United States Department of Transportation
Annual Modal Research Plans FY 2023
Program Outlook FY 2024

Intelligent Transportation Systems Joint Program Office (ITS JPO)
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Egan Smith, Acting Director

Contents

Executive Summary

The Intelligent Transportation Systems Joint Program Office (ITS JPO) was created as a result of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) Public Law 102-240 (December 18, 1991). ISTEA established a federal program to research, develop and operationally test Intelligent Transportation Systems (ITS) and to promote ITS implementation. The ITS Program is designed to facilitate the deployment of technology to enhance the efficiency, safety, and convenience of surface transportation resulting in improved access, saved lives and time, and increased productivity. The ITS Program continues to address Congressional goals for transportation and technology under the new Bipartisan Infrastructure Law (BIL).

The mission of the U.S. Department of Transportation (USDOT) is to deliver the world's leading transportation system, serving the American people and economy through the safe, efficient, sustainable, and equitable movement of people and goods. The ITS JPO serves as the USDOT's multi-modal technology research program, working toward improving transportation safety, mobility, and efficiency; and enhancing productivity through the integration of innovative technologies within the nation's transportation system. Through these efforts, the ITS JPO serves as a Departmental leader in addressing innovation.

The ITS JPO is uniquely positioned within USDOT to facilitate multi-modal intelligent transportation system activities and has organizational relationships with the Office of the Assistant Secretary for Research and Technology (OST-R) and FHWA and reports to both the FHWA Administrator and OST-R Assistant Secretary. The ITS JPO is a FHWA Office and utilizes FHWA support functions while receiving research portfolio guidance from OST-R and is charged with executing *Subtitle C- Intelligent Transportation System Research of Public Law 109-59 Safe Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, enacted August 10, 2005*.

The **Vision** of the ITS JPO is to "Accelerate the use of ITS to transform the way society moves." That vision is executed through leading collaborative and innovative research, development, and implementation of intelligent transportation systems technologies to improve the safety and mobility of people and goods. By undertaking the research and deployment of advanced and innovative technologies, the ITS JPO serves as the USDOT's organizational resource for avoiding duplication and ensuring the Department is on the forefront of advancing technologies to make certain our transportation system is safe and efficient.

The ITS JPO will continue to provide a focused role for the Department in supporting development and deployment of new technologies as well as adopting and adapting innovative technologies from other industries to meet the specific needs of the surface transportation system. By working with industry partners, academia, and stakeholders

through cooperative agreements and grant programs, the ITS JPO will continue to develop intelligent and advanced technologies that address some of the more intractable transportation-specific problems. However, the ITS JPO's broad mission is neutral to any particular technology or platform that meets performance and interoperability requirements.

To fulfill its mission, the ITS JPO is guided by the ITS JPO Strategic Plan 2020-2025 which is aligned with the BIL and the Department's new 2022-2026 Strategic Plan; and outlines a focused set of strategies to lead collaborative ITS research, development, and implementation across USDOT modal administrations and with the private and public sector.

The ITS JPO continually assesses the feasibility, maturity, and benefits of ITS technologies and approaches, and shepherds' transportation solutions from inception to implementation. The ITS JPO capitalizes on past investments in key research areas including automation, connectivity, and data access and exchanges. The ITS JPO will continue to augment such efforts with our USDOT partners to focus on new emerging technologies that will impact and transform transportation.

The ITS JPO includes a portfolio of research and technology deployment support programs focused on diverse systems and technologies geared towards producing the most effective set of public benefits from transportation's increasing technological transformation. The ITS JPO is responsible for coordinating the ITS Program and multimodal technology research initiatives among the various USDOT operating administrations: Federal Highway Administration (FHWA); Federal Motor Carrier Safety Administration (FMCSA); Federal Transit Administration (FTA); Federal Railroad Administration (FRA); National Highway Traffic Safety Administration (NHTSA); Maritime Administration (MARAD) and the Great Lakes St. Lawrence Seaway Development Corporation (GLS). The ITS JPO partners with the Office of the Assistant Secretary for Technology and Research (OST-R) on research and analysis for key ITS enablers—spectrum access and communications engineering plus advances in positioning, navigation, and technology for ITS services (i.e., automation); both of which include a focus on cybersecurity including resiliency for these key enablers. In addition, close collaboration with current industry and academic technology innovators and leaders is a cornerstone of the ITS Program. The research builds on, leverages, and transfers knowledge and technology advances, and seeks to integrate and make interoperable, the technology and applications developed across all modes to deliver advances such as connected-smart communities, Vision zero transportation crash goals, significant reduction of transportation environmental impact, greater accessibility and mobility, and other future advances in an equitable manner for travelers of this Nation.

Through our research activities the ITS JPO serves two distinct roles within the USDOT, as both the project lead and as a multi-modal coordinator, working to ensure effective ITS research and technology deployments are successful. The ITS JPO serves as the lead in forward looking and emerging work that is not limited to just one mode and undertakes emerging projects where cross cutting capabilities are required to manage them. This includes connected data systems and large-scale pilot deployments. In our multi-modal coordinator capacity, the ITS JPO ensures that capabilities across the USDOT are harnessed to bring about the greatest good. An example of a major multimodal initiative led by the ITS Joint Program Office through partnerships with OST, FTA, and FHWA, is the Complete Trip - ITS4US Deployment Program. Since 2021 the Program has made over $40 million available to enable communities to showcase innovative business partnerships, technologies, and practices that promote independent mobility for all travelers. The Program leverages innovative technologies and facilitates public private partnerships to allow for a traveler-centric approach that improves mobility options for all travelers, including travelers with disabilities, travelers from rural areas, and lower income travelers. The Program is designed to bring publicly and privately sponsored research together to create large-scale, replicable deployments that generate increased multimodal mobility options for all travelers regardless of location, income, or disability.

In the near term, vehicles with various levels of driving automation systems that enter the market may potentially offer new benefits in travel comfort, convenience, and affordable accessibility. There is a clear government role in both ensuring public safety as these vehicles are introduced into service, and in ensuring that these vehicles are integrated into the road network in a manner that improves the efficiency of the system, and provides equitable mobility for all. The private sector is leading technology research and development focusing on vehicles that will behave in a way that works best for their own business models, but with limited consideration for wider impacts to the road network. As more vehicles are deployed, coordination through connectivity could ensure that the continued introduction of automated driving technologies produces system-wide safer passage, mobility, and congestion-reduction benefits in addition to vehicle-level improvements in traveler safety, comfort, and convenience.

The ITS JPO Automation Program's collaborative and multi-modal research portfolio provides cross-cutting support across the USDOT. Through the development of cooperative and standards-based interoperable technologies and comprehensive, stakeholder-driven policies, ITS JPO works to ensure the safe and efficient adoption of automated vehicles across the transportation system.

In addition, securing transportation's critical assets and infrastructure against cyber threats is a shared responsibility of both the public and private sectors. A common vision and a framework for achieving that vision help guide the public-private partnerships that

will secure transportation systems. Presidential Executive Order 13800 (issued May 11, 2017) on Cybersecurity of Federal Networks and Critical Infrastructure, holds heads of Departments accountable for managing cybersecurity risk of their ecosystem.

The ITS JPO is uniquely positioned to work across the USDOT with our modal partners to develop and coordinate multimodal research projects that are central to meet ITS cybersecurity needs. These efforts have included convening and facilitating the transportation ecosystem around shared priorities, facilitating the development of related policies, identifying, and addressing cross-modal issues, sharing best practices and information, and eliminating "silo" activities.

The USDOT has an important role to play in pursuing research and analysis in the area of cybersecurity for ITS to deliver public benefit. USDOT leadership can support needed research and coordinated stakeholder-driven development and implementation of best practices that can then in-turn be adopted by the diverse community of Infrastructure Owner Operators (IOO) including State, Local, Tribal, and Territorial (SLTT) agencies, private and public-private facility operators as well as vehicles and other mobile participants in the transportation system. Individual IOOs often have limited capabilities in this area; USDOT led collaboration can support both nationwide interoperability as well as development and implementation of best practices. The ITS JPO produces reference materials to support these decision makers and USDOT leadership efforts; for instance, translating the National Institute of Standards and Technology's (NIST) Cybersecurity Framework (CSF) for ITS deployers to determine how best to implement new controls while still achieving their transportation mission.

A cross-modal ITS Cybersecurity Research Program helps guide decisions on priorities for USDOT cybersecurity research. This research maps to the Cybersecurity Technical Research Working Group's (TRWG) goals to identify needs, common interests, and cooperation opportunities and engage in information sharing. ITS cybersecurity research is coordinated with our modal partners who actively participate in scoping and management of specific projects and includes areas such as the adaptation of the NIST Cybersecurity Framework and other Information and Communications Technology (ICT) best practices to better meet ITS needs. This research facilitates the capacity of our SLTT and industry partners and will enhance the skills of the USDOT to support proactively and effectively use demonstrated and proven transportation cybersecurity practices. The research will also assist in our efforts to appropriately identify suitable standards and system architecture approaches, that when combined with suitable operational practices can maximize the security and cyber-resilience of ITS installations and operations nationwide.

The Emerging and Enabling Technologies Program focuses on identifying, assessing, and accelerating adoption of new and innovative technologies such as Artificial Intelligence (AI)

for ITS; or investigating parameters for data and computing resources needed from SLTT agencies for employing AI in their ITS environments.

Likewise, this program also focuses research on Next Generation Wireless Communications research for ITS; inclusive of the next generation of Dedicated Short Range Communications (DSRC), Long-Term Evolution Vehicle-to-Everything (LTE-V2X), new forms of satellite communications, or the upcoming 5G New Radio (NR) Cellular V2X (C-V2X) or 5G NR Unlicensed (5G NRU), as well as future "Gs". Current and next generation of wireless communications technologies – both wired/fiber and wireless - are essential to enabling the safe, secure, and efficient operations of ITS. Based on specific communications needs for latency, interoperability, reliability, or sensitivity to interference, transportation agencies have incorporated a wide variety of communications into their operational environments (i.e., field systems, management centers, and public fleets). Vehicle manufacturers are increasingly including multiple types of wireless communications capabilities on their vehicles which can, increasingly, interact with the infrastructure; and travelers are increasingly using portable devices to employ wireless-based applications to bring greater safety, mobility, and accessibility into their travel. New and emerging communications technologies will continue to offer transformative opportunities for the transportation system. The USDOT has an important role to play in pursuing research and analysis regarding suitability and safety performance as well as addressing issues of latency, interoperability, or interference as new forms of telecommunications (i.e., emerging forms of 5G or high-altitude platforms (HAPs) among others) are proposed for delivery of public benefit. USDOT's test information and analysis allows SLTT agencies to articulate their needs and requirements to telecommunications industry service providers that more directly support their advanced ITS use cases and requirements that cross jurisdictional, geographic, and market boundaries.

