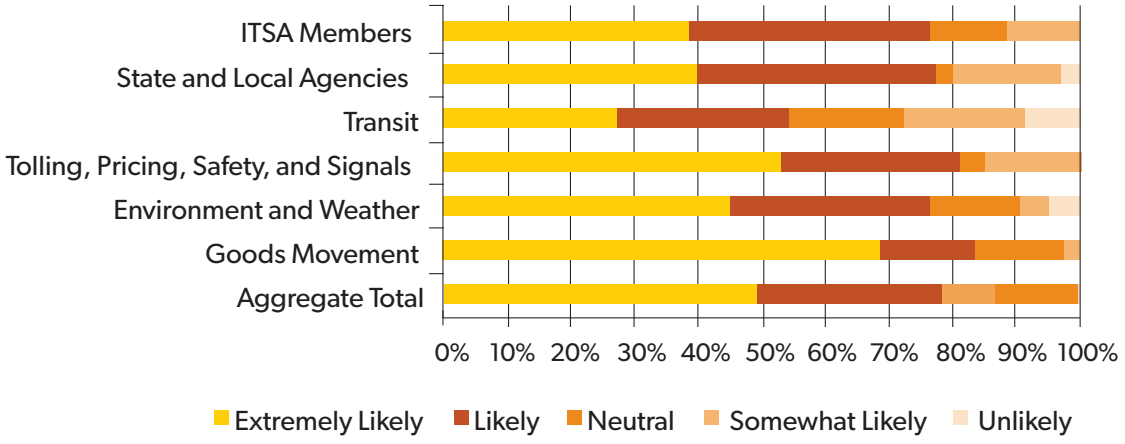


1.2.6 Privacy Sensitivity

TABLE 7. Impact of Privacy Sensitivity

6. Likelihood that PRIVACY SENSITIVITY will have an impact?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Extremely Likely	19	38.78%	14	40.00%	12	60.00%
Likely	18	36.73%	13	37.14%	4	20.00%
Neutral	6	12.24%	1	2.86%	0	0.00%
Somewhat Likely	6	12.24%	6	17.14%	3	15.00%
Unlikely	0	0.00%	1	2.86%	1	5.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Extremely Likely	30	51.72%	10	45.45%	23	67.65%
Likely	17	29.31%	7	31.82%	5	14.71%
Neutral	2	3.45%	3	13.64%	5	14.71%
Somewhat Likely	9	15.52%	1	4.55%	1	2.94%
Unlikely	0	0.00%	1	4.55%	0	0.00%
Aggregate	Total					
Extremely Likely	108	49.54%				
Likely	64	29.36%				
Neutral	17	7.80%				
Somewhat Likely	26	11.93%				
Unlikely	3	1.38%				

FIGURE 8. Impact of Privacy Sensitivity – Distribution



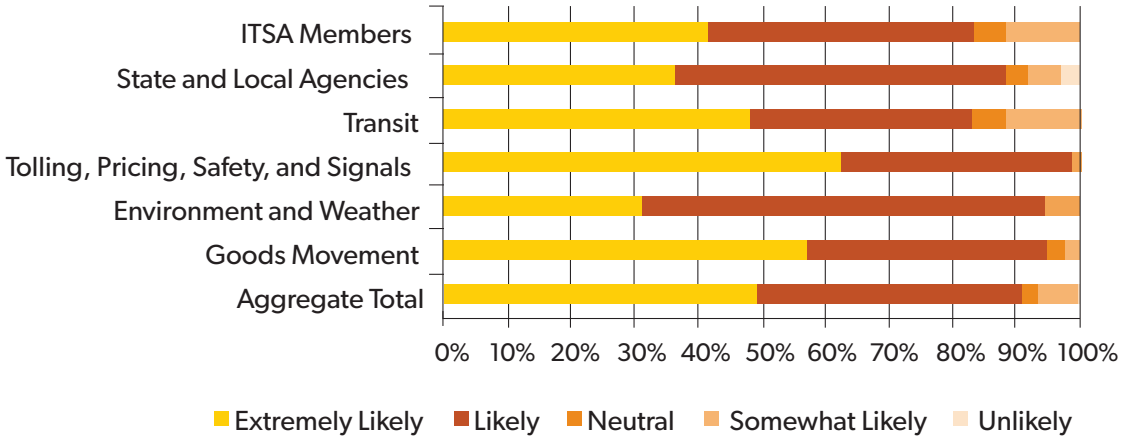
1.2.7 Public Perception

TABLE 8. Impact of Public Perception

7. Likelihood that PUBLIC PERCEPTION will have an impact?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Extremely Likely	19	41.30%	13	37.14%	9	47.37%
Likely	20	43.48%	18	51.43%	7	36.84%
Neutral	2	4.35%	1	2.86%	1	5.26%
Somewhat Likely	5	10.87%	2	5.71%	2	10.53%
Unlikely	0	0.00%	1	2.86%	0	0.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Extremely Likely	37	62.71%	7	31.82%	20	57.14%
Likely	21	35.59%	14	63.64%	13	37.14%
Neutral	1	1.69%	0	0.00%	1	2.86%
Somewhat Likely	0	0.00%	1	4.55%	1	2.86%
Unlikely	0	0.00%	0	0.00%	0	0.00%

Aggregate	Total	
Extremely Likely	105	48.61%
Likely	93	43.06%
Neutral	6	2.78%
Somewhat Likely	11	5.09%
Unlikely	1	0.46%

FIGURE 9. Impact of Public Perception – Distribution

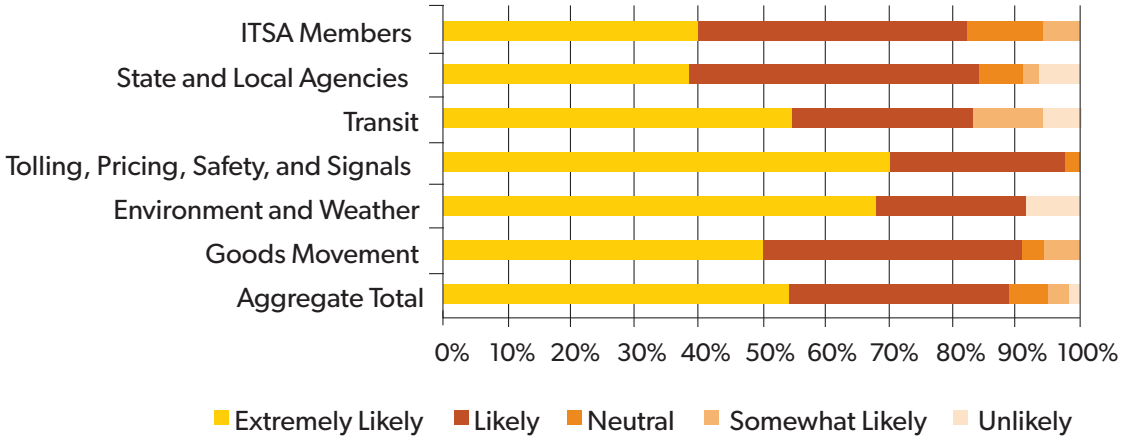


1.2.8 Security

TABLE 9. Impact of Security

8. Likelihood that SECURITY will have an impact?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Extremely Likely	19	40.43%	13	39.39%	11	55.00%
Likely	20	42.55%	15	45.45%	6	30.00%
Neutral	5	10.64%	2	6.06%	0	0.00%
Somewhat Likely	3	6.38%	1	3.03%	2	10.00%
Unlikely	0	0.00%	2	6.06%	1	5.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Extremely Likely	40	70.18%	16	66.67%	18	50.00%
Likely	15	26.32%	6	25.00%	15	41.67%
Neutral	2	3.51%	0	0.00%	1	2.78%
Somewhat Likely	0	0.00%	0	0.00%	2	5.56%
Unlikely	0	0.00%	2	8.33%	0	0.00%
Aggregate	Total					
Extremely Likely	117	53.92%				
Likely	77	35.48%				
Neutral	10	4.61%				
Somewhat Likely	8	3.69%				
Unlikely	5	2.30%				

FIGURE 10. Impact of Security – Distribution

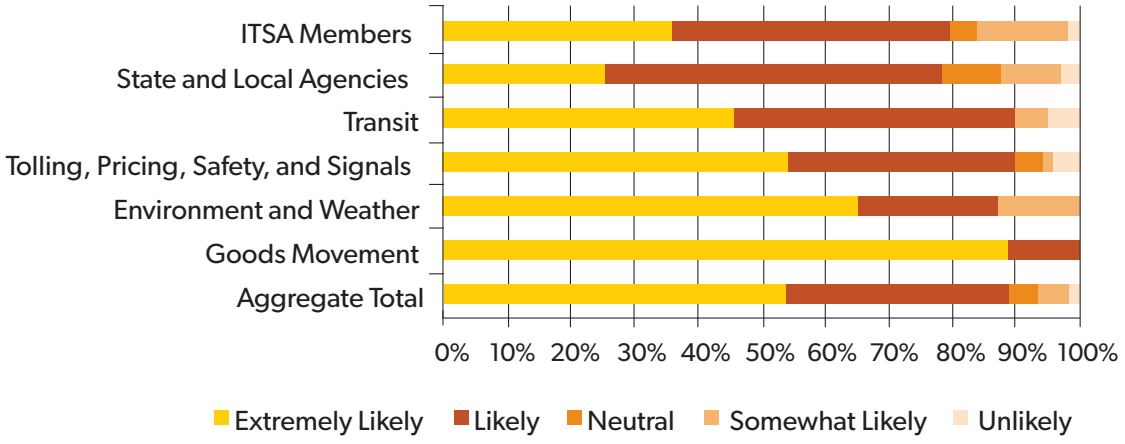


1.2.9 Public Agency Support

TABLE 10. Impact of Public Agency Support

9. Likelihood that SUPPORT OF PUBLIC AGENCIES will have an impact?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Extremely Likely	16	36.36%	6	26.09%	9	45.00%
Likely	19	43.18%	12	52.17%	9	45.00%
Neutral	2	4.55%	2	8.70%	1	5.00%
Somewhat Likely	6	13.64%	2	8.70%	1	5.00%
Unlikely	1	2.27%	1	4.35%	0	0.00%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Extremely Likely	30	54.55%	15	65.22%	32	88.89%
Likely	20	36.36%	5	21.74%	4	11.11%
Neutral	2	3.64%	3	13.04%	0	0.00%
Somewhat Likely	1	1.82%	0	0.00%	0	0.00%
Unlikely	2	3.64%	0	0.00%	0	0.00%
Aggregate	Total					
Extremely Likely	108	53.73%				
Likely	69	34.33%				
Neutral	10	4.98%				
Somewhat Likely	10	4.98%				
Unlikely	4	1.99%				