This next generation wireless research also provides USDOT with a significant understanding of the potential benefits and disruptions these technologies could represent to the transportation system. This research also incorporates an understanding of how the electromagnetic radio frequency spectrum is used by transportation and whether transportation has unique needs with regard to spectrum. Spectrum is a crucial resource needed to facilitate the exchange of vast data quantities that support cutting-edge technologies from automated vehicles and telemedicine to advanced public safety communications networks.[1] As noted in 2019 in two documents from the White House— *Ensuring America Reaches Its 5G Potential* and *Research and Development Priorities for American Leadership in Wireless Communications*—efficient spectrum use and spectrum availability are fundamental to the Nation's security and prosperity, requiring a "whole-spectrum solution" that encompasses and addresses scientific research, technology,

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[1] Quoted from https://www.whitehouse.gov/articles/ensuring-america-reaches-its-5g-potential/

policy, legislation, operations, and economics.[2] The ITS JPO works with OST-R on spectrum management and interference studies; participates in the Federal cross-Agency/Department efforts to implement secure 5G; and further monitors break-through research in using currently under-utilized spectrum to understand whether there are opportunities for transportation.

Also, under the Emerging and Enabling Technologies Program, Artificial Intelligence (AI) has been identified as an area of prioritization, both for the benefits it promises and the opportunity to extend those benefits across modes within USDOT. On February 11, 2019, an Executive Order was issued on Maintaining American Leadership in Artificial Intelligence[3] (AI) to promote sustained investment in Research and Development (R&D) in collaboration with industry, academia, and other non-Federal entities to generate technological breakthrough in AI. The Executive Order directs heads of agencies to consider Artificial Intelligence as a Research and Development priority with respect to federal investment, an agency's mission, and research priorities. The ITS JPO is seeking to consider prioritizing R&D research with a focus on AI in ITS as well as data and computing resources need to promote AI per the Executive Order. Moreover, the ITS JPO Strategic Plan[4] has established AI in Intelligent Transportation Systems (ITS) as Emerging and Enabling Technology research area.

In FY23 the Emerging/Enabling Technologies Program plans to support reengagement with its modal partners on research activities in support of Departmental goals related to climate change and the environment. The program intends to leverage past and current research in this area, including the research accomplished in the AERIS (Applications for the Environment: Real-Time Information Synthesis) Research Program.

The Data Access and Exchanges Program facilitates effective generation, acquisition, governance, management, and analysis of ITS data and code across all modes to advance the state of multimodal ITS research and support deployment of innovations in operations. While enabling broader ITS research and deployment activities, these investments drive implementation of various Federal and USDOT directives on increasing access to data, source code, and federally funded research results. Between FY2018 and FY2022, the ITS JPO developed and enhanced technical assets and governance documents to improve access to data and source code produced through multi-modal ITS research investments. In FY2023, the ITS JPO will maintain mature capabilities and refine governance and related knowledge transfer activities to continue to build a culture of data and code within the

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[2] From: https://www.whitehouse.gov/articles/ensuring-america-reaches-its-5g-potential/ and https://www.transportation.gov/sites/dot.gov/files/2020-02/EnsuringAmericanLeadershipAVTech4.pdf.
[3] https://www.whitehouse.gov/presidential-actions/executive-order-maintaining-american-leadership-artificial-intelligence/
[4] An internal document which is currently under review for approval so it will be provided at a future date

Department and in DOTs across the Nation. Consistent with the ITS JPO Strategic Plan, this research area will also continue to help identify, prioritize, monitor, and – where necessary – address multi-modal data exchanges across traditional organizational boundaries.

The Accelerating Deployment Program will take the lead in building evidence-based decision-making capacity both inside and outside of USDOT and supporting activities that work to accelerate the deployment of ITS, including: data acquisition about the costs, benefits and extent of deployed ITS; knowledge transfer with a focus on both the existing and future workforce; development of the Smart Community Resource Center; support for system interoperability with a focus on evolving the ITS National Architecture Reference and supporting industry-consensus ITS standards; and enhancing outreach and communication with our stakeholders.

The ITS Deployment Evaluation Program will continue to generate data and analyses related to the benefits, costs, and extent of deployed ITS. These data have been instrumental in understanding trends in ITS technology deployment and emerging priorities in agencies' ITS deployment plans. The ITS JPO has been collecting data on the benefits, costs, and extent of deployed ITS for over 20 years. These unparalleled, globally unique data resources offer the ITS JPO an extraordinary opportunity to continue to support Departmental goals related to evidence-driven and data-based decision making.

The ITS JPO uses the ITS deployment data it collects to:

- Assess the current state of ITS deployment and communicate the benefits that might be accrued by deploying ITS technologies and systems;
- Highlight ITS technologies that have had particular success in solving common transportation problems;
- Highlight ITS technologies that enjoy widespread use and show how they have been successfully deployed over time;
- Identify opportunities for strategic action and more intensive tech transfer, training, support, and data collection related to ITS; and
- Identify gaps or needs that the ITS JPO and its modal partners can address with respect to ITS deployment data.

As a key part of the Accelerating Deployment Program area, the ITS Professional Capacity Building Program is the ITS JPO's primary mechanism for educating the public sector's transportation workforce about ITS. The ITS JPO will continue to support activities that deliver multimodal ITS learning opportunities to the public-sector workforce by coordinating outreach related to the ITS JPO's research initiatives and providing technical assistance. The ITS JPO has developed and delivered technology transfer in close coordination with key stakeholders and ITS-engaged organizations, including the National

Highway Institute (NHI), Intelligent Transportation Society of America (ITSA), Institute of Transportation Engineers (ITE), National Operations Center of Excellence (NOCoE), National Association of Development Organizations (NADO), universities and other stakeholders. The public-sector participants representing State DOTs, Metropolitan Planning Organizations (MPOs) and local agencies have benefited from this cooperative arrangement. Participants have favorably evaluated the ITS JPO technology transfer for its delivery of much needed training and technical assistance with feedback indicating that participants use the training to improve grant applications, purchasing decisions, procurement designs, or systems operations and management. Evaluators have also mentioned a reassessment of infrastructure vulnerability including information technology (IT)-data management improvements as a result of technology transfer events provided by the ITS JPO.

The Accelerating Deployment Program area also supports efforts to ensure system interoperability which allows transportation system users to access ITS services anywhere they may travel. This capability is essential to maximize safety, mobility, environmental, and connectivity benefits from rapidly advancing ITS technologies. To support interoperability, ITS JPO maintains and evolves a system architecture reference along with companion planning and diagramming software tools ITS JPO cooperates with stakeholders to evolve this architecture reference – currently supporting tailorable implementations of over 150 ITS services – to accommodate, and when appropriate lead, technological evolution. ITS JPO cooperates with stakeholders to develop needed ITS voluntary, industry-consensus voluntary technical standards and to specify and adapt appropriate Information and Communications Technology (ICT) standards to support customized local ITS infrastructure implementations as well as large-scale interoperable integration of automation and connectivity technologies. When requested by modal partners, ITS JPO will also support development of ITS standards content to be published via Standards Development Organizations (SDOs), that is suitable for incorporation into regulations by the modal partner(s). ITS JPO also provides architecture and standards technical support including reference implementations of key standards to assist SLTT and other implementers of ITS technologies. ITS JPO works closely with the Office of the Assistant Secretary for Aviation and International Affairs (OST-X) to support advocating active use of U.S. ITS architecture and standards products in other nations; and to continue support of cross-jurisdictional border and North American interoperability efforts that seek to maximize benefits of multi-regional approaches to architecture and standards.

The Communications and Outreach Program supports ITS JPO efforts to engage with the ITS community. By constantly engaging with the transportation industry and maintaining ties with national and international ITS practitioners, the ITS JPO research efforts can better identify transportation problems worth solving. The Communications and Outreach

Program also facilitates the ITS JPO's engagement within the transportation industry to address system safety, multimodal improvements, interoperability, underserved populations, and other long-term challenges.

Topical Research Working Groups

The ITS JPO is actively engaged with the USDOT topical research working groups (TRWGs). These groups are designed to break the siloed, "modal-centric" approach of the past and, instead, establish a truly multimodal, "One DOT", research endeavor. A coordinated topical-driven approach will enable the Department to respond to new research needs that span one or more modes, guard against duplication of research efforts, and provide a resource for the modes and DOT leadership on a wide range of research topics. Each working group is assigned to a DOT agency or OST office and chaired by a representative for that agency/office. Working group membership is composed of representatives from each mode and OST office working within that topic area, with members selected based on recognized expertise within the topic area and/or broad awareness of their agency's activities within the topic area. The groups are designed to leverage existing cross-modal coordination bodies where possible. The ITS JPO actively engaged in and/or chairs/co-chairs four working groups:

1. Automation: The goal of this working group is to "Enable the safe integration of Automated Vehicles and Unmanned Aircraft Systems into the transportation system."
2. Emerging/Enabling Technologies: The goal of this working group is to "Advance the development of emerging/enabling practices and technologies."
3. Data: The goal of the Public Access Implementation TRWG, with the Data Access Task Force under it, is to "Ensure access to high-quality data to support data-driven technologies, operations, and decision making."
4. Cybersecurity: the goal of this working group is to "Develop approaches for maintaining the cybersecurity of the transportation system."

Table 1 - FY 2023 RD&T Program Funding Details

RD&T Program Name	FY 2023 President's Budget Request* ($000)	Applied ($000)	Technology Transfer ($000)	Facilities ($000)	Experimental Development ($000)	Major Equipment, R&D Equipment ($000)
Complete Trip - ITS4US		$2,000				
Automation		$12,000				
Emerging/ Enabling Technologies		$15,000				
Cybersecurity for Intelligent Transportation Systems		$5,500				
Accelerating Deployment		$22,000	$6,000			
Data Access and Exchanges		$6,500				
Advanced Transportation Technologies and Innovation Mobility Deployment (ATTIMD)			$21,000			
Small Business Innovation Research (SBIR)		$2,200				
Program Support		$9,000				
*Estimated Budget Authority Rescission		$8,800				
Totals	**$110,000**	**$83,000**	**$27,000**			

* FY 2023 President's Budget ($110M) adjusted for 8.0% rescission of budget authority "lop-off"

The AMRP reflects funding as found in the FY 2023 President's budget request per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning. The FY 2023 enacted numbers will be posted as part of the FY2024 President's budget request.