FIGURE 11. Impact of Public Agency Support – Distribution

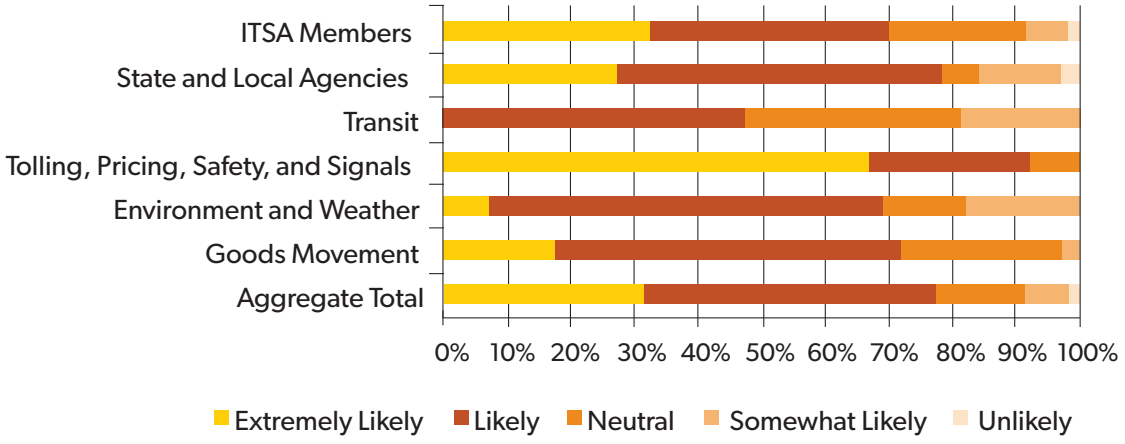


1.2.10 Technology Developers

TABLE 11. Impact of Technology Developers

10. Likelihood that TECHNOLOGY DEVELOPERS (not currently associated with connected vehicles) will have an impact?						
Webinar Series I	ITS America Members		State and Local Agencies		Transit	
Extremely Likely	15	31.91%	9	27.27%	0	0.00%
Likely	18	38.30%	17	51.52%	8	47.06%
Neutral	10	21.28%	2	6.06%	6	35.29%
Somewhat Likely	3	6.38%	4	12.12%	2	11.76%
Unlikely	1	2.13%	1	3.03%	1	5.88%
Webinar Series II	Tolling, Pricing, Safety, and Signals		Environment and Weather		Goods Movement	
Extremely Likely	37	66.07%	2	8.70%	6	17.65%
Likely	15	26.79%	14	60.87%	19	55.88%
Neutral	4	7.14%	3	13.04%	8	23.53%
Somewhat Likely	0	0.00%	4	17.39%	1	2.94%
Unlikely	0	0.00%	0	0.00%	0	0.00%
Aggregate	Total					
Extremely Likely	69	32.86%				
Likely	91	43.33%				
Neutral	33	15.71%				
Somewhat Likely	14	6.67%				
Unlikely	3	1.43%				

FIGURE 12. Impact of Technology Developers – Distribution

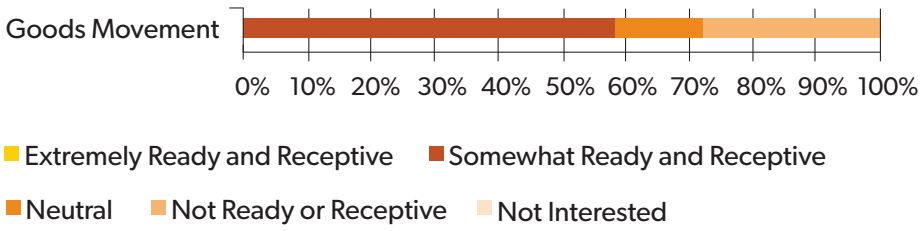


1.2.11 Readiness of New Connected Vehicle Technology

TABLE 12. Readiness/Receptiveness of New Connected Vehicle Technology

11. Please select your perception of the readiness/receptivity of the goods movement community to new connected vehicle or similar technology?		
Webinar Series II	Goods Movement	
Extremely Ready and Receptive	0	0.00%
Somewhat Ready and Receptive	21	58.33%
Neutral	5	13.89%
Not Ready or Receptive	10	27.78%
Not Interested	0	0.00%

FIGURE 13. Readiness/Receptiveness of New Connected Vehicle Technology – Distribution



1.3 Qualitative Data

This section contains the qualitative data, as well as some quantitative analyses of the qualitative data acquired through the webinars. The analysis of the stakeholder input, summarized at the end of this section, showed recurring themes and topics. The results of some of the common discussion topics are shown in Tables 13 and 14, and Figures 14 and 15.

TABLE 13. Recurring Topics Chart

(Topics that surfaced at a higher frequency than others)

Response Category (Topic)	Frequency	Percentage
Partnerships (Public/Private)	28	1.6%
Standards Needs	109	6.3%
Education and Collaboration	122	7.1%
Leverage Current Progress	10	0.6%
Utilize Multiple Resources	26	1.5%
Funding/Costs	180	10.3%

FIGURE 14. Recurring Topics Distribution Graph

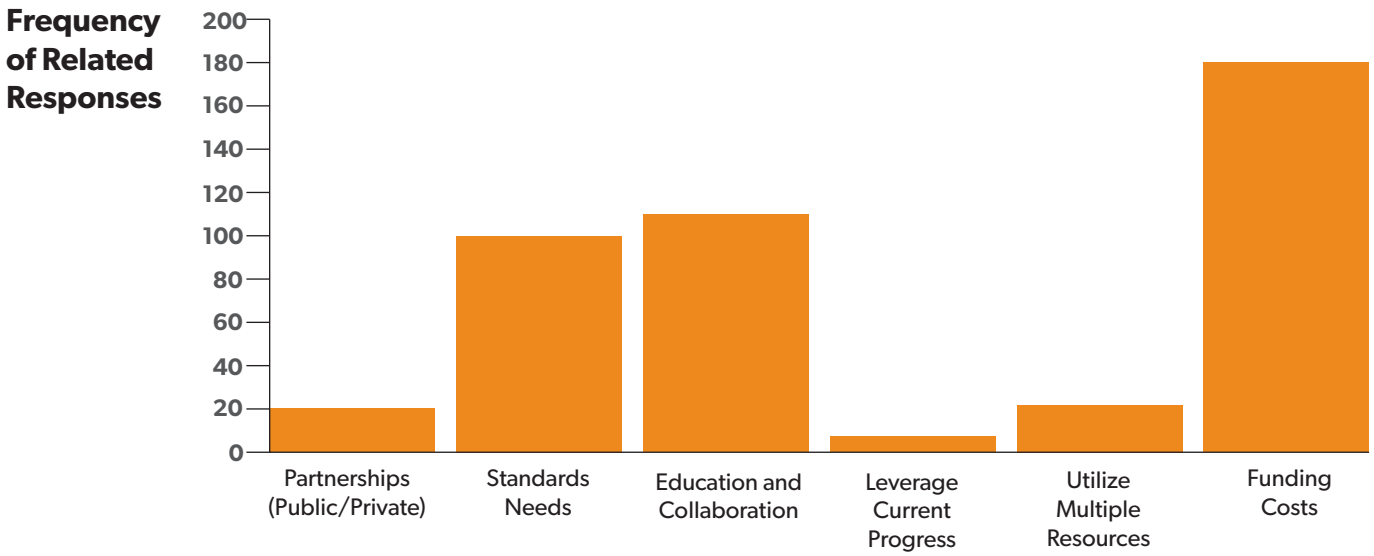
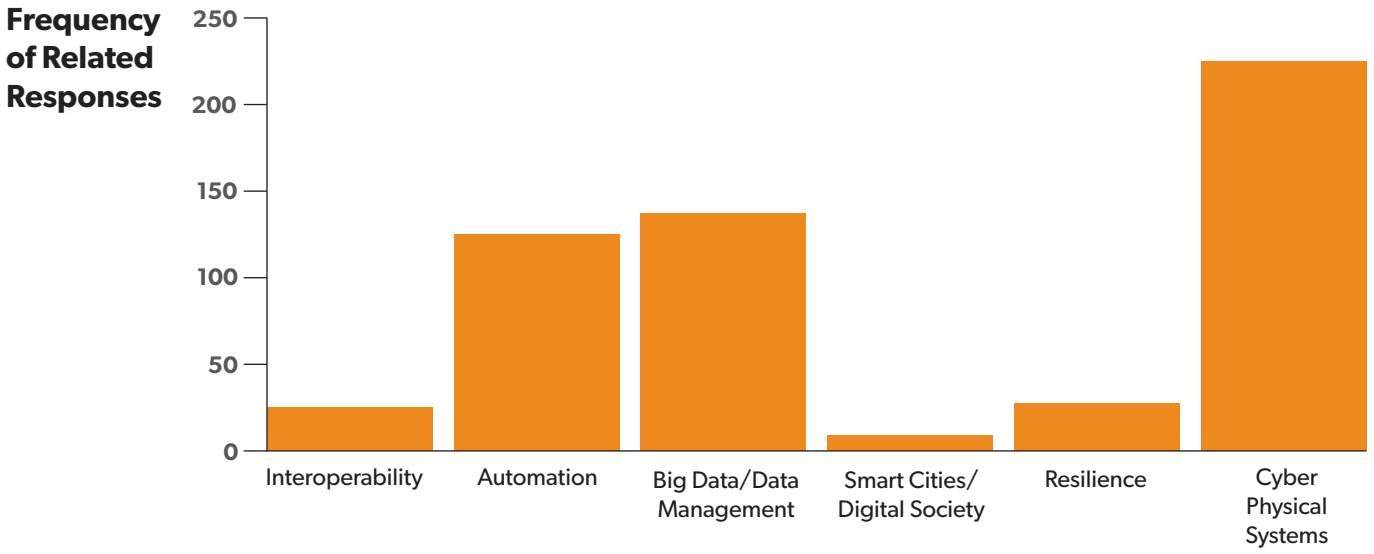


TABLE 14. Potential Program Focus Areas / Recurring Themes

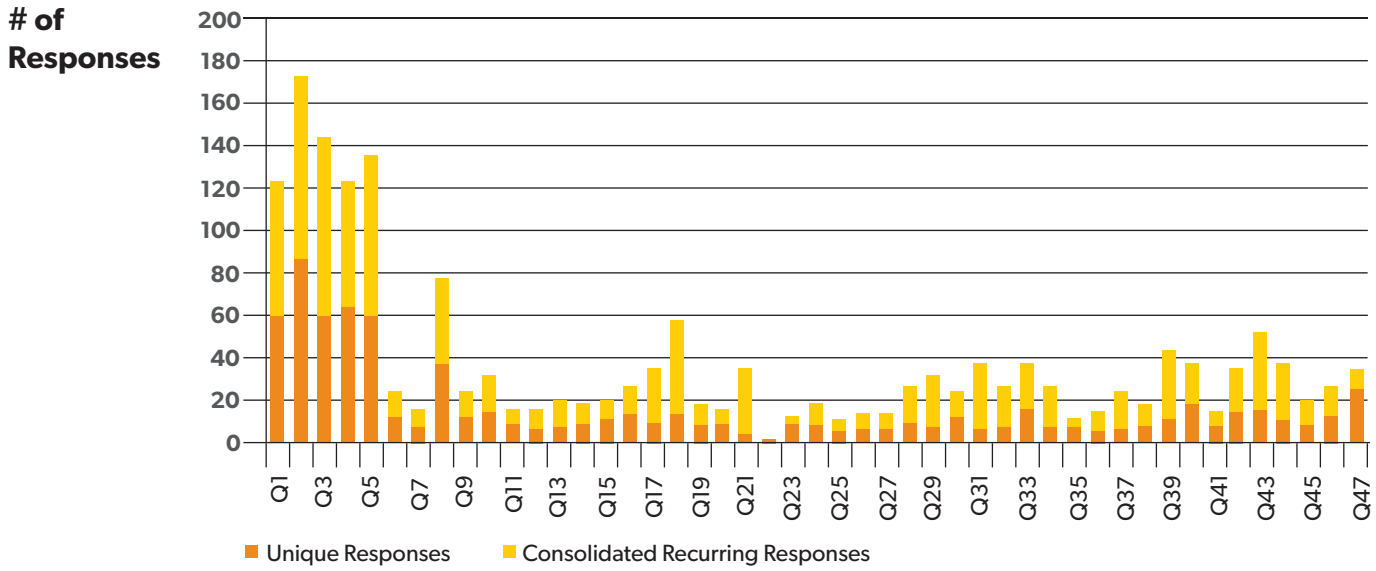
Focus Area	Related Responses	Percentage
Interoperability	217	12.6%
Automation	103	6.0%
Big Data / Data Management	107	6.2%
Smart Cities / Digital Society	88	5.1%
Resilience	92	5.3%
Cyber Physical Systems	238	13.8%

FIGURE 15. Potential Focus Area / Recurring Theme Distribution Graph



As shown throughout this appendix, stakeholders from a variety of organizations, backgrounds, and interests were tapped to inform and validate the direction of the ITS Strategic Plan throughout its development. Through the webinar outreach, many open-ended questions were asked to allow for maximum creativity and innovative thinking. As such, a wide variety of responses were gathered and analyzed. Figure 16 shows an overview of the analysis effort in consolidating stakeholder responses. Many similar responses were gathered, however, many unique responses were also obtained, providing granularity, detail, and diverse insight to each topic discussed.

FIGURE 16. Unique and Consolidated Recurring Responses



The following summary shows the questions asked in the webinars. It should be noted that not all questions were asked in every webinar; rather, general questions were asked in addition to more targeted questions specific to the area of expertise of the stakeholder group. Due to the vast amount of responses and information gathered, not all data can be given in this appendix. However, to provide an idea of the kinds of responses acquired, some of the most common responses have been summarized here.

Webinar Questions and Common Responses Summary

1. What ITS Program has had the biggest impact on your organization?

- ITS Deployment Program
- Connected Vehicle Program
- Incident and Corridor Management
- Traveler Information
- Tolling - Electronic Toll Collection and Open Road Tolling
- Weather-Related Programs

2. What other area(s) of emphasis should the ITS JPO be focused on?

- Energy Efficiency and Use - Electric Vehicles
- Automated/Autonomous Vehicles
- Inter-Agency Coordination - Data Exchange and Interoperability
- Liability Issues Related to Connected Vehicle Travel
- Privacy and Security
- Connected Trucks - Routing and Parking

3. What would you view as the most critical aspect of vehicle-based technology that needs attention (that hasn't been a focus to date)?

- Data Collection, Management, and Dissemination
- Human-Machine Interface - Driver Interaction and Information Delivery - Minimize Driver Distraction
- Education and Outreach - of Decision-Makers and Increasing Awareness and Lessons Learned
- Public / Private Sector Cooperation
- Uniform Standards

4. What would you view as the most critical aspect of roadside technology that needs attention (that hasn't been a focus to date)?

- Operation and Maintenance Strategies
- Reliable Communications and Communication Strategies
- Information Integration and Use
- Maximizing Efficiency While Minimizing Costs (i.e., Installation, Operations, and Maintenance)

5. What specifically can ITS JPO do to better support the ITS goals of your agency?

- Increased Education and Outreach

- More Agency Coordination
- Encourage Modal Shifts
- Increased Focus on Deployment
- More Funding for Implementation, Operations, Maintenance, Research, Testing, etc.
- More Traveler Information
- Focus on First/Last Mile Issue

6. What kinds of private industry partnerships or collaborations should the ITS JPO support and lead in the future?
   - Coordination Among Roadway Operators, OEMs, Suppliers, Researchers, etc.
   - Partnerships Between Entities that Have Proven Technologies
7. How can industry groups be more involved in the development and planning for connected vehicles and other ITS technologies?
   - Avoid Redundant Development - Monitor Private Technology Development and Provide Information Sharing Opportunities
8. What are some measures of success for your organization's projects?
   - Mobility - Reduced Travel Time
   - Safety - Decreased Crash Severity, Injuries, and Deaths
   - Benefit/Cost Ratios < 1
   - Travel Time Reliability - Congestion Mitigation and Delay Reduction
   - Vehicle Miles Traveled (VMT) and Greenhouse Gas Reductions
9. Does using ITS metrics help to measure and improve the performance of your systems, and why or why not? Which measures?
   - Helps Planning Loop Back with Operations and Monitor/Improve Actual Performance
10. Data Management - Please list some specific issues.
    - Limited Access
    - Need for Common Data Dictionary
    - Data Quality - Redundant Data, Lack of Relevant Data, Lack of Granularity, Timing, etc.
11. How do these data issues directly impact your organization?
    - Slow Adoption of Data-Driven Performance Measures
    - Restricted Use
    - Filtering Through Unnecessary Data Is Unproductive
12. Considering the issues mentioned, if these issues were to be addressed, what additional capabilities would be provided to your organization?
    - More Time for Effective Analysis and Utilization
    - Research and Development Enabler

13. Data Issues - what issues come to your mind in the realm of data capture, management, etc.
    - Managing Data - Data Size and Data Management
    - Security and Privacy
    - Common Standards
14. Automated Vehicles - What areas would be good to put resources and effort into?
    - User Expectations - Public Education, Trust, and Acceptance/Adoption
    - Limiting Risks
    - Safety and Security
15. Automated Vehicles - what aspects of automated vehicle research are you interested in? Where do you think ITS JPO should focus?
    - Design and Deployment
16. How might automated vehicle technology be applied for freight movement in the future?
    - Safety - Warnings and Advisories During Inclement Weather
    - Efficiency - Platooning, Congestion Alerts, Alternate Safe Routing, etc.
17. From your perspective, what is necessary to optimize ITS deployment?
    - Funding and Education - Prioritizing What To Do First
18. What are the conditions of new technology that will induce members of your community to invest or adopt?
    - Affordability and Proven Returns on Investment
    - Proven Return on Investment (in Realistic Time Frame) - Time Savings, Improved Reliability, Efficiencies Gained, Productivity, etc.
19. What are the major particularities between geographic areas with regard to ITS technologies?
    - Access to Communications - Rural Areas (Power, Cell Coverage, Wireless Communications, etc.)
20. Interoperability - What are your challenges in terms of interoperability? Where would you like to see additional focus?
    - Standards - Functionality Provided Regardless of Vendor or Location
    - Data Sharing and Coordination of Operations
21. What is required to achieve national interoperability in toll technology?
    - Standards and Requirements
22. Transit Topics - Integration of Payment Systems
    - Need Interoperability of Fare Media - Regional Fare Cards, PIV, Open Loop Payment Implementation
23. Transit Topics - Multi-modal integration: What are current issues? Challenges? What are effective ways to increase the level of multi-modal integration?
    - Transit Priority Treatments

- Information and Data - Pre-Trip Planning Information, Dynamic Multimodal Information, Schedule Integration - Connection Protection, Improved Information about Mobility Options

24. Transit Topics - How do we use ITS technologies to increase transit ridership?

- Focus on Moving People, Not Cars
- On-Demand Services for 1st/Last Mile Connection

25. Transit Topics - Accessibility: What are ways that ITS technologies or programs can provide a wider range of access to users?

- Disabled Access and Rural Services

26. What kinds of ITS technologies and programs are currently being developed in various transit situations?

- Easy-Access Information - Travel Time, Comparative Trips Times by Mode, Parking Availability, etc.

27. How can ITS technologies help transit agencies reduce costs, increase efficiencies, etc.?

- Utilize Capacity More Efficiently and Provide More Information Pushes

28. How do you see mobile technology affecting the tolling industry in the future?

- Ease of Use for Users - Seamless Connectivity and Billing Process, Mass Adoption Opportunity, Interoperability
- Offers More Options for Management of Road Facilities

29. What impact will connected vehicle technology have on traffic signal infrastructure?

- Improved Signal Operations
- Increased Infrastructure Demands
- Increased Safety

30. What impact will connected vehicle technology have on traffic signal operations?

- Better Fuel Efficiencies, Smarter Flow Algorithms, More Accurate and Real-Time Data

31. Why haven't adaptive signal systems been more widely adopted by transportation agencies?

- Cost - Installation, Retrofitting, and Maintenance - Too Expensive, Lack of Resources, etc.

32. What are the greatest challenges you face with the operation and maintenance of traffic signal systems?

- Cost and Funding - Installation, Operation, Maintenance, etc.
- Training and Education

33. Do you see VMT pricing pilot projects as a threat or an opportunity to the tolling community? Why?

- Opportunity - Allows Expansion Beyond Dedicated Toll Facilities
- Threat - Public Perception

34. How do you think the widespread use of connected vehicles will reduce the negative impacts of transportation on the environment?