Table 2 - FY 2023 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2023 President's Budget Request* ($000)	Safety ($000)	Economic Strength and Economic Competitiveness ($000)	Equity ($000)	Climate and Sustainability ($000)	Transformation ($000)	Organizational Excellence ($000)
Complete Trip - ITS4US				$2,000			
Automation						$12,000	
Emerging/ Enabling Technologies					$2,000	$13,000	
Cybersecurity for Intelligent Transportation Systems						$5,500	
Accelerating Deployment				$6,000		$22,000	
Data Access and Exchanges						$6,500	
Advanced Transportation Technologies and Innovation Mobility Deployment (ATTIMD)				$21,000			
Small Business Innovation Research (SBIR)			$2,200				
Program Support							$9,000
*Estimated Budget Authority Rescission			$8,800				
Totals	**$110,000**		**$11,000**	**$29,000**	**$2,000**	**$59,000**	**$9,000**

* FY 2023 President's Budget ($110M) adjusted for 8.0% rescission of budget authority "lop-off"

The AMRP reflects funding as found in the FY 2023 President's budget request per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning. The FY 2023 enacted numbers will be posted as part of the FY2024 President's budget request.

Chapter 1 – FY 2023 RD&T Programs
Complete Trip – ITS4US Deployment Program
($2,000)

Program Description:
The Complete Trip - ITS4US Deployment Program is a multimodal effort led by the Intelligent Transportation Systems Joint Program Office (ITS JPO) through partnership with the Office of the Secretary of Transportation (OST), Federal Transit Administration (FTA), and Federal Highway Administration (FHWA). The Program makes $40 million available to enable communities to deploy innovative technologies, partnerships, and practices that promote independent mobility for all, regardless of location, income, or disability. The program is designed in three phases (planning, design and testing, and operation and evaluation) to bring publicly and privately sponsored research together to create large-scale, replicable, and integrated ITS and other emerging technology deployments to address the challenges of planning and executing all segments of a complete trip. The Program leverages innovative technologies that improves mobility options for all travelers, including travelers with disabilities, travelers from rural areas, and lower income travelers.

The Complete Trip-ITS4US Deployment Program is funding multiple large-scale, replicable deployments of integrated innovative technologies to address the challenges of planning and executing all segments of a complete trip. In 2021, the USDOT awarded 5 teams with Phase 1 funding to support the development of their deployment concepts. The 5 deployment projects include:

- University of Washington (UW) - Transportation Data Equity Initiative
- California Association of Coordinated Transportation (CALACT) – Trip Planning for All
- Heart of Iowa Regional Transit Agency (HIRTA) - Health Connector for the Most Vulnerable
- ICF International, Inc. (ICF) - Complete Trip Deployment in Buffalo
- Atlanta Regional Commission (ARC) - Safe Trips in a Connected Transportation Network

The program is conducting deployments through a phased approach with decision gates at the end of each phase. In FY22, the program began Phase 1 which included the complete trip concept development and system requirements. In FY23, successful Phase 1 teams will be eligible to move to Phase 2 and Phase 3 after successfully completing their complete trip deployment plans. Phase 2 will be the designing, building, and testing phase and it is

expected to take up 24 months. Phase 2 also includes the planning for evaluation of the deployment.

In FY22, the USDOT finalized and released the Notice of Funding Opportunity (NOFO) for procuring the work for the Phase 2 and 3, where the successful sites will leverage their deployment concept developed in Phase 1 and move to systematically design in detail, build, and test (Phase 2) and operate and evaluate (Phase 3). In FY22, the 5 awardees completed their Phase 1 concept development documents and developed a response to the USDOT NOFO solicitation and briefed their proposal at oral presentations. USDOT expects to award Phase 2 and 3 cooperative agreements in late FY22.

An Independent Evaluation of the deployments will run concurrent with the three deployment phases of the program. In addition, an evaluation of the overall Complete Trip-ITS4US Deployment Program will also be conducted. In FY21 an Independent Evaluator (IE) was selected.

Major Program Objectives:
The Complete Trip - ITS4US Deployment Program aims to solve the mobility challenges of all travelers, regardless of location, income, or disability, in accessing jobs, education, healthcare, and other activities. The objective of this program is to develop multiple large-scale, replicable, real-world deployments of integrated innovative technologies to address the challenges of planning and executing complete trips.

- **Vision:** Innovative and integrated complete trip deployments to support seamless travel for all users across all modes, regardless of location, income, or disability.
- **Mission:** Facilitate the integration and deployment of emerging technologies, along with innovative and replicable, traveler-centric partnerships, business models and practices to foster reliable, spontaneous, independent, safe, affordable, accessible, and efficient mobility options for all travelers.

The Complete Trip-ITS4US Deployment Program has developed four Guiding Principles for deployers to consider while planning and designing their complete trip deployments:
1. *Integrated, Innovative and Emerging Technologies:* Design flexible and integrated systems with innovative and emerging technologies that combine multiple technologies, modes, operators and payment systems to facilitate the Complete Trip vision with efficient and optimized travel, for spontaneous or planned trips.
2. *Inclusive Design:* Plan, design and deploy for the mobility and safety needs of all travelers. Ensure that all technologies, systems, modes, and infrastructure are universally accessible, affordable, and user friendly.
3. *Long-term Viability and Partnerships:* Develop robust, replicable business models and identify funding sources that allow successful deployments to continue beyond

the pilot phase. Encourage strong partnerships, both public and private, to expand opportunities for innovation and integration.

Open and Secure Data and Standardization: Establish or enhance public access to open data platforms. Encourage civic engagement and development of third-party solutions along with ensuring the security of sensitive information. Adopt the use of standards, specifications, and best practices for implementation of infrastructure and technologies.

The flagship effort of the Complete Trip Program will be the demonstration of a "Complete Trips for All" for one or more underserved populations. The program is designed to bring publicly and privately sponsored research together to create large-scale, replicable, and integrated ITS and other emerging technology deployments to address the challenges of planning and executing all segments of a complete trip.

Anticipated Program Activities:

In FY23, the program will continue with Phase 2: Design and Testing. Successful Phase 1 teams will be eligible to move to Phase 2 and Phase 3 after completing their complete trip deployment plans. Phase 2 will be the designing, building, and testing phase and it is expected to take up 24 months. Phase 2 also includes the planning for evaluation of the deployment. A significant number of complex systems engineering, and performance/evaluation deliverables will be developed by the Phase 2 teams. Teams will be leading and participating in design documentation walkthroughs with the USDOT and technical services support. Once the design has been approved by USDOT, Phase 2 teams will be deep into software, system integration, and interface development. Teams will be engaged in Technical Roundtables to discuss and share technical issues and solutions from which all can benefit. Other Roundtables will be scheduled and conducted to support cross-team sharing and discussion. In FY23, the program will continue stakeholder engagement and sites will begin outreach activities in earnest. Project participants will be recruited, and participant training materials will be developed.

Technical services activities in FY23 will include assisting USDOT in managing and integrating the portfolio of deployment projects ensuring that the projects produce actionable results while remaining on schedule and on budget. This includes, but not limited to, performing technical program management functions, including roadmap development, meeting coordination and note taking, quick-response scanning and on issues and challenges, assistance in stakeholder coordination and collaboration, developing technical templates and trainings (significant effort for Phase 2), validation and verification of other project deliverables (significant system engineering effort in the first six months of Phase 2), white paper development, drafting responses to data calls, and procurement life-cycle support. This technical services support is needed to assist in oversight and management due to the complex technical nature of this program. If the program is going to be successful, additional technical services support is vital part of ensuring that occurs.

Technical services support is envisioned to last the duration of the Complete Trip-ITS4US Deployment Program.

Independent Evaluation efforts will continue in FY23 with the IE participating in Roundtable meetings (e.g., All Sites, Technical, and Human Use Approval/Performance Evaluation), awardees public webinars, and reviewing and commenting on several Phase 2 deliverables. A key activity the IE will conduct in FY23 is the execution of the plans developed in FY22 in performance of the Independent Evaluation. The USDOT program leadership and technical services support will provide review and comment on the reports.

Potential Program Outputs, Outcomes and Impacts:

Outputs: The ITS4US Program conducted extensive stakeholder outreach during the past several years that entailed three main efforts:

- Assembled a large, active multimodal federal team.
    - Over fifty Federal staff from ITS JPO, OST, FTA and FHWA modal offices including offices of research, civil rights, planning, policy, infrastructure and safety; FHWA Contracts, FHWA Division Offices and Resource Center; and FTA Regional offices have been engaged in the program.
    - Federal staff serve as Site CORs, Technical SMEs, Trainers, Advisors, and Active Stakeholders
- Garnered strong stakeholder involvement for the 5 sites throughout concept development with broad representations from
    - 260+ advocacy groups with representation from 50+ disability advocacy organizations and 35+ low-income advocacy groups
    - 70+ transportation service operators
    - 70+ government agencies, universities, and other project partners
    - 60+ application and data developers and producers
- Conducted extensive public outreach to disability advocacy groups; transportation providers; state, regional, and local agencies; universities; consultancy groups; integrators; and others through
    - **7** pre-award webinars reached over **800** unique attendees and **360** different organizations
    - **5** site ConOps webinars reached more than **500** unique registrants and **330** attendees.
    - **5** site Performance Measurement and Evaluation webinars with an average of **170** registrants and **110** attendees per webinar.
- **5** site Deployment Plan webinars to be conducted by the end of Phase 1.

Following these extensive stakeholder outreach activities, the ITS4US Program produced a series of deliverables to encourage replicability of complete trip deployments:

- The deliverables for the 5 Phase 1 sites included:
  - **65** published plans expected by end of Phase 1
  - **15** documents for PMPs, Stakeholder Registries, and Needs Summaries
  - **10** Multi-Day Stakeholder Engagement Sessions: Concept of Operations (ConOps) & System Requirements Specification (SyRS) walkthroughs
- USDOT Phase 1 Program outputs included
  - **16** deployment concept development documentation templates
  - **4** stakeholder engagement and webinar templates
  - **14** deliverable training sessions
  - technical reviews of **80** technical documents
  - Site collaboration meetings to date:
    - **10** All-sites update meetings
    - **15** Site Roundtables: Technical, Outreach, Performance Measurement

Outcomes: The ITS4US program is designed to solve a very important gap in the transportation system of providing safe and reliable transportation services for all travelers with a focus on underserved communities. This program is designed to identify and provide solutions to local challenges that can then be replicated nationwide.

The ITS4US program has identified five program-level goals. Information presented below reflects progress made by the five site's Phase 1 deployment efforts to support USDOT achieving strides towards these goals.

1. **Spur high-impact integrated complete trip deployments nationwide.** Assist the transportation industry in tackling the difficult challenge of providing complete trips for all travelers nationwide by streamlining and expediting solution development through complete trip deployments. High impact, replicable, integrated solutions developed by complete trip deployments will reduce the cost of future deployments of these critical personal mobility enhancements.
Progress made toward achieving this goal includes:

- Five Phase 1 sites, selected via a competitive bid process, geographically represented nationwide
- Three sites have developed plans for deployments that will use open-source software (e.g., OTP, GTFS)
- All sites have identified in their Concept of Operations (ConOps) integrating several technologies with existing transportation systems and infrastructure
- All site's ConOps support complete trip travel by removing barrier to mobility for all including targeted underserved communities.