- Improved Mobility, Reduced Congestion, Platooning, Reduced Fuel Consumption and Emissions

35. How do you think that connected vehicles will allow us to incentivize green choices by individual users?
    - Cash Incentives, Reduced Costs, Insurance Discounts
    - Use Data to Provide Feedback - Show How Usage and Impacts Compare to Peers, Friends, Community, etc.
36. How do you think that connected vehicles will allow us to incentivize green choices by transportation organizations?
    - Cash Incentives - Federal Money to State and Local Agencies for Greener Programs, Tax Breaks for Transit Agencies, etc.
    - Competitive Appearance - Prompt Organizations to Be More "Green-Minded"
37. How do you believe ITS overall will impact Road Weather Management?
    - Maintenance - Detection and Forecasting
    - Improved Data and Traveler Information
38. Historically, the ITS program has succeeded in developing programs such as the maintenance decision support system, Clarus, and Weather Responsive Traffic Management Strategies, and now, we have made inroads in connected vehicles, where should we go from here?
    - Operational Sustainability - Offer Operation and Maintenance Guidance
    - Funding and Implementation - Plan Realistic Deployment Strategies
39. What are the greatest challenges to the trucking community related to safety?
    - Human Factors - Hours of Service, Distracted Driving, Fatigue, Reaction Time and Following Distance, etc.
40. What are the greatest challenges to the trucking community related to productivity?
    - Congestion - Time to Deliver Goods, Traffic in Urban Settings, Avoiding Unexpected Traffic Incidents, Lack of Traffic Data
41. How is the emphasis on driver distraction impacting productivity?
    - Could Be Restrictive - Safety May Come at the Price of Slower Operations
42. What can be done to overcome truck driver distraction? Driver fatigue?
    - Parking - Availability, Reservation System
    - Research Human Factors - Human-Machine Interface and Information Should Not Additionally Distract
43. What are the greatest challenges to international freight movement?
    - Wait Times and Security - At Ports, Borders, and Customs
44. How can better truck parking information help safety and productivity?
    - Well-Rested Drivers Are Safer
    - Facilitate Planning - Drivers Know Ahead of Time Where Parking is Available and Plan Accordingly - Allows Vehicles to Travel to their Full Complement of Hours Rather than Stopping Short in Order to Secure Parking

45. What is the reach of commercial navigation systems?

- Needs Real-Time Information - Traffic Data, Road Conditions, Restriction Information (especially for Re-Routing for Incidents & Road Closures)
- Needs Interoperability - Cannot Depend on "Off-the-Shelf" Navigation

46. Do you have any thoughts about how new technology can complement existing in-cab information? What is still needed for in-cab devices or information?

- More (Localized) Push-Type Communication - Traffic Weather, Wait Times, Public Event Schedules, Road Spray Conditions, Surface Wetness, Fog and Visibility Limitations from Fire, etc.
- Road Restriction Information

47. Stakeholder Suggested Topics

- Road Weather - Demonstrations
- "Smart Cities"
- Interoperability
- Highway of the Future - Automated Vehicles
- Standards Development
- Flexible Demand-Responsive Services
- Intermodality
- Connected Vehicle Technology – Communications, Applications, & Impacts

2. Survey Monkey Questionnaires

Survey Monkey Strategic Plan Input

Progress in the current ITS Strategic Research Plan (2009-2014)

What do you believe was the most successful aspect of the last ITS Strategic Research Plan (2009 -2014)?

- Safety pilot project
- Vision of how elements of ITS "fit" together
- The execution of the V2V roadmap for connected vehicles

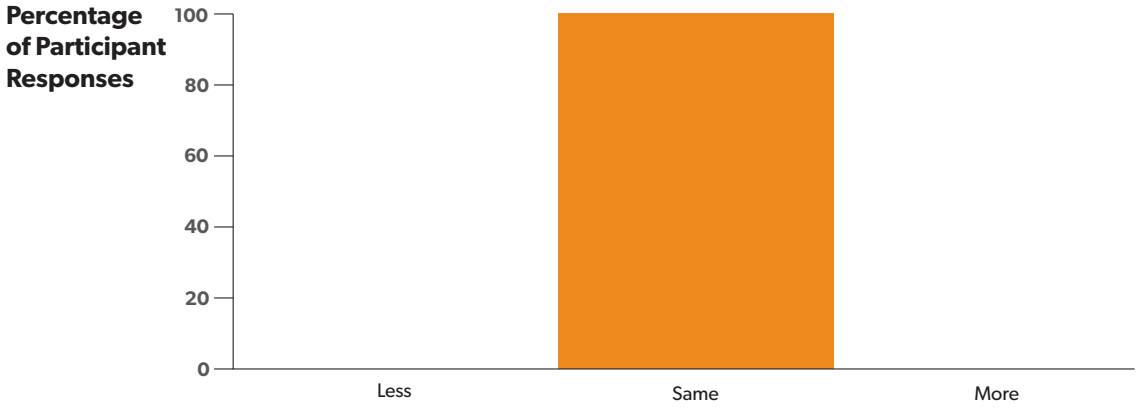
What do you believe is in need of the most improvement from the last ITS Strategic Research Plan?

- Less focus on vehicles; more on transportation system as a whole
- Include more commercial motor vehicle research
- Looking beyond and preparing for post-Connected-Vehicle
- Better modal coordination. For example, briefings to Associate Administrators, Deputies, and Modal Administrators on final approaches

What ITS Program has had the biggest impact on your agency?

- Connected Vehicle Program
- Safety pilot project
- Connected vehicle in general, mobility in particular
- V2V communications

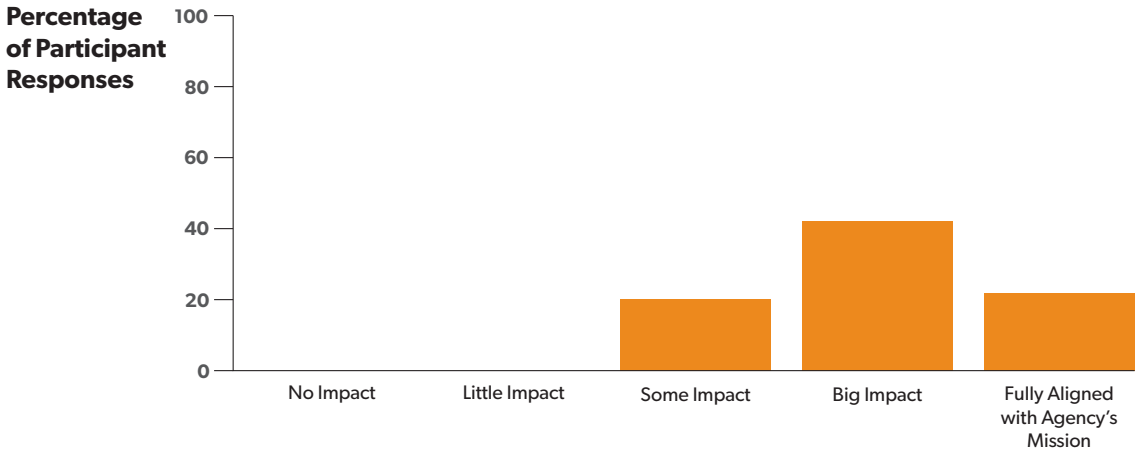
Should the level of emphasis on connected vehicles research be more, less, or the same?



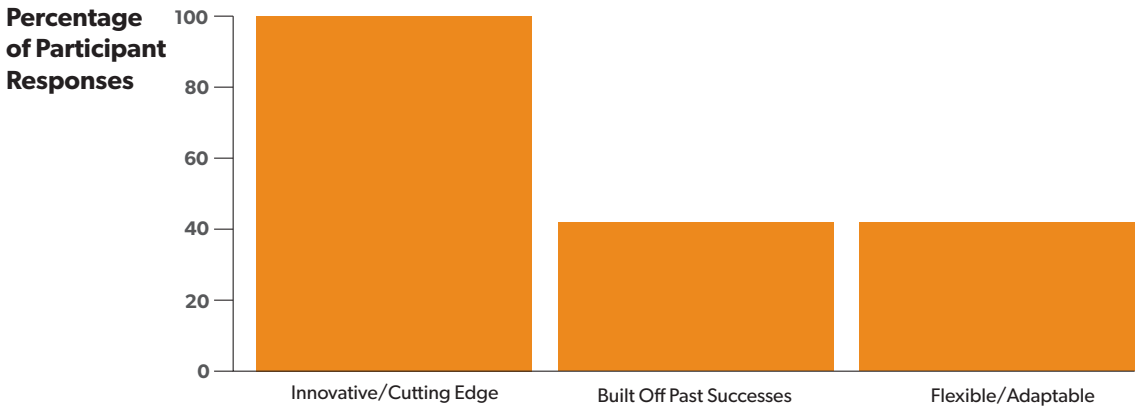
In what other areas would you like to see the ITS JPO focus?

- Moving from information to control, i.e., automation
- Commercial motor vehicle
- Nanotechnology implications on transportation
- Research on automated vehicles that cuts across all modes to inform DOT policy positions for example on data, integration, etc.

What would you say the level of impact is that the ITS JPO Programs have had on supporting your agency's goals?

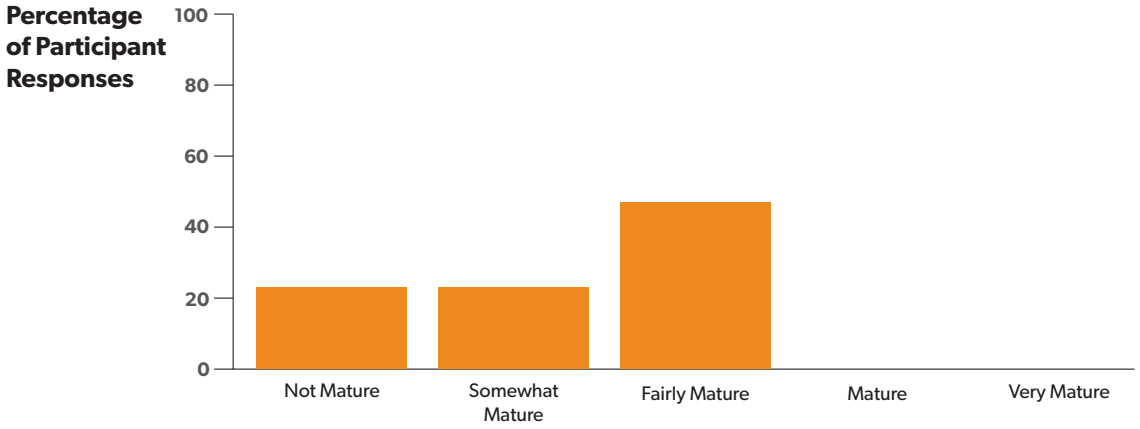


- From your standpoint, select the "2" most important elements of the Strategic Plan:

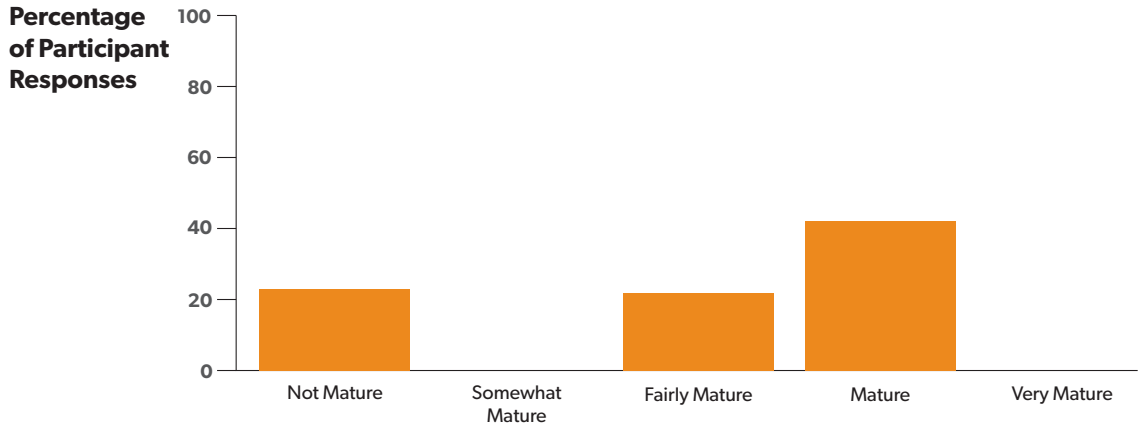


Considerations for Maturing Connected Vehicle Systems

- What would you view as the most critical aspect of vehicle based technology that needs most attention?
  - Communications
  - Human aspects of autonomous controls, i.e., drivers paying less attention to driving task
  - Application refinement, security gaps, spectrum sharing
- What would you view as the most critical aspect of road side technology that needs the most attention?
  - Communications
  - Security, both digital (hacking) and physical
  - Integration with the vehicle work, deployment, application development
- How would you define the level of the maturity of the road side technology? (0=Not Mature; 1=Somewhat Mature; 2=Fairly Mature; 3=Mature; 4=Very Mature)