2. **Identify needs and challenges by populations.** Identify the transportation challenges and needs of communities to support mobility options for all travelers regardless of location, income, or disability. Populations within each community have different needs and challenges in accessing transportation options to improve their quality of life.

Progress made toward achieving this goal includes:

- Sites have documented focus on local mobility challenges for underserved populations (e.g., older adults and individuals with disabilities), LEP, low-income population, rural travelers, and veterans
- Sites have documented robust needs and challenges assessment through rigorous systems engineering documentation (e.g., User Needs Identification, ConOps and System Requirements Specification (SyRS) and extensive stakeholder input (e.g., needs assessment, ConOps and SyRS walkthroughs)

3. **Develop and deploy mobility solutions that meet user needs.** Support and encourage communities to take revolutionary steps to integrate advanced technologies – especially those that enable adaptive and assistive transportation technologies – into the management and operations of the transportation network, including non-motorized modes. Engage key partners, within the federal government, the research community, stakeholder organizations, and private industry to support development of potential solutions for all travelers.

Progress made toward achieving this goal includes:

- Sites have developed concepts and plans that support creating replicable models of emerging technologies (e.g., machine learning, automated electric vehicles, CV, technology integration
- Sites have developed concepts and plans to leverage enabling components to create innovative solutions to provide seamless travel through trip segments (e.g., more reliable trip information, improve access to healthcare, increase traveler safety, spontaneous travel, integrating transit planning, booking and payment, indoor and outdoor wayfinding
- Sites are working to enhance and unify capabilities into mobile apps provided in accessible formats (translations, tactile technology, integration with assistive devices)

4. **Measure the impact of integrated deployments.** Quantify and evaluate the impact of the integration of these advanced technologies, strategies, and applications towards the improved safety and mobility of all travelers. Quantified impacts support communication of technology benefits to future deployers and decision makers.

Progress made toward achieving this goal includes:

- All sites are required to self-evaluate deployment. In Phase 1, all sites developed a performance measurement plan. In Phase 2, sites will refine their plan and data collection. In Phase 3, each site will collect data and conduct analysis.
- USDOT supports an independent evaluation that requires the IE to be engaged throughout all three phases. The IE has been engaged throughout Phase 1 attending site meetings and reviewing and commenting on Phase 1 deliverables.
- IE developed initial plans that will support conducting a program evaluation to inform future deployment programs.

5. **Identify replicable solutions and disseminate lessons learned.** Determine which technologies, strategies, applications, and institutional partnerships demonstrate the most potential to address identified barriers to providing Complete Trips to all travelers in a variety of communities and built environments. Disseminate lessons learned from replicable solutions developed by deployment sites to catalyze additional deployment.

Progress made toward achieving this goal includes:

- All sites have followed a system-engineering process in Phase 1 that will support replicability
- All sites have incorporated plans to document lessons learned for sharing with future deployers.
- All sites developed an Institutional, Financial and Partnership Plan of which key aspects will be demonstrated in Phase 2.
- USDOT and IE developing a national replicability assessment plan.

Impacts: As a result of the continued progress toward achieving the ITS4US Program goals, there will be an increase in deployment of systems and services that help underserved communities achieve the ability to complete their trips that previously have not always been attainable. These completed trips will be safe, efficient, and affordable. The increased accessibility for all will be the result of integration of new capabilities with exiting systems; leveraging emerging technologies and technology integration; and project outreach and recruitment to targeted populations. Use of open-standards and open-source software will support cost-effective replicable deployments through the U.S. In addition, lessons learned captured during the program will assist future deployers avoid missteps, minimize mistakes, and spurring resource efficient deployments. The program is being evaluated to ensure that the program goals are being met.

Potential Economic or Societal Impacts:
Safety, equitable economic strength, rebalancing investments to meet racial equity and economic inclusion goals are all supported by ensuring complete trips for all travelers. In order to address transportation needs of all travelers, and specifically travelers of

transportation underserved communities, the entire trip from conception and planning to execution and from origin to destination must be considered. The USDOT has defined the Complete Trip Concept to capture the idea that a trip can be composed of several parts or segments and any individual traveler must be able to execute every part of their trip from origin to destination regardless of location, income, or disability. A complete trip can be made up on any combination of trip segments such as: trip planning, outdoor navigation, intersection crossing, boarding and using vehicles, transferring between vehicles, modes and payment services, using stops and stations, indoor and outdoor transitions, indoor navigation and completing travel to destination. The different segments of the trip may have unique challenges that can be addressed to support a successful complete trip. If the infrastructure is not available or in a state of good repair or if one segment of the trip is inaccessible, unreliable, or inefficient, then access to subsequent segments is broken, and the trip cannot be completed. This Program will help local partners develop and deploy integrated mobility solutions to achieve complete trips for all travelers.

Potential Progress Made Toward Achieving Strategic Goals:
The ITS4US Program is a critical USDOT effort supporting independent and seamless travel for all users across all modes, regardless of location, income, or disability. This program is designed to solve an important gap in the transportation system of providing safe and reliable transportation services for all travelers with a focus on increasing mobility options for underserved communities. ITS4US is high-profile deployment program aligned with USDOT strategic priorities with the potential to make significant impact on people's lives.
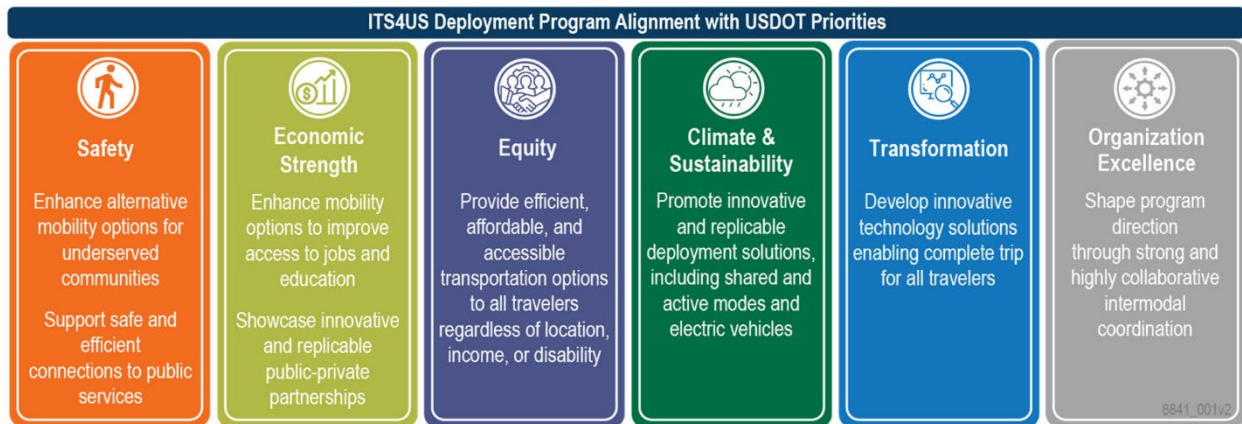
Although the ITS4US program addresses the six USDOT priorities laid out in the FY 2022-26 USDOT Strategic Plan (as shown in the figure above), the primary and secondary goals are safety and equity, respectively.

Safety. Enhance alternative mobility options for underserved communities, and support safe and efficient connections to public services. In Phase 1, the 5 sites have developed project concepts and supporting planning documents with safety a foremost priority. Three sites (ICF/Buffalo, ARC, and UW) are specifically targeting to increase traveler safety. The concepts and planning documents will be further developed as part of the Phase 2 Design and Build in FY23 and FY 24.

Equity. Provide efficient, affordable, and accessible transportation options to all travelers regardless of location, income, or disability. The 5 sites have focused on local mobility challenges for underserved populations. Specifically, older adults and individuals with disabilities (All 5 sites); limited English proficiency (HIRTA, ICF and ARC); low-income populations (ARC and ICF); rural travelers (HIRTA and CALACT); and veterans (HIRTA).

Collaboration Partners:
The Complete Trip - ITS4US Deployment Program is a multimodal effort led by the Intelligent Transportation Systems Joint Program Office (ITS JPO) through partnership with the Office of the Secretary of Transportation (OST), Federal Transit Administration (FTA), and Federal Highway Administration (FHWA). The Program is a part of the USDOT's Complete Trip portfolio. The Complete Trip portfolio consists of several efforts including: The FTA's Mobility for All Pilot Program, the Inclusive Design Challenge, and this Complete Trip - ITS4US Deployment Program. This effort obtains input from a range of interagency Federal partners including the Departments of Health and Human Services (DHHS), Labor (DOL), Defense (DOD), and others.

Automation Program
($12,000)

Program Description:
Driving automation is one of the major transportation industry trends of this decade. Through close collaboration and monitoring of current industry and academic technology innovators and leaders in automation the ITS JPO continues the pursuit of an automation program that will support the safe deployment of an automated future. Advanced Driver Assistance Systems (ADAS) with automation of lateral or longitudinal controls are widely available in passenger vehicles, although their development and refinement continue. Automated Driving System (ADS)-equipped vehicles are being piloted in passenger vehicles, commercial motor vehicles, and transit buses. While driving automation research has been, to some degree, mainstreamed across the Department's Operating Administrations, research needs are evolving alongside the technology. The technological and practical challenges of translating research breakthroughs into daily transportation are significant and often are not fully understood at the outset. Many foundational questions around ADS and ADAS cannot be resolved until more and better data are available. The ITS JPO Automation Program's collaborative and multi-modal research portfolio provides cross-cutting support across the USDOT.

As excitement builds around an automated future, we must continue to ask the following:

- How will vehicles with a range of automated driving capabilities interact with one another on the road?
- What are potential impacts on personal mobility, user costs, and equity?
- What physical and digital infrastructure are needed or desirable to facilitate the safe deployment of ADS-equipped vehicles?
- How will driving automation influence the operational characteristics, costs, and structure of the nation's freight network?
- How can limited deployments and pilots inform long-term policy-making?
- How might ADS-equipped vehicles use communications technologies to improve safe operation as they mature?

The ITS JPO Automation Program will continue to coordinate cross-modal research and build on past activities to achieve program objectives. The program will provide a platform for internal USDOT research coordination and exchange, contributing to better outcomes across the Department.

Major Program Objectives:
The ITS JPO Automation Program will promote cross-modal safety, operations, and policy research through:

- **Business Intelligence and Emerging Issues Assessment**: What is the current state of the industry? What companies appear to be leading? Which have failed? Where are investments being made? Where is testing most concentrated, in terms of: geography, vehicle types, ADS levels, operating models? New questions and issues can emerge quickly and may need modest short-term investigation.
- **Research Coordination and Information Exchange**: Addressing some big questions may require input and collaboration across modal subject areas.
- **Cross-Modal Research:** Facilitate the planning and execution of research on topics that span the information needs, capabilities, and interests of multiple operating administrations, as well as topics that are important to USDOT as a whole, but may not fit cleanly into the mission of a single agency.