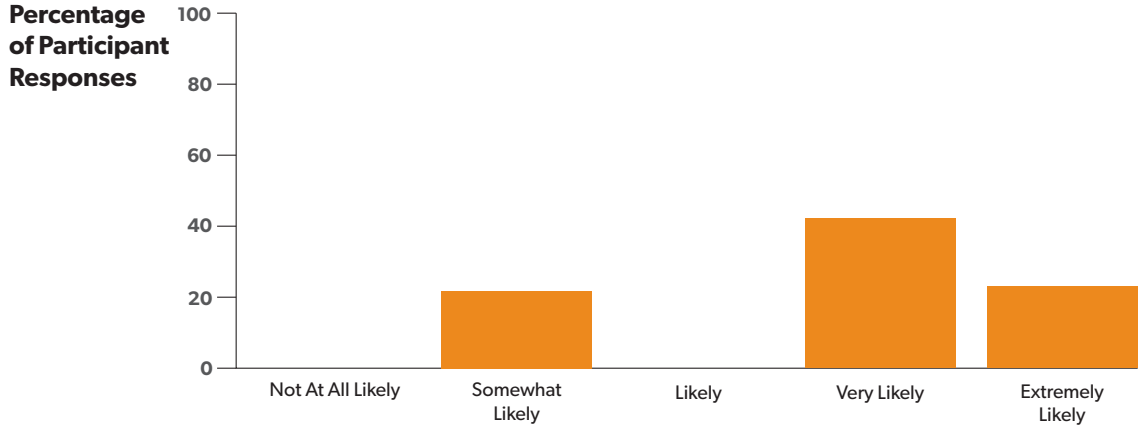
- How would you define the level of maturity of the vehicle based technology? (0=Not Mature; 1=Somewhat Mature; 2=Fairly Mature; 3=Mature; 4=Very Mature)



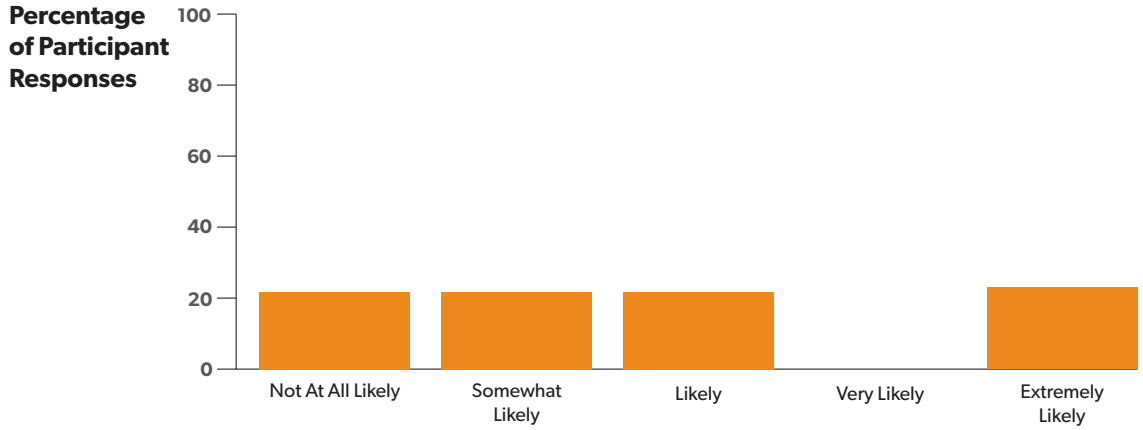
Considerations for Piloting and Deployment Readiness

- Please rank the following based on how likely it is to affect the establishment of a connected vehicle environment:

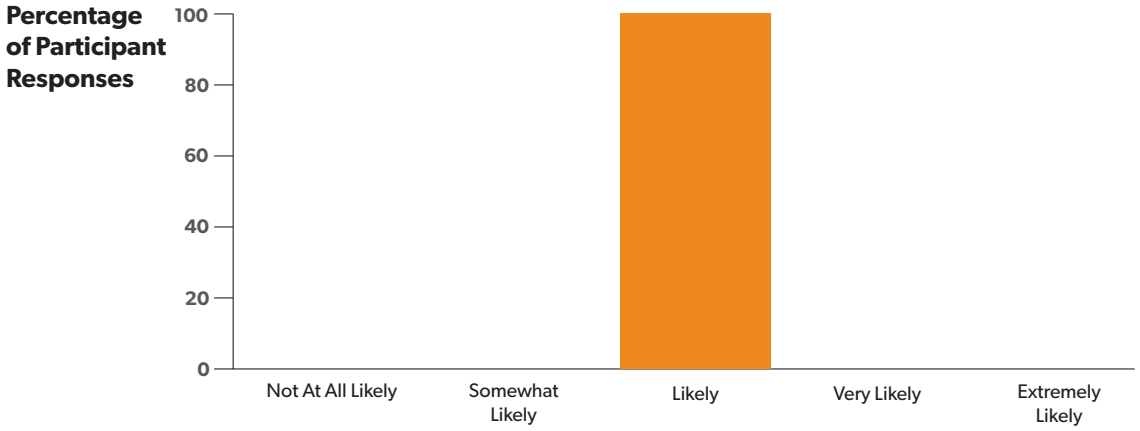
Privacy sensitivity



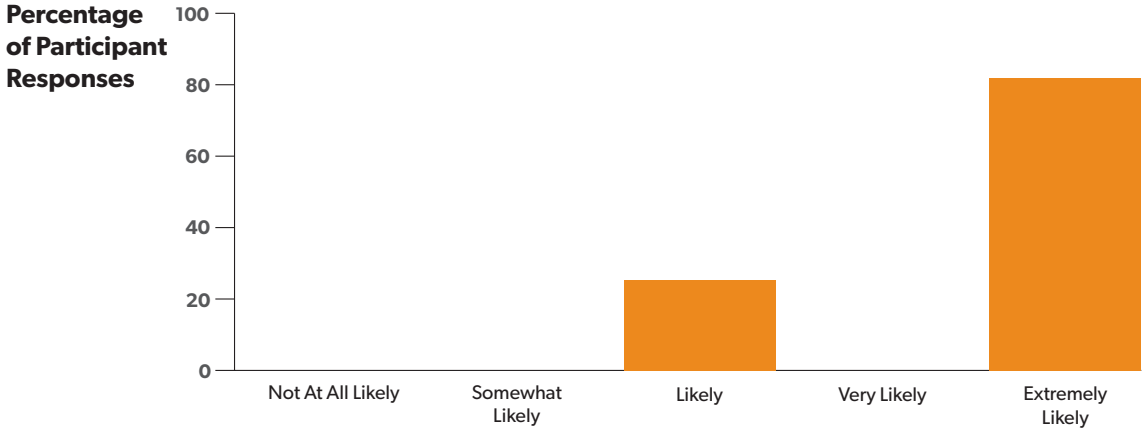
Public perception



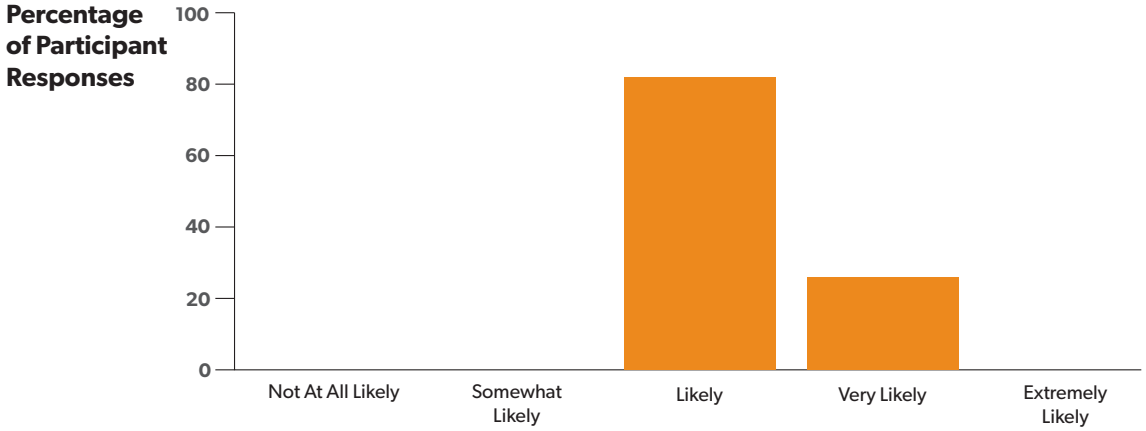
Support of public agencies



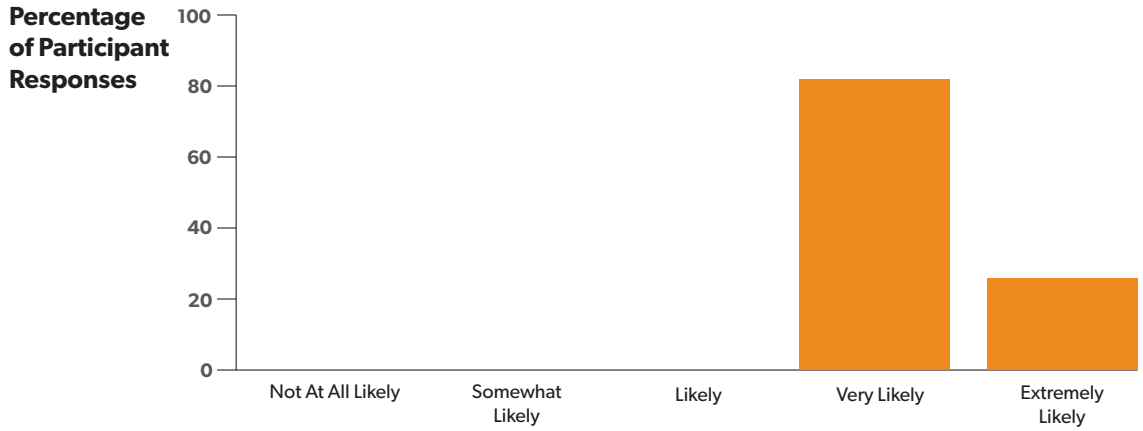
Private industry



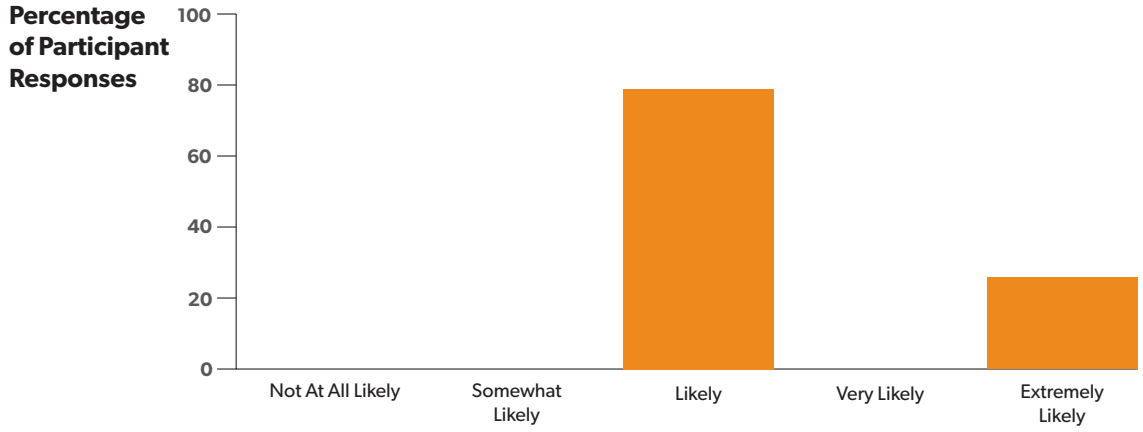
Technology developers not currently associated with connected vehicles



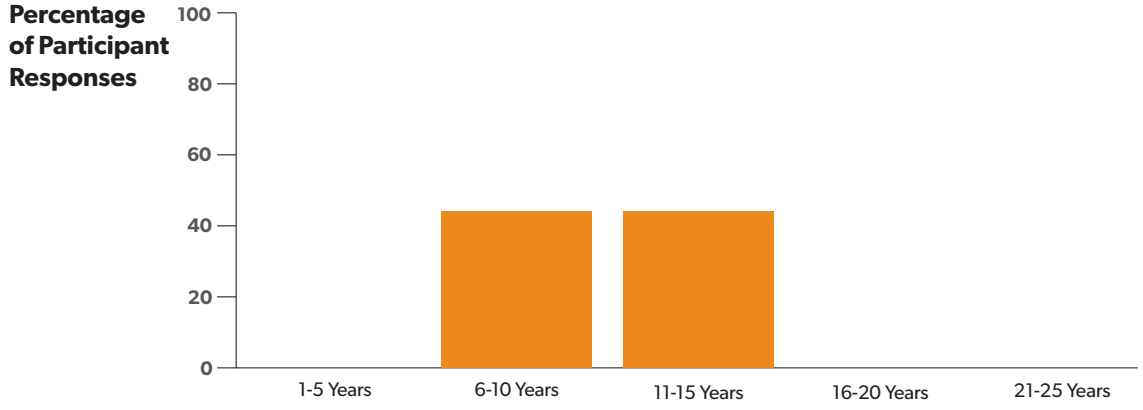
Other 'disruptive' technology (e.g., Google Glass)



Security

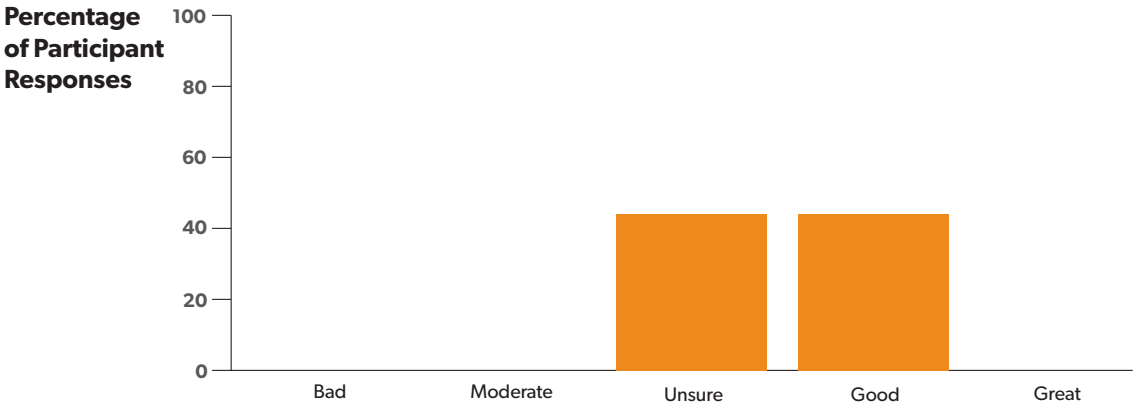


- Select from the time frames below for which you believe a connected vehicle environment will make an impact on the vast majority of Americans

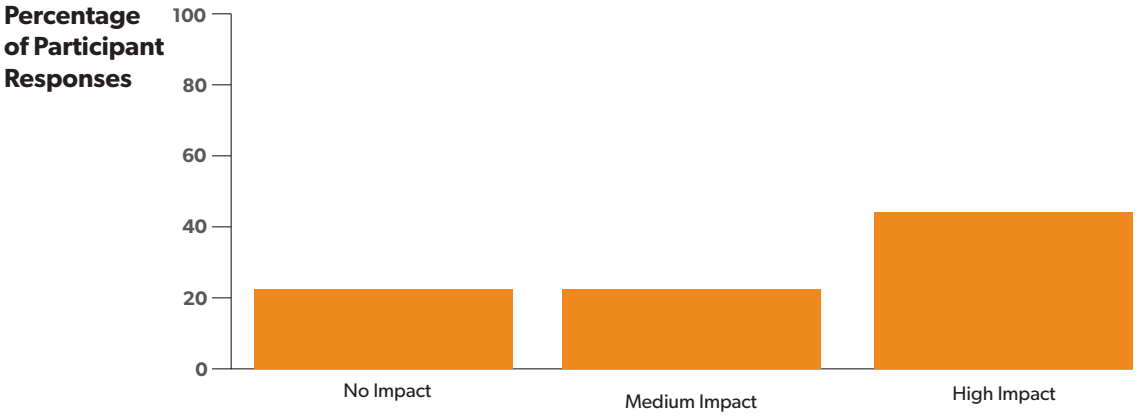


Considerations for Integrating with the Broader Environment

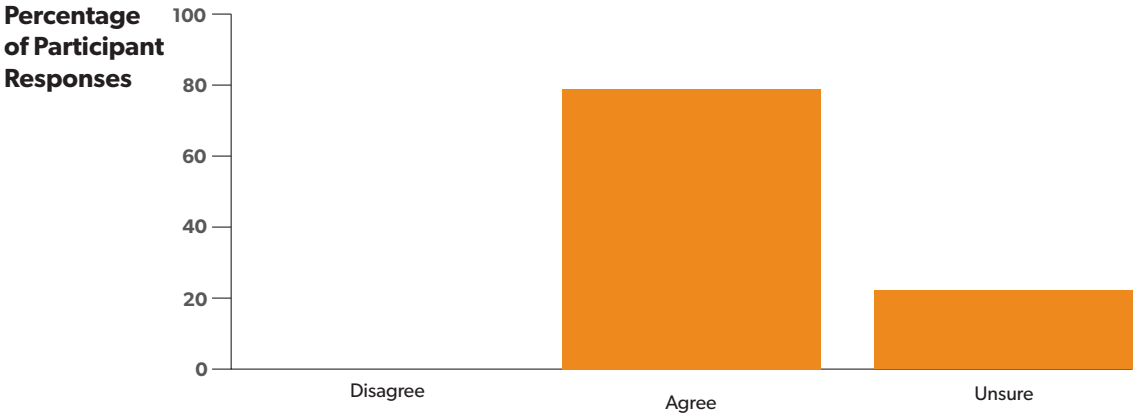
- How would you rate the capabilities of transportation management centers to integrate new technology among roadway operations, transit, and freight?



- What role will personal devices have in managing transportation demands at the personal level?



- Please rate how much you agree with the following statement: "Public agencies of all types will need to share information in a 'system of systems' environment."



Working with ITS JPO

What specifically can ITS JPO do to better support the ITS goals of your agency?

- Outreach to non-traditional organizations (Safety; Policy; Planning and Environment; Infrastructure; Federal Lands; Public Affairs in the administration). Why should we fund this; the JPO does this work? So, we don't need to get involved
- "Keep it real" i.e., continue to engage implementation and operation stakeholders to keep research efforts in perspective
- More efficient delivery of funds. Earlier coordination by JPO after the approval of spend plans

3. IdeaScale On-line Open Forum

Applicability / Usability of IdeaScale Inputs

Liability

"The DSRC Committee identified the issue of Liability and responsibility of an ITS System/Implementation failure as a big issue that has not been addressed by government and/or industry. The typical example given was: 'What happens when an Intersection Collision Avoidance System is implemented at an intersection and there is a major crash?'

When drivers give up some of the control of their vehicle, do they still have full responsibility for the safe operation of that vehicle? Failsafe implementations must be designed into any ITS system but the liability and responsibility issues must also be addressed from the beginning."

Transit within Connected Vehicle

"We have reviewed the draft of the next ITS Strategic Research Plan, and we find it to be, for the most part, well conceived. However we do have a concern that the conception of what constitutes a connected vehicle may be overly narrow. Automated Transit Networks (ATNs) are a type of connected vehicle system that goes a step further to full automation on a dedicated right-of-way. It is perhaps counter-intuitive, but taking this bolder step actually simplifies the technical challenges, and greatly increases the potential benefits. For example, some of the most intractable problems, such as the interaction of connected vehicles with unconnected vehicles, and protocols for suddenly overriding manual driver control, become non-issues in ATN systems. This will enable researchers to deliver the kind of real-world, near-term results that will be helpful in sustaining long-term funding. We can be confident of these results because existing ATN systems, that were developed with relatively little investment, have already established impressive records of safety and reliability in passenger service. ATNs offer other advantages as well. Detecting obstacles is a worthy goal, but keeping obstacles out of the path of vehicles is even better. Providing some automatic driving modes can be helpful to drivers, but only full automation will make a difference to the millions of people who do not drive. V2X can increase the efficiency of traffic signals, but only ATNs have the capability to eliminate stops at intersections. There is still significant work to be done to increase ATN performance and better understand their capabilities in large-scale applications. No one is suggesting that existing infrastructure should be discarded. But as we build new infrastructure, and rehabilitate old, we should be looking for opportunities to do it better.