Anticipated Program Activities:

The ITS JPO Automation Program will focus on the following activities, aligned with its major program objectives:

Business Intelligence and Emerging Issues Analysis

- **Automated Driving System Testing and Deployment Tracking** – The ITS JPO will continue to provide offices across USDOT with insight into the state and extent of ADS testing and deployment on public roads through industry monitoring and regular internal briefs.
- **Emerging Issue Analysis** – ITS JPO will continue to conduct short, targeted studies on emerging issues related to vehicle automation and its potential impacts on/implications for key USDOT priorities.

Research Coordination and Information Exchange

- **Automation Research Working Group Facilitation and Management** – ITS JPO will continue to facilitate and manage exchange of information around automated vehicles research across USDOT, including providing a weekly discussion forum and facilitating discussions on topics of cross-modal interest.
- **Research Product Dissemination** – ITS JPO will continue to provide a central online library of USDOT automation research publications.
- **External Engagement** – the ITS JPO will continue to support Departmental participation in events such as those sponsored by the Transportation Research Board and facilitate international research exchange through the European Commission-Japan-United States Automation in Road Transportation Working Group.

Cross-Modal Research

- **Advanced Driver Assistance Systems (ADAS)** – Research to better understand the impacts of increasing adoption of ADAS in production vehicles on the transportation system.
- **Commercial Vehicle Automation Research –** Collaborative research across USDOT modes focused on the safe deployment of Automated Driving Systems and Advanced Driver Assistance Systems on commercial motor vehicles.
- **Work Zones -** Research with FMCSA and FHWA to support work zone safety for mixed fleets

- **Vulnerable Road User Safety and Complete Streets –** Research with modal partners to support safe streets for all users.
- **Connectivity –** Research with FHWA regarding the role of communications technologies in the operations of vehicles using driving automation.

Potential Program Outputs, Outcomes and Impacts:
Safety outcomes will include results from driving simulator and field experiments to better understand the human factors issues related to the adoption of automation in varied modes, use cases, and settings. They will also inform understanding safety issues related to automated vehicle interactions with transportation systems management and operations (TSMO) functions, as well as infrastructure.

Cross-cutting activities will improve information dissemination, identification of emerging needs, and research coordination across internal and external actors.

Potential Economic or Societal Impacts:
Socio-economic benefits will result from the pursuit of an automation program that will support the safe deployment of an automated future. The analyses, coordination, and outreach will inform cross-modal policy development moving the national transportation system closer to the goal of zero roadway fatalities and serious injuries.

Potential Progress Made Toward Achieving Strategic Goals:
The Program pursuit of research to lead to the safe deployment of an automated future addresses the USDOT's strategic goal of **making our transportation system safer for all people**.
This program also addresses the **Transformation** strategic goal of the USDOT by investing in research and innovation to help spur the implementation of a safe automated future within an infrastructure connected through technology.

Collaboration Partners:
The ITS JPO will continue to facilitate multimodal automation research in collaboration with the Office of the Secretary and Operating Agency partners. Through close collaboration and monitoring of current industry and academic technology innovators and leaders in automation the ITS JPO continues the pursuit of an automation program that will support the safe deployment of an automated future.

External partners include stakeholder communities such as Transportation Research Board (TRB) standing committees, the National Cooperative Highway Research Program (NCHRP), the Association of American State Highway and Transportation Officials (AASHTO), and Standards Development Organizations (SDOs), such as SAE International.

By collaborating extensively, the ITS JPO can improve the quality and comprehensiveness of the Automation Program research by providing diverse and informed perspectives and subject matter expertise and expand outreach to inform the transportation community regarding Automation Program work products.

Emerging and Enabling Technologies Program
($15,000)

Program Description:

The Emerging and Enabling Technologies Program focuses on cultivating the next generation of transportation systems. As the scale of Intelligent Transportation Systems (ITS) increases and expands to become part of other industry IoT environments (i.e., smart cities), vehicle manufacturers, infrastructure providers, innovators, and entrepreneurs discover new opportunities to use technology and the data that will be generated. These technological advances, along with new functionality, new applications, new operational concepts, and disruptive innovations, need to be tracked and planned for by the USDOT. Current examples of these Emerging and Enabling technologies include Artificial Intelligence (AI), Next Generation Wireless Communications (including the emerging 5G variations), quantum computing, blockchain, and others. These technologies have the potential to greatly impact transportation operations and create positive outcomes that are aligned with USDOT goals in *Safety*, *Economic Strength and Global Competitiveness*, *Equity, Transformation*, and *Climate and Sustainability*. In particular, this program recognizes the interdependence among the Department's strategic goals with respect to the introduction of new technologies. For example, this program addresses issues related to climate change and resilience by leveraging past and current research into new opportunities for environmental innovation and how technology can play a role. As such, there is a need to determine technological, market, and demographic trends across the globe and across industries to seek, evaluate and sometimes incubate emerging capabilities that demonstrate the potential to transform transportation. Moreover, it will be critical to evaluate potential risks posed by these emerging technologies, including where risks and/or benefits may inequitably impact citizens of different racial groups, socioeconomic backgrounds, or other demographic characteristics.

The USDOT will be positioned and engaged as a partner to guide research, development, and technology adoption in a systematic manner. The USDOT recognizes the need to advance the adoption and use of emerging practices and technologies for transportation—particularly, where they play a key role in providing public benefits to Americans. The ITS JPO will coordinate and conduct investigations and exploratory research into emerging technologies across government, academia, and the private sector. This research will provide the USDOT with a significant understanding of the potential benefits and disruptions these technologies could represent to the transportation system. Through multi-modal coordination, the ITS JPO works to avoid duplicative ITS work and to ensure the efficient allocation of ITS resources.

The Emerging and Enabling Technologies Program is focused on supporting research, development, and technology efforts. A few examples are highlighted below.

Safety. Communications technologies are critical to the safe, secure, and efficient operations of transportation systems across the nation. New forms of technologies could drastically increase the speed at which information is communicated and the amount of data communicated between vehicles and other entities, like roadside infrastructure, other vehicles, or even pedestrians with smartphone applications. AI could be used to improve safety, reduce fatalities, and secondary crashes. For example, AI could help detect multimodal failures and incidents before they put users' safety at risk. AI could potentially be used by agencies for emergency management. For example, AI could be used to identify high-risk crash locations, identify populations vulnerable to natural calamities, and plan for evacuation needs of specific population groups.

Equitable Economic Strength and Improving Core Assets. High quality roadways and other core assets that provide adequate transportation options to all users are essential for robust economic activity. AI could potentially help save existing federal, state, and local investments and provide cost-effective approaches in asset management and roadway construction and maintenance. For example, agencies could use AI to detect or even predict the health of roadway and infrastructure assets, thus allowing them to more efficiently and equitably allocate resources. This could result in better roads and assets at lower costs, with fewer crashes, and safer operations for their maintenance crews.

Rebalancing Investments to Meet Racial Equity and Economic Inclusion Goals. An equitable transportation network successfully delivers all roadway users safely, securely, and efficiently to their destinations. To be equitable, the transportation system must be accessible and accountable to users of all abilities and backgrounds, living in all geographic locations. AI could potentially enhance the capability of users to execute independent travel for all links in their travel chain safely and reliably. For example, AI using advanced communications that all citizens have access to, could support trip planning, wayfinding, situational awareness, and intersection crossing especially for underserved communities. This would allow underserved communities greater access to economic opportunities that had previously been unavailable to them.

Climate and Resilience. Emerging technologies in ITS (such as cellular-vehicle-to-everything (C-V2X) and 5G, as well as AI and also vehicle automation) could enable and support more efficient, data-driven transportation system and vehicular operations to better optimize multiple objectives related to climate change, including reducing overall fuel use, reducing GHG emissions, and improving air quality. These technologies could also help to improve transportation system resiliency. For example, by predicting demand, AI could optimize services across modes to meet the demand for the entire transportation network, helping to reduce emissions. Additionally, AI could support data-driven decision making to Build Back Better, more efficient, and sustainable transportation infrastructure. AI could also assist jurisdictions with more efficient and effective transportation system

management in the event of an emergency, such as flooding, storms, or other natural disasters.

Transformation and "Future Proofing." The ramifications of ITS have already begun to transform the transportation sector. Vehicle manufacturers, infrastructure providers, innovators, academics, entrepreneurs, and other groups are invested in the safe implementation and efficient usage of ITS technologies. ITS can help "future proof" infrastructure and assets so the overall transportation system can adapt to changing circumstances and perform better for longer. ITS offers opportunities to extend the useful life of existing assets in a variety of ways, such as by predicting when preventative maintenance should occur, preventing crashes and damages, and distributing positive impacts to the system more equitably.

Major Program Objectives:
The Emerging and Enabling Technologies Program area focuses on cultivating the next generation of transportation technologies that either change the way we deliver transportation or enhance existing systems, services, and applications. As emerging technologies offer the potential to enter the transportation environment, ITS JPO will evaluate their safety, performance, and suitability for meeting transportation needs, and partner with USDOT modal agencies to accelerate adoption and extend resulting benefits from these technologies across the transportation ecosystem.

Artificial Intelligence: In support of the White House American Artificial Intelligence (AI) Initiative the ITS JPO has been supporting a coordinated Federal Government strategy and participating in the National Science and Technology Council (NSTC) on Machine Learning and Artificial Intelligence (MLAI) sub-committee. Since our world is being increasingly shaped and optimized by the transformative power of AI, the U.S. government elevated AI as one of its key priority science and technology areas.

In ITS, AI can be used to augment actions of field, handheld and remote sensing devices, connected and automated vehicles, Traffic Management Centers' operators, transit and freight operators, decision-makers, and travelers. For example, AI can be used to identify objects and images, recognize speech and audio, process large amounts of data to recognize patterns, learn from experience, and adapt to new environments to predict traffic phenomena, provide situational awareness, assist drivers with maneuvering, recognize unsafe driving conditions in real-time, identify or isolate malfunctioning or misbehaving system entities, improve cyber-security, operate infrastructure devices and vehicles, monitor pavement, support decision-making, and improve efficiency. AI can be embedded in any system entity (vehicle, mobile device, roadside infrastructure, or management center) or be distributed among many entities in the system.