Many municipalities have expressed an interest in Automated Transit Networks, but have concluded that local and regional transit agencies are not up to the task of pioneering a new form of ground transportation. This is where we believe USDOT has a significant role

to play in encouraging research, prototyping operational systems, and supporting pilot projects. Therefore we believe that the Strategic Plan would benefit greatly from the explicit inclusion of ATNs in the definition of connected vehicles. This enhancement to the Strategic Plan would also have the effect of bringing it into conformity with the Memorandum of Cooperation that USDOT signed with the Swedish Ministry of Enterprise, Energy, and Communications on September 30, 2010. Finally we would like to express our appreciation for your active engagement of the stakeholder community in the development of this very important Strategic Plan."

Safety

"The focus for connected vehicles should be in making a dramatic improvement in road safety; for too long we have accepted a level of death and injury on the roads that would not have been acceptable in any other mode for many decades. I am confident that we can achieve an order of magnitude reduction in road deaths (90% reduction) by the application of systems engineering to the four contributing domains:

- road design and traffic control systems;
- vehicle design and networking;
- information and communications technology applied to road traffic safety; and
- human systems integration optimization.

Driverless vehicles have been authorized in several jurisdictions and automobile companies have showcased autonomous vehicles in Las Vegas in the Consumer Electronics show. Nowhere however was there any mention of how the vehicles could cooperate with other vehicles and the road environment.

What has not yet been done is put all these factors together in a systematic manner to achieve a dramatic improvement in road safety. And that is what systems engineering can do as it has in so many other big challenges."

Big Data/ Data Management

"V2I presents a whole new method to deliver real-time information to travelers. Not only can it provide information on road conditions it could be utilized to suggest routing and speeds to the drivers (speed suggestions could be used to reduce congestion by disrupting shockwaves). Therefore, the theme of "Redefining Roadway Planning, Geometry, Modeling, and Operations, should not solely focus on how automated vehicles will influence the transportation system. Ways in which V2I could affect roadway operation should also be explored (particularly in a world where connected and automated vehicles could be controlled by a central authority in order to minimize overall delay/emissions/required maintenance on the system). New algorithms would need to be improved to determine optimum speeds and routing for individual vehicles. Once all vehicles are connected and automated, further research could also include algorithms that can dynamically alter road topology, such as changing the way a vehicle views an intersection (whether it sees the intersection as a roundabout, a four-way stop, or some sort of signalized intersection). While a fully automated system is likely two or more decades away, the research into dynamically altering road geometry, vehicle speeds, and routing will require considerable modeling and development and should begin in the 2017-2019 time frame.

The presence of automated vehicles will likely change the "opportunity costs" associated with driving a vehicle, i.e. because the "driver" can perform non-driving actions, such as watching a movie, while the car is driving, the driver's external costs associated with single occupancy vehicle use is greatly reduced. Such a reduction in "cost" may affect planning and modeling currently used for transportation and transit. Therefore, current models used for planning will need to be reexamined."

Security

"Security, including cybersecurity, is a fundamental need for any intelligent or connected system. This needs to demonstrated through a significant program, functionally equivalent (though not necessarily at the same $$ resource amount) to the Safety Pilot."

Backwards Compatibility

"The average vehicle has a lifespan of 12 years, whereas consumer electronics' lifecycles are closer to 2 years. Given these different lifecycles, research into ways to address the obsolescence of on-board equipment (OBE) should be undertaken. Such research could examine the development of easily upgradable OBE devices (whether physically or via firmware or software updates) or scenarios utilizing only after market retrofits. As this research aligns with the theme of "Retrofit," it belongs in the near-term 2012 to 2014 time-frame."

Partnership with Industry

"Apart from the DOT connected vehicle efforts, car companies are already connecting vehicles to the Internet for consumer and business applications such as entertainment and hands free use of cell phones, etc. This is already available on vehicles being sold today, and so integrating with this consumer environment should be a focus in the near time frame, rather than pushed to the long term time frame."

User Confidence and Funding

"The ITS Joint Program Office's report, "Review of Existing Literature and Deployment Tracking Surveys: Decision Factors Influencing ITS Adoption" (FHWA-JPO-12-043), notes that the early adopters (EA) of ITS are not viewed by the early majority (EM) of ITS adopters as "peers." Therefore, adoption decisions by EA may not influence EM's adoption of technologies. Currently, the theme, "State and Local Implementation Issues" wants to focus on planning grants, pilots, and incentives. This focus may encourage adoption of connected vehicle technology by the EA group but fails to adequately address the divide between the groups. Additional research under this theme should focus on how to convince the EM group to adopt connected vehicle technology.

V2I technology could potentially become a high profile technology, such as smartphones. However, any failure of V2I would generate a high level of negative publicity and could shake road user's confidence in the system as whole. Although failure of V2I due to technical problems may be likely, expected, and planned for, planning for the possibility of the premature termination of a V2I system from exhaustion of funds is unlikely to be pursued. The theme of "Private Sector Roadside Investments" wants to explore the possibility of public-private partnerships in connected vehicles. As some public-private partnerships have not succeeded in the past (e.g. SR 91) and required additional tax-payer support, the theme of "Private Sector Roadside Investments" should include an exploration the possibility of failure of public-private partnerships on V2I infrastructure in order to develop a standard set of contingency plans that could be enacted in the event of such problems."

Standards

"As vehicle manufacturers require about 4 years to develop new vehicle platforms, the research on vehicle communications standards should be moved to the earlier 2012-2014 timeframe in order to provide vehicle manufacturers adequate time to incorporate any technology mandated or recommended by NHTSA's rule-making decision on connected vehicles."

Automation

"Nothing short of full vehicle automation provides the magnitude jump in mobility and safety that is desperately sought. Yet our vision and research objectives are clouded with incremental steps, evolution of manual driving, and statements like 'no impact on infrastructure'. We dedicate lanes to HOV, HOT and other concepts with only incremental benefit, and shy from considering dedicated infrastructure to concepts that are transformative.

Let's explore automation scenarios that could provide development targets to manufacturers. Can some freeways be converted to full automation for freight in the overnight hours, incentivizing trucks to operate at night, freeing up daytime capacity? Can 'automated only' infrastructure be introduced in urban areas, using geometric designs that are efficient to build and safe for computer operated vehicles, and providing incentive for production and ownership of vehicles capable of utilizing the new capacity? Can automated transit circula-

tory systems be introduced that use that new dedicated infrastructure? In another scenario, can automated operation be introduced within a confined roadway network (intermixed with manually driven cars), by augmenting the roadways with either communications or signage, such that a driverless fleet can provided targeted mobility to a mobility disadvantaged sector such as the elderly, or blind? Can a universal automated parking standard be introduced to enable valet parking anywhere, opening up new possibilities urban and sub-urban design by breaking the fundamental relationship with regard to proximity to parking?

The public's long term research vision should focus on solution scenarios, and less on enabling technology which is the purview of private industry. Bold transformations are needed, and are historically the norm for innovation."

Environmental Impact

"The 4,424,361 streetlights in our nation's ten largest metropolitan statistical areas use an estimated 2,988,500,000 kilowatt□hours (kWh) per year of electricity annually producing the equivalent of 2.3 million metric tons of CO2. A 50 percent reduction in kWh used would result in savings of 1,494,250,000 kWh and 1,161,716 metric tons of CO2. The nation's streets and highways are a major source of greenhouse gases from vehicles and from the lighting and related electrical infrastructure. The lamps that light the way for those vehicles consume 52.8 terawatt□hours per year.

By switching to more efficient controllable lighting for these roads - driven by V2I technology, the ten largest metropolitan areas could reduce annual carbon dioxide emissions by 1.2 million metric tons — the equivalent of taking 212,000 vehicles off the road — and save $90 million a year.

One area to examine, in depth, is Adaptive Roadway Lighting driven by V2I communications. This convergence of ITS and the Smart Grid technology and standards would illuminate roadways only when users - vehicles, pedestrians and bicyclists - are present.

Two papers published last year in the Journal of the International Municipal Signal Association give some background: ""Smart Cities: Intelligent Transportation and Smart Grid Standards for Electrical and Lighting Management Systems."" and ""Smart Cities: V2I and Adaptive Lighting Communication Standards."" They can be downloaded at www.bit.ly/JrsBFz and http://bit.ly/MaWopc respectively.

Additionally, this brief December 2012 presentation to the IEEE Power & Energy Society addresses the topics of adaptive roadway lighting and it's support of ITS SAE J2735 http://foothill.ieee-bv.org/wp-content/uploads/2012/12/IEEE-US-DOT-Intelligent-Transportation-Systems-Standards-for-ELMS1.pdf. "

Environmental Impact and Public Transit

"There is plenty of merit in promoting ITS ideas that improve the safety and efficiency of vehicular traffic in our roadways. It remains, however, that the 20th century U.S. strategy of auto dependency as our primary transportation mode is the most energy intensive and dangerous approach to providing transportation on a national scale. Huge improvements in safety, energy use, emissions and congestion can be gained with only a marginal reduction in the number to cars on the road. I would support a dedicated an expanded effort in the ITS Strategic Plan for ITS solutions that reduce private auto dependency – i.e. transit, rideshare, ATN, bicycle, pedestrian, and/or car share supportive ITS solutions."

Expansion Beyond Current Transportation (bicycles and pedestrians)

"Connected vehicles will be adopted by different demographic communities at different rates. In addition, bicyclists and pedestrians are likely to lag in their adoption of vehicle connectivity technologies if they require antennas, batteries, or other cumbersome devices (as opposed to a smartphone). Connected and unconnected road users must be able to safely share the road. When discussing intersection improvements and other technologies that optimize the road for connected vehicles, the continued safety and convenience of those who remain unconnected must be considered. Pedestrians and bicyclists need signal phases and other technologies that reduce motor

vehicle efficiency in order to feel safe and comfortable. We should not replace our automobile-optimized infrastructure with a similar connected vehicle-optimized infrastructure mindset, but instead should have a broader view of what makes good infrastructure for all road users."

Big Data/ Data Management 

"Demand response transportation providers, mobility managers, and state DOT staff are being called upon to make decisions about what scheduling software to purchase, how to exchange data with other providers, and how to provide information on travel choices to consumers - including to those consumers who could use fixed route service for part of their trip. They do not have the knowledge to adequately address these questions. It is important to provide training so they will understand the available options and applicability of the options in their region or state. Informed consumers are needed as the nation invests tens of millions of dollars in these information technology systems.

Comment: This is an excellent point. Small transportation agencies are frequently being left behind as they try to find the best ways to use technology in their operations. Money spent based solely on vendor promises frequently results in buyer's remorse. For many smaller agencies it's not viable to have embedded technologists who can do the detailed systems engineering that's required for reliably good procurements. More technical assistance needs to be in place to assure solutions that are best for each agency."

Big Data/ Interoperability 

"Create a free, graphical road traffic simulator to help small towns and cities improve the coordination of their traffic light timing to increase vehicle throughput could be a great ITS initiative. The idea is to make it easier and cheaper for small municipalities to do their own customized traffic studies. Once the simulator is developed, perhaps sponsoring nationwide contests among high schools to see which municipality/high school can create the best, most helpful traffic model for their town's traffic department. Contests should have a cash prize and/or college scholarship for study in transportation sciences. The simulator could be developed using Linux/Open Source technology to run on a variety of Operating Systems including Microsoft, Linux, etc. Generating an Open Source simulator would also allow other future contests where students could modify the simulator to improve it creating other future contest opportunities. The student involvement might help generate career interest transportation work and recruitment possibilities."

Transit 

"For automation of some of the automobile functions, and further more regarding full automation of the driving process, the impact on insurance prices has to be taken into account. It will have an impact on the incentive for users to adopt vehicles equipped with V2V systems. In that respect, education regarding the reliability cannot be focused only towards consumers, but some technical information has to be communicated to related businesses."

Stimulating Investment in Rural Area 

"While it is the intent of connected vehicles to reduce the rates of automobile crashes, injuries, and deaths, one must remember that systems always have glitches. We can try to think of every glitch that could happen and create a solution response to this, but sometimes things happen that are out of our control. We must also think about computer hackers and what this could do to both connected vehicles and automated vehicles. Another issue is not all vehicles on the road will be connected for many years. So while in this transition, one cannot truly depend on the signals from their connected vehicle. For instance, if you are turning left and do not see a vehicle coming towards you, and it is not a connected vehicle, then your vehicle will not pick up on the oncoming car and this is a potential crash. People will become lazy and assume that they can rely on their connected vehicles when that will not be the case for a very long time. One must project a year in which it is assumed that all vehicles will be connected. Drivers must also be encouraged/warned that they must still rely on their own safe driving practices and not simply on a vehicle. There will be plenty of drivers who will not take necessary precautions, for instance, looking before you switch lanes and checking your blind spot. They will instead depend on the car for a warning if it is not safe. This cannot be done when they will be a mixture of cars with the connected capabilities, and those without."

Partnership with Industry

"Trip planners have advanced a great deal in the last decade, and using the general transit feed specifications (GTFS) one can now find out auto and fixed route transit options. Adding demand response services is the next step. More transit systems use general public demand response services in areas where fixed route is not feasible, so connecting information is important. Many people with disabilities could take rail or fixed route bus for a major portion of their trip, and only need more expensive specialized transit for the last mile. Incorporating demand response information into trip planners would encourage the use of both fixed and flexible travel options, providing riders with more travel options.

Comment: I agree completely with Suzanne and would like to add that a community of professionals exists with a great deal of interest in precisely the issue Suzanne has detailed. The Atlanta Regional Commission (ARC) in Georgia has received funding through the Veterans Transportation and Community Living Initiative (VTCLI) grant of the Federal Transit Administration (FTA) to develop a One-Click system. The Atlanta Region One-Click system will be connecting standardized fixed route data (GTFS format) with information on demand-response services within one trip planning platform to find a preliminary solution to the problem Suzanne has mentioned. However, without standardized data for demand-response systems, the challenge is substantial."

Contingency Planning for Technology Failures

"Software for reservations, scheduling, dispatch, and the back-office functions of billing multiple fund sources is provided by a dozen or more vendors. With the exception of those systems that have developed translators using data dictionaries as one-off solutions, data exchange between systems is not possible. To provide efficient specialized transportation, it is important for agencies to be able to use a variety of providers, matching the needed trips with available capacity. Developing specifications that would allow the exchange of the data necessary for these transactions, as well as the communications interfaces to support the data exchange is a priority.

Comment: Suzanne has explained in a very succinct way a primary and complex contributor to sharing clients on specialized (often demand-response) transportation services. Many agencies rely upon software connectivity solutions to enable their systems to connect (e.g., translators, data dictionaries), while agencies with less funds make the most with what they have with great limitations as a result. The lack of standardized data stifles the opportunity to easily share clients between various systems and increases the overall cost of specialized/demand-response/human services transportation trips.

Comment: Agreed. Because of the complete lack specifications for exchanging data trip and service-related data, it is currently near impossible to find efficiencies that scale across providers without merging providers' systems into one. Monolithic architectures do not scale well, and eventually an agency will come up against some other system it wants to coordinate with.

ITS can help by supporting industry stakeholders who are taking on these challenges and supporting the formation of special interest groups that bring together agencies and vendors to identify or create the tools we need to coordinate more broadly.

A solid set of tools for interoperability in flexible transportation, freely available for any vendor or agency to implement would be a boon to the industry and allow it to keep pace in this age of Uber, Car2Go, and similar transportation startups. The General Transit Feed Spec, which is focused on fixed route transit, is a good example of this approach. We sorely need a GTFS-type spec (or set of specs) for demand-response transportation."

B

Appendix B

Acronyms

The following appendix contains a list of acronyms and associated definitions for terms appearing throughout the plan.

TABLE 1: List of Acronyms

Acronym	Definition	Acronym	Definition
AAR	Association of American Railroads	PCB	Professional Capacity Building
AMS	American Meteorological Society	RPO	Regional Planning Organizations
CTIA	Cellular Telecommunications Industry Association	SAE	Society of Automotive Engineers
CV	Connected Vehicle	SCMS	Security Credential Management System
CVTA	Connected Vehicle Trade Association	TMC	Transportation Management Center
DOT	Department of Transportation	USDOT	United States Department of Transportation
DSRC	Dedicated Short-Range Communications	V2I	Vehicle-to-Infrastructure
DSS	Decision Support System	V2V	Vehicle-to-Vehicle
FHWA	Federal Highway Administration		
FMCSA	Federal Motor Carrier Safety Administration		
FRA	Federal Railroad Administration		
FTA	Federal Transit Administration		
IBTTA	International Bridge, Tunnel and Turnpike Association		
IEEE	Institute of Electrical and Electronics Engineers		
ITE	Institute of Transportation Engineers		
ITS	Intelligent Transportation Systems		
JPO	Joint Program Office		
MAP-21	Moving Ahead for Progress in the 21st Century Act		
MPO	Metropolitan Planning Organization		
NHTSA	National Highway Traffic Safety Administration		
NRITS	National Rural ITS Conference		

C

Appendix C
Glossary of Terms

The following appendix contains a list of definitions for terms appearing throughout the plan.

TABLE 2: Glossary of Terms

Term	Definition
Aftermarket Safety Device (ASD)	A connected device, not integrated during vehicle manufacture, but added after sale. It is installed in a vehicle, and capable of sending and receiving messages over a DSRC wireless communications link. The device has a driver interface, runs V2V and V2I safety applications, and issues audible or visual warnings and/or alerts to the driver of the vehicle.
Application	A software program with an interface that provides functionality enabling people to realize safety, mobility, environmental, or other benefits.
Cellular Telecommunications Industry Association (CTIA)	An industry trade group that represents the international wireless telecommunications industry. Its members include cellular, personal communication services and enhanced specialized mobile radio providers and suppliers, and providers and manufacturers of wireless data services and products.
Connected Vehicle Reference Implementation Architecture (CVRIA)	A research effort by the ITS JPO that aims to identify key interfaces of the Connected Vehicle environment and to develop a plan for Connected Vehicle Standards.
Connected Vehicle Trade Association (CVTA)	A non-profit business league established to facilitate the interaction, and advance the interests, of the entities involved in the vehicle communication environment. The association enables the collaboration of companies, organizations, and governmental bodies engaged in developing bidirectional vehicle communications. Membership is open to any corporation, public entities, standards and specification organizations, educational institutions and qualified individuals.
Connected Vehicles (CV)	Connected vehicles interact with each other (V2V), the roadside (V2I), and beyond (V2X) via wireless communications.
CV Penetration	The proportion of a vehicle fleet that is equipped with CV technology.
Dedicated Short-Range Communications (DSRC)	DSRC is a two-way short- to- medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications.
Early Adopter	A person who starts using a CV product or technology as soon as it becomes available.
Electric Vehicle (EV)	A vehicle that uses one or more electric motors or traction motors for propulsion.
Emergency Responders	Staff of providers of emergency services, including public safety providers. Examples include law enforcement, fire department, ambulances, or environmental protection agencies that respond to hazmat incidents.
Intelligent Transportation Systems (ITS)	ITS are defined as the application of advanced information and communications technology to surface transportation in order to achieve enhanced safety and mobility while reducing the environmental impact of transportation.
Interoperability	The ability of two or more systems or components to exchange information and to use the information that has been exchanged.

Metropolitan Planning Organization (MPO)	A federally mandated and federally funded transportation policy-making organization in the U.S. that is made up of representatives from local government and governmental transportation authorities.
Mobility	The ease with which members of a society move using transportation infrastructure such as roadways, bridges, pedestrian walkways, bike lanes, rail, etc.
Moving Ahead for Progress in the 21st Century (MAP-21)	The Moving Ahead for Progress in the 21st Century Act (P.L. 112-141), was signed into law by U.S. President Barack Obama on July 6, 2012. Funding surface transportation programs at over $105 billion for fiscal years (FY) 2013 and 2014, MAP-21 is the first long-term highway authorization enacted since 2005.
Naturalistic Testing	Testing of new technologies in a real-world setting or one that closely mimics or resembles the context and elements that are present in real-world settings.
On-Board Unit (OBU)	A vehicle mounted device used to transmit and receive a variety of message traffic to and from other connected devices. Also referred to as On-Board Equipment (OBE).
Opt-In Services	A connected vehicle may require a user to opt-in prior to transmitting any 'sensitive' data. Each opt-in prompt shall provide the user with a full description of the data that may potentially be transmitted if the user agrees to the option.
Professional Capacity Building (PCB)	PCB provides the ITS workforce with flexible, accessible ITS learning through training, technical assistance and educational resources. The program assists transportation professionals in developing their knowledge, skills, and abilities to build technical proficiency while furthering their career paths.
Roadside Unit (RSU)	A connected device that is only allowed to operate from a fixed position (which may in fact be a permanent installation or from temporary equipment brought on-site for a period of time associated with an incident, road construction, or other event). Some RSUs may have connectivity to other nodes or the Internet. Also referred to as Roadside Equipment (RSE).
Security Credential Management System (SCMS)	Security system for cooperative vehicle-to-vehicle crash avoidance applications using 5.9 GHz DSRC wireless communications.
Social Equity	The situation in which all people within a society or group have the same status with respect to access to and use of CV technology and products.
Transportation Agencies	Traffic operations agencies at any level of government (e.g., national, state or local), transit agencies, toll authorities, or private companies operating a highway concession. Also include private information service providers who might collect vehicle data to support, and commercial vehicle credentials and safety agencies, as well as maintenance personnel.
Vehicle-to-Infrastructure (V2I) Communications	The wireless exchange of (critical safety and operational) data between vehicles and highway infrastructure, intended primarily to avoid or mitigate motor vehicle crashes but also to enable a wide range of other safety, mobility, and environmental benefits.
Vehicle-to-Vehicle (V2V) Communications	The dynamic wireless exchange of data between nearby vehicles that offers the opportunity for significant safety improvements and a wide range of other mobility, and environmental benefits.

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