The ITS JPO sees significant potential in AI for the future of transportation and ITS. Therefore, the ITS JPO initiated the AI for ITS Program within the Emerging and Enabling Technologies Program area. The AI for ITS Program's vision is to advance next generation transportation systems and services by leveraging trustworthy, ethical AI (including ML) for safer, more efficient, and accessible movement of people and goods. The AI for ITS Program identifies, develops, implements, evaluates, and coordinates technology and policy research to advance the contextualization and integration of AI (including ML) into all aspects of the transportation system. The AI for ITS Program's goal is to cost effectively build and deploy AI for ITS capabilities in real-world modal use. The objectives of the program are to:

- Engage stakeholders to assess current capabilities, gaps and needs, ongoing research and innovations, and impacts and effectiveness of leveraging AI.
- Foster research and innovation in AI techniques for transportation.
- Conduct small-scale demonstrations of early prototypes in real-world settings.
- Deploy high value use cases in real-world operational environments.
- Measure impacts of the prototype demonstrations and deployments.
- Identify policy issues and provide inputs and insights into AI-related policy development.
- Assess needs for AI-related standards and provide inputs to standards developing organizations.
- Facilitate collaboration among AI researchers and deployers.
- Disseminate insights, lessons learned, and potential benefits, to accelerate adoption of AI by agencies to advance next generation transportation systems and services.

Next Generation Wireless Connectivity/ Spectrum: Given the magnitude of impacts that transitioning to the next generation communications can have on transportation, the ITS JPO proposes the establishment of a focused research initiative. There are four proposed research objectives that will concern the USDOT moving into the future:

A. *Research and Analysis for a next generation wireless communications safety and security framework:*
- Develop and maintain a set of transportation communications requirements associated with safety and system efficiency against which any new technology can be assessed and tested including cost and lifecycle expenses.
- Test new communications technologies for their suitability for the transportation environment, including testing for interoperability, interference challenges, or other harms to existing operations.

B. *Institutional adoption of next generation wireless communications technologies:*
- Promote adoption of next generation wireless technologies with SLTT agencies by assisting them in articulating their communications and connectivity needs,

identifying the institutional and technical challenges to adoption, analyzing impacts of adoption, and coordinating transition planning from older technologies to new ones.

- Analyze the additional skills/knowledge needed by transportation workers to manage each next generation of communications technologies, equipment, and systems.
- Work with transportation private sector equipment manufacturers and application developers to facilitate transition of safety-critical elements and interoperability.

C. *Public sector representation:*

- Conduct necessary research and analysis in partnership with modal administrations and stakeholders to gather public sector needs and requirements.
- Create transportation safety use cases to facilitate the incorporation of transportation safety requirements into each next generation of communications technologies.
- Participate in and leverage existing relationships with US-based globally relevant SDOs (e.g., SAE, IEEE) along with international (e.g., ISO, ITU, 3GPP) SDOs to ensure that the transportation needs are represented in each next generation communications systems.

Environment and Climate Change: The objective is to leverage past and current ITS and environmental research into new, innovative research and analysis opportunities in partnership with modal partners and stakeholders.

Anticipated Program Activities:
The Emerging and Enabling Technologies Program area is focused on the following planned activities:

- **Identify** research needs and opportunities by exploring federal, state, local, private, and academic research on technologies
- **Research** and test communications technologies to support transportation connectivity, enabling cooperative ITS and connected and automated transportation
- **Investigate** future spectrum use models that support transportation safety and system efficiency
- **Develop** new institutional models to help accelerate adoption of technology innovations
- **Transfer** technologies from exploratory research to development and deployment when appropriate

The ITS JPO and its modal partners have been leaders, collaborating on fundamental problems in safety, mobility, productivity, efficiency, equity, and climate change by leveraging emerging technologies, such as Artificial Intelligence (AI) and next generation communications technologies.

Artificial Intelligence: In support of the program vision, mission, goal, and objectives, the AI for ITS Program has sought to understand the dynamic landscape of AI for ITS and develop a roadmap.

In FY20, the AI for ITS Program published three reports to: (1) define broad categories of AI for ITS and summarize existing and potential applications of AI for each category, (2) illustrate real-world transportation scenarios for possible deployment of AI-enabled ITS applications to address specific ITS needs, and (3) outline an initial five-year roadmap for the AI for ITS Program.

In FY21, the AI for ITS Program conducted multiple stakeholder engagement activities including:

- **Creating awareness of the AI for ITS Program and published reports**, by conducting a public webinar on May 12, 2021, that reached 530+ transportation professionals.
- **Conducting a virtual strategic session with 30+ modal partners across 11 agencies**, to inform the development of a Sources Sought Notice (SSN) for conducting market research to shape potential Federal investment in AI for ITS.
- **Issuing a Sources Sought Notice (SSN) on July 30, 2021,** to solicit feedback from public, private, and academic sectors on availability of deployment-ready applications that leverage AI to address ITS needs, challenges and capabilities in developing and deploying AI-enabled ITS applications, and potential USDOT role and investment areas to facilitate next generation ITS leveraging AI.

In FY22, the AI for ITS Program developed two reports, including:
- **AI for ITS Market Research:** The report documents insights from the Sources Sought Notice responses as well as from various stakeholder events, to help shape potential Federal investment in the development, testing, pilot deployments, and evaluation of applications leveraging AI to address transportation needs, specifically in ITS. The SSN responses revealed that AI has broad potential in ITS to save lives, improve mobility, equity, security, and efficiency, and reduce negative impacts on the environment. There is capability among large and small business concerns to implement AI-enabled ITS solutions. The top three areas that the respondents felt would benefit from the government's engagement, included resolving AI-related policy issues (e.g., data governance and data sharing policies), developing standards to ensure easy access and sharing of data for execution, and conducting prototype testing/demonstrations of AI-enabled ITS applications.
- **AI for ITS Challenges, Insights, and Lessons Learned:** The report provides awareness of potential challenges to the use of AI for ITS as well as insights, lessons learned, and potential solutions to help overcome them. Recognizing that these

challenges are broad, this report does not attempt to be comprehensive in its discussion. Instead, this report attempts to highlight pertinent available information with a focus on insights that could be most relevant to ITS and transportation agency staff.

In addition, on March 29-30, 2022, the AI for ITS Program held a virtual strategic event with the ITS JPO Data Access and Exchanges Program to identify collaboration opportunities between the two programs, define specific projects, and prioritize high-value near-term projects.

Information gathered from the SSN responses and other multimodal stakeholder engagement activities, including discussions with ATCMTD grantees, helped to assess the nature, potential, and maturity of promising AI for ITS applications and revealed agencies' topmost concerns related to lack of resources for sustained development and implementation of AI-enabled ITS applications, lack of quality data, educating their leadership, and demonstrating value. Informed by these market engagement activities, in FY23 the key activities in the AI for ITS Program will include:

- **Conducting procurement-related efforts to accelerate deployment of mature AI-enabled ITS applications** that can make an immediate impact on safety, mobility, equity, efficiency, economic growth, and climate change. Influenced by the SSN responses, the program will target ready-to-deploy applications to demonstrate the near-term potential of AI for ITS. The goal is to pilot transferable, scalable mature solutions that can be replicated and speed broader deployment across the nation.
- **Conducting procurement-related efforts to spur innovation regarding potentially transformative AI for ITS applications**, by sponsoring a multi-stage innovation challenge. This initiative will create the R&D foundation on which future, long-term deployments may be built.
- **Continuing coordination of complementary efforts within ITS JPO and other USDOT programs to make the best use of ITS JPO and departmental resources** by focusing on most urgent and highest priority activities that create value for the community.

In developing our research initiatives, we are looking at technology neutral approaches to support fair market competition, understand the liability implications, consider privacy, bias, ethics, equity, data and infrastructure readiness, and impacts on the workforce.

Next Generation Wireless Connectivity/ Spectrum: USDOT monitors and assesses wireless technologies and available devices to determine their capabilities to support a wide range of transportation system communications requirements regarding safety, effectiveness, and other capabilities. These technical research and assessment activities

provide data-driven inputs to the USDOT policy decision-makers. Currently, ITS JPO is testing whether the LTE-V2X technology can meet the requirements for Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) safety-of-life and public safety systems; as well as whether these emerging communications technologies are interoperable with existing technologies which currently support these systems. Based on evolving industry standards, there is a need to assess newly available commercial off-the-shelf (COTS) devices as well as prototype devices with any of these technologies if we expect to continue an uninterrupted and seamless advancement toward the greater safety that these technologies might provide. Using the results of previous DSRC testing combined with the emerging LTE-V2X testing, the next step will be to test the 5G New Radio (NR) V2X prototypes that are expected to become from industry available in 2023. In monitoring these standards developments, the spectrum team is following whether and how the transportation needs and requirements are being addressed in 5G and working to identify when the standards become stable enough to produce the first working prototypes for 5G V2X (inclusive of a new emerging capability for 5G New Radio to work as an unlicensed device (5G NRU).

This rapid pace of communications technologies evolution has the potential to disrupt transportation operations and, as is noted with early 5G network rollouts, has disrupted transportation operations at airports. As such, there is a need to determine the impact of these changes before they are put into use.

The two main research objectives for FY23 are to: (1) secure 5G V2X testing service agreements for modeling and simulation, laboratory testing and field-testing services and (2) procure 5G V2X devices for testing.

In FY2021, this program released a 5G V2X Testing Sources Sought notice that received 27 responses and identified commercial and industry partners that can may the USDOT's needs for test facilities and expertise. In FY2022, this program will begin the process of developing an acquisitions package, incorporating this market research and, further incorporating research into government and military test beds that might also be available. Testing is anticipated to begin in later 2023 and will focus first on performance and whether the technologies are mature and suitable for safety communications, and then further look at interoperability performance, reliability when GPS is unavailable, and sensitivity interference by testing in laboratories in 2023 and then in controlled, test tracks whereby a range of safety-critical scenarios can be performed with hundreds of devices to demonstrate the 5G NR V2X capabilities for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), and vulnerable road user safety applications at both small and large scale.

Environment/Climate Change: In FY23 the Emerging/Enabling Technologies Program plans to support reengagement with modal partners on research activities in support of

Departmental goals related to climate change and the environment. The program expects to leverage past and current ITS-related research in this area into new opportunities for technological innovation, including the research accomplished in the AERIS (Applications for the Environment: Real-Time Information Synthesis) Research Program. In FY2023 the program also plans to develop a roadmap for new environment- and climate-oriented ITS research activities moving forward and baseline the state of the practice/state of the art.

Potential Program Outputs, Outcomes and Impacts:

Artificial Intelligence

Outputs: In FY23, the following outputs are expected:

- Targeted strategic sessions held with other ITS JPO programs and modal offices to identify collaboration opportunities and share insights and best practices.
- Procurement materials developed for issuing multi-stage innovation challenge.
- Procurement materials developed for sponsoring accelerated deployments of AI for ITS.
- Multiple pre-procurement stakeholder outreach activities held to create awareness of upcoming solicitations.

*Outcome*s: The primary long-term outcome of the AI for ITS Program is to advance next generation transportation systems and services by leveraging trustworthy, ethical AI for safer, more equitable, accessible, and efficient movement of people and goods. To do so, the program will coordinate and lead research and innovation in AI for ITS, deploy and demonstrate the value of AI-enabled ITS, and support implementation of AI-enabled ITS by agencies through knowledge and tech transfer.

Impacts: If these efforts are successful, the ITS JPO hopes that this program will be able to significantly contribute to the meeting the government's priorities and goals related to safety, equity, climate change, and economic growth/efficiency.

Next Generation Wireless Connectivity/ Spectrum

The primary outcome of the next generation wireless communications research is two-fold: ensure suitability and safety for SLTT agencies, vehicle manufacturers, and citizens in adoption of the new technologies; and to continuously advance effective, cost-effective, and available communications solutions for meeting transportation needs, including spectrum availability.

Environment/Climate Change

With respect to the environment and climate change, the primary near-term output is a (1) baselining effort describing the current state of the practice/state of the art in R&D related to ITS and climate change and (2) creation of roadmaps for R&D on this topic moving forward. Longer-term outcomes include undertaking R&D activities with partners and stakeholders, and advancing the state of the practice/state of the art related to the use of ITS technologies to help meet climate change objectives and goals.

Potential Economic or Societal Impacts:
The 2021 AI for ITS Sources Sought Notice (SSN) highlighted several relatively mature AI applications related to improving transportation system user safety, equity, efficiency, and accessibility. For example, the use of AI to improve object identification and path prediction has demonstrated potential to assist in detecting pedestrians and other vulnerable road users as they navigate complex intersections. In response to the detection of potentially unsafe conditions, AI can also play role in mitigating or eliminating these risks through the extension of pedestrian crossing times or other changes to traffic signals and other traffic control measures. AI-based object detection and machine learning can be used to assess the health of roadway assets and predict future maintenance needs. Agencies can plan for timely maintenance and repair of their assets, prevent further deterioration and resulting crashes and increased emissions; and extend the life expectancy of their assets.

Further, to meet the goals of economic strength and global competitiveness, the US needs to stay at the forefront of producing innovations and new emerging technologies, and to ensure that the learning resulting from this work is captured as US-based intellectual property, which typically is incorporated into standards. The testing and analysis of next generation wireless research translates into leading-edge knowledge about translating communications for a rapidly moving, highly variable transportation environment; and further positions the US to take a lead role in creating or enhancing standards, harmonizing technologies, ensuring open global markets for the transportation industry. Last, the data collected through testing becomes publicly available, allowing researchers and innovators to continue to advance the transportation communications technologies.

Finally, the ITS JPO hopes its climate and environment-related research efforts contribute to departmental and national goals related to reducing the emissions impact of the transportation sector and improving transportation system resiliency.

Potential Progress Made Toward Achieving Strategic Goals:
Currently, ITS JPO is testing the current generation of V2X communications (LTE-V2X) and preparing for testing the emerging generation (5G V2X). In 2022, research progress was

made in the identification of the maturity of LTE-V2X for use in transportation communications; certain test results fed into the drafting of the standards; and real-world and highly variable conditions provided greater reality to the performance of LTE-V2X that can be compared against the models of 2018-2020 to see whether those predictions about performance under varying conditions hold true. Real-world testing at the Tampa, Florida test site provided unexpected insight into how communications are affected by the built environment, including insights into whether glass buildings offer enough transparency to be a problem versus whether concrete buildings ability to present an obstacle to communications. This is data that that National Telecommunications and Information Administration (NTIA) has said is needed for better, more accurate signal propagation modeling that informs spectrum rules and decisions.

Collaboration Partners:
The private sector, academia, and governments around the world have formulated questions associated with whether new communications technologies can reliably support interoperable, safety-critical applications, provide crash avoidance, and facilitate safe integration of automated vehicles and infrastructure. Chipset and vehicle manufacturers are working on prototypes to prove out the concept while experts are working to design performance-based test procedures that demonstrate the capabilities as well as the gaps that still need to be addressed.

One of the lessons learned from previous deployments is that the transportation environment introduces unique requirements for telecommunications; for instance, users and equipment move at high speeds—over 80 miles per hour, which has effects on the basic safety message signals and transmissions. Because the communications are used for safety, there are additional requirements associated with the high frequency and high reliability of the signals. Another is that any viable communication technology needs to scale to allow hundreds of nearby devices to communicate without causing channel congestion.

We have also learned that the telecommunications industry evolves at a rate that is dramatically different from the deployment of these technologies in SLTT transportation system operations. The replacement cycle within the telecommunications industry is typically 18-24 months whereas the replacement cycle within transportation system operations is typically 10-15 years. This disparity is impacting how transportation agencies decide to invest in and procure communications and connectivity in both the near term as well as in their longer-term investment planning.

With these requirements in mind, USDOT, modal partners, and stakeholder partners (e.g., NTIA) have invested in research and analyses including:

- Development of a spectrally efficient and effective band plan for the 5.9 GHz part of the spectrum which the Federal Communications Commission (FCC) is seeking to change and which requires further analysis of those changes.
- Testing of new technologies as they become available to gauge the suitability for high speed, rapidly moving and changing environments that may also be subject to land elevation, urban canyons, and other challenges.
- Assessment of out-of-band and adjacent channel interference from other users of the nearby spectrum to ensure that the transportation safety messages cannot be suppressed with the transmitting device or corrupted in transmission, or that the receiving device cannot hear or receive the messages.
- Analysis of the role of the immediate reporting of timing and location through GPS on devices and assessment of how the communications can continue to operate during any loss of GPS.

With respect to environmental and climate change activities, the ITS JPO expects to engage modal partners across the Department to address this Department-wide priority. The ITS JPO also expects to engage with partners and stakeholders at other Federal agencies, including the Department of Energy. The ITS JPO also hopes to reengage with its international counterparts on topics related to international coordination.

With respect to the AI for ITS Program, the ITS JPO has conducted multiple strategic sessions to engage modal partners across 11 offices of the Department, to shape Federal investments in this area. The ITS JPO will continue to conduct targeted events to share insights and best practices as well as to identify collaboration opportunities within ITS JPO as well as modal offices. The ITS JPO has also initiated engagement with ATCMTD grantees, National Science Foundation, and Transportation Research Board Committees to understand capabilities, innovations, gaps, and needs related to the use of AI for ITS.

Cybersecurity for Intelligent Transportation Systems (ITS) Program
($5,500)

Program Description:
The USDOT cooperates across a diverse range of stakeholders to support research to address ITS cybersecurity needs. The USDOT works to support SLTT agencies and other ITS deployers regarding their decisions for securing their ITS deployments. The USDOT further works to develop the cybersecurity best practices adapted to the ITS environment, lessons learned as well as facilitate a cybersecurity-minded workforce culture among deployers that is essential for secure and resilient ITS deployments. necessary preconditions to deploy and maintain interoperable, safe, effective, and efficient ITS operations.

To facilitate secure, nationwide, interoperable ITS, the USDOT ITS Cybersecurity Research Program advances multimodal research that underpins adaption and implementation of cybersecurity best practices across diverse ITS infrastructure deployments. The research is coordinated with modal partners and industry stakeholders to ensure that results are representative of public sector needs and requirements. These research efforts are then, in-turn, adopted by the diverse community of Infrastructure Owner Operators (IOO) including State, Local, Tribal, Territorial (SLTT) agencies, private and public-private facility operators, vehicle and equipment suppliers, application and service developers along with mobile participants in the transportation system from vulnerable road users to vehicle operators and fleet managers. Individual IOOs often have limited capabilities in this area; USDOT led collaboration can facilitate bringing options to stakeholders to use in their planning and operations of their system as well as any recovery needed from a cyber-attack. This remains a complex and continuously evolving challenge - ITS system architectures are complicated systems of systems that vary greatly across jurisdictions, with diverse current approaches to security and a broad range of equipment in service – some new, some decades old.

Current research continues to adapt the National Institute for Technology and Standards (NIST) Cybersecurity Framework for diverse and complex ITS infrastructure environments, following the successful completion of CSF profiles for the Connected Vehicle Environment. Tenets of cybersecurity remain applicable to transportation operations and equipment including concepts of identify, protect, detect, respond, and recover. The NIST Framework provides a process that assists entities in understanding their mission-critical cybersecurity risks within the context of their needs and business practices, and how to best manage risks via combination of approaches to security and resiliency.

Cybersecurity considerations – including resiliency - are an essential part of good engineering practice, and thus should be included in any transportation systems deployment. The ITS Cybersecurity Research Program seeks to address ITS cybersecurity needs, supporting the development and deployment of secure, well-engineered ITS systems that maximize the public benefits of ITS.

Major Program Objectives:
The overall objectives for the USDOT's ITS Cybersecurity Research Program are to provide the tools for widespread implementation of cybersecurity best practices for ITS, and to provide the capabilities for deployers to assure that ITS deployments remain secure. This security is a necessary precondition for their efficient, effective, and safe operation. ITS systems need to be both resistant to cyber-attacks and resilient, allowing for a quick recovery from cyber-attacks that are not prevented. Complex Information and Communications Technology (ICT) systems, of which ITS is one example, require extensive and adaptive technical and institutional solutions to remain both appropriately secure and sufficiently resilient to recover from attacks and other disruptions.

The NIST CSF is now recognized as one of the leading best practices, along with other guidance documentation on securing ICT systems; as such, the adaption performed for connected and automated environments (completed) and broader ITS environments (underway) offer SLTT deployers with a clear path and tools to establish their security profile. Assisting in this effort is the security classification information integrated into the ITS National Architecture Reference. In addition, many Standards Development Organizations (SDO) have developed standards products that support secure ICT systems or are integrating security into existing standards with the assistance of the ITS JPO. The ITS Standards Program adopts when appropriate, adapts based on transportation requirements, and develops new security standards as needed. ITS supporting infrastructure, including connected and automated physical systems where failures can have severe consequences, require a greater level of care to both maximize public benefit and to minimize the risk of harm.

The long-term goal of this research program is to establish and support a National multimodal intelligent-transportation system that is both secured from a wide range of evolving cyber-threats and resilient enough to gracefully degrade and quickly recover should cyber-attacks initially succeed.

Anticipated Program Activities:
The ITS Cybersecurity Research Program works to adapt and leverage ICT best practices to benefit the unique requirements of ITS, identify and fill-in gaps, and support implementation of best practices across ITS deployments:

Adaption of the NIST Cybersecurity Framework (CSF) to ITS: ITS infrastructure, connectivity and automation services represent a complex system of systems which must remain secure in order to provide the safety and mobility benefits promised by rapidly evolving ITS technologies. Recently completed efforts include translating the NIST CSF into a candidate Connected Vehicle cybersecurity profile to support V2X communications and systems. An effort to apply the CSF to the much more complex and diverse ITS infrastructure environment began in FY21 and will continue through FY23. These ITS environments vary greatly across jurisdictions, with differing approaches to cybersecurity in general, along with diverse uses of wired, fiber and communications technologies; and with equipment ranging from new to some decades old that was never intended to be connected via any network, much less to the public internet. Analyses will be conducted to identify an optimal path forward to develop sufficiently detailed best practices information that is also sufficiently flexible to accommodate the diverse needs of implementers.

Identification and Addressing of Gaps via Analysis and Testing: Research is being conducted to identify and fill cybersecurity gaps that are unique to ITS and thus not easily addressed by available ICT solutions without further adaptions. Gaps are identified via analyses of system architectures and other means identified in the CSF as well as via penetration testing of deployed systems in cooperation with IOOs. System-wide needs, such as the ability for multiple security certificate issuers – Security Credential Management Systems (SCMS) – to coordinate secure movement across National and jurisdictional borders, are being documented with analysis being performed to identify efficient, effective candidates for large-scale, interoperable, secure deployments of rapidly advancing ITS infrastructure, connectivity and automation technologies.

5G Cybersecurity Analysis: Research is being conducted to analyze the emerging specifications for 5G NR (fifth generation new radio cellular wireless) and assessed against the unique needs for a transportation environment to identify gaps. This project is assembling the data and information associated with 5G specifications, the worldwide working groups (such as those in 3G Partnership Project (3GPP) or International Telecommunication Union (ITU)), and emerging transportation use cases to identify security and gaps from a transportation perspective; and is testing the security of 4G Long-Term Evolution Vehicle-to-Everything (LTE-V2X) devices as a proxy until the 5G V2X prototype devices become available (anticipated in mid-2023). This research will assess issues that may occur if key features, such as use of GNSS/GPS, are hacked or unavailable. The project also supports expert participation in the specifications and standards development organization working groups as well as coordinated collaboration with other US Government (USG) agencies with overlapping interest in 5G communications security; the LTE-V2X testing will help inform where security in the 5G V2X standards development effort might need to focus. Last, the project work will perform precursor research on the

integration of transportation 5G-based services with smart city/smart community systems to identify new types of threats and vulnerabilities; and to research and test new mitigation solutions once prototype devices are available. This project will utilize the ITS architecture reference, ITS standards, and ITS tool sets to provide a holistic analysis to identify where 5G may support transportation information flows, field devices, vehicle fleets, back-hauls, back-office systems, and other component elements of a transportation environment.

Cybersecurity for Transportation System Users: This research will identify critical concerns for privacy and security of individual transportation system users, particularly vulnerable road users (VRU) (e.g., pedestrians, cyclists, people with disabilities) in connected/automated vehicle environments and integrated mobility systems. In an integrated mobility system, the personally identifiable information (PII)/sensitive data gathered takes the form of payment information, saved addresses or phone numbers, disability status, or any other data that may be required for a user to engage mobility services. Individually some of these elements may not need special protections, but when they are all co-located and correlated within an application or database these efforts may require stricter protections. This project will identify best practices related to sensitive data, reviewing legal and regulatory requirements and restrictions, and clarifying previous Federal guidance. VRUs are more likely to use assistive mobility devices that would be connected to the transportation network. However, the use of an assistive mobility device such as a cane, wheelchair, or stroller, should not jeopardize a traveler's safety or privacy. This project is intended to develop a framework where the privacy and cybersecurity considerations of personal-to-everything (P2X) devices for pedestrians and cyclists, including those with mobility aids, are created to begin the integration of those devices into existing security mechanisms such as the SCMS.

Cybersecurity for the Advanced Transportation Controller Standards Family: The Institute of Transportation Engineers (ITE) Advanced Transportation Controller (ATC) family of standards includes interoperable requirements for ATCs, the ATC Application Programming Interface (API) and the ATC (formerly ITS) Cabinet. These standards provide key interfaces between the transportation infrastructure and connected vehicles as ATCs provide the signal, phase and timing information that can be used for vehicle-to-infrastructure (V2I) safety applications such as Red-Light Violation Warning. These standards provide physical dimensions, environmental/electrical requirements, as well as the ports and protocols supported by these devices, however the security requirements associated with these devices have not been fully addressed to date. As these devices are critical interfaces to Connected Vehicle communications as well as attack surfaces for the ITS infrastructure, standardized security requirements and guidance is necessary to ensure future secure ITS infrastructure systems. This effort will develop new security

requirements for all of the standards in the ATC family via a holistic security approach that covers all of the critical attack surfaces.

National Transportation Communications for ITS Protocol (NTCIP) Security Updates:
This effort will execute the NTCIP security update roadmap completed in FY2021 under the Infrastructure System Security Assessment (ISSA) effort. The NTCIP standards developed by ITE, American Association of State Highway and Transportation Officials (AASHTO) and National Electronics Manufacturers Association (NEMA) started development in the 1990s when the industry standard network management protocol (Simple Network Management Protocol Version 1 (SNMPv1)) did not support robust cybersecurity mechanisms. To meet the cybersecurity challenges of today, the industry has recognized the need to move to SNMPv3 which provides modern cybersecurity mechanisms. This program will update the NTCIP standards, starting with the most used and critical standards, in accordance with the guidance developed during the ISSA effort.

Cybersecurity Best Practices for the Transportation Sector: This research will document best practices for information sharing across the ITS transportation-ecosystem and with other sectors with a focus on infrastructure systems, as well as identify organizational preparedness training needs for transportation professionals. This includes identifying training content and technology transfer to strengthen the cybersecurity skills and practices of relevant ITS stakeholders.

Working with FHWA and other infrastructure stakeholders, the program facilitates development of prototype cyber-incident management protocols and best practices with the goal of eventually developing a Transportation Cyber Assessment Tool for IOO use. The tool will assist transportation professionals in assessing their organizational cyber risk and providing ways to mitigate risk in line with the NIST Cybersecurity Framework.

The best practices also include procurement guidance. Due to the current capabilities of transportation sector organizations, many transportation organizations will need to procure transportation equipment that meets cybersecurity requirements and/or they will need cybersecurity technical assistance or services. The procurement guidance will provide information on the provisions to include in the procurement requests and subsequent contracts to support obtaining the appropriate cyber functionality or services.

Cybersecurity Awareness and Cybersecurity Culture: Making available tools and best practices to support secure and resilient ITS deployments is necessary, but not sufficient, to meet national needs. The Program will work to develop broad understanding of new and emerging cybersecurity concepts and analyze their effectiveness as best practices or tools applicable to ITS cybersecurity noting that IOO ITS deployments are sufficiently complex and diverse – keeping in mind also the rapidly evolving threat landscape - such that it would not be possible to effectively "prescribe" a nationally-applicable solution. Rather,

developing the capacity of deployers to implement and maintain secure deployments is essential; for these to remain effective, a cybersecurity culture needs to be established that integrates security consideration rather than treating these as an 'add-on.'

Cybersecurity Analysis of Cooperative Driving Automation: This project will analyze the cybersecurity of selected Transportation Systems Management and Operations (TSMO) use cases based on cooperative driving automation (CDA) concepts, by utilizing the approaches outlined in the concept phase of ISO/SAE 21434, Road Vehicles - Cybersecurity Engineering. This analysis will identify the cybersecurity goals and functional cybersecurity concept based on the cybersecurity threats, attack paths, and resulting potential damages. As defined by SAE J3216, CDA aims to improve the safety and flow of traffic and/or facilitate road operations by supporting the coordinated movement of multiple vehicles based on four classes of cooperation. This project will assess the cybersecurity between CDA entities in TSMO use cases that involve vehicle-to-infrastructure communications, focusing on the digital infrastructure and its impact on transportation cybersecurity for all road users. Furthermore, this project will consider only the safety-relevant aspects of CDA cybersecurity; financial, privacy, or other non-safety-relevant cybersecurity concerns are out-of-scope. This project will not include a cybersecurity assessment of enterprise systems or the vehicle itself. This project will complement another ongoing project (awarded in FY21) that will analyze traffic hazards, assess safety risk, and devise safety goals and high-level safety considerations for two CDA-based TSMO use cases. Specifically, this project will identify cybersecurity properties for these use cases and their damage and threat scenarios, assess the attack paths and risk value of each threat scenario, specify cybersecurity goals, and derive the cybersecurity concepts. As a result, this research will provide the level of cybersecurity and safety assurance needed for future expanded testing and eventual deployment of CDA-based TSMO applications on public roads.

Model for State, Local, Tribal, and Territorial (SLTT) agencies Cyber Incident Tabletop Exercise: Looking to leverage the results of the successful Transportation Cybersecurity Incident Response and Management Framework (TCIRMF), this project will develop an independent capability that SLTT transportation agencies may use to test their cybersecurity incidents response plans for their ITS systems. The TCIRMF Project identified improvements to procedures and processes for communication and information sharing prior to and during a cyber incident. These improvements are documented as recommended process flows that describe how a particular transportation stakeholder (e.g., Municipal Infrastructure Owner/Operator (IOO)) would report information when faced with a cyber incident. The procedures were tested in a Cyber Incident Exercise which presented a group of transportation stakeholders with a simulated cyber incident. This demonstrated that the developed procedures helped to improve metrics such as cyber incident response time and content of information shared. This project will develop a table-

top version of the exercise and supporting materials that SLTT transportation agencies may use independently to test their cybersecurity incidents response plans for their ITS systems. This will draw upon best practices from other critical infrastructure sectors to develop an exercise that identifies key personnel to be involved and procedures to follow when responding to a cyber incident and ITS infrastructure. It will be based on the DHS CyberStorm activity and focused on operational, not Enterprise IT, systems. In addition, this project will bring in key stakeholders to pilot this exercise, as well as modify it, based on feedback and lessons learned.

Potential Program Outputs, Outcomes and Impacts:
As noted before, he long-term goal of this research is to establish a multimodal intelligent-transportation system that is both resistant to a wide range of current and future cyber-attacks and resilient enough to gracefully degrade and quickly recover when those cyber-attacks that occur. With that goal, the desired outcome of the USDOT ITS Cybersecurity Research Program is to support the efforts of the broad stakeholder community in their implementation of, secure nationally interoperable ITS systems that ensure broad access to the safety and mobility benefits of ITS while remaining resilient to quickly address threats and attacks, minimizing any disruptions to services and system performance. This will help create and sustain a culture where cybersecurity practices are reflexive and expected among all transportation sector stakeholders. Specific program outcomes that support the required stakeholder actions include developing and making available best practices information to support IOO and other stakeholders' actions to appropriately secure their ITS systems, integration of those options into the National ITS Architecture Reference and incorporation into ITS standards, workforce change and knowledge-building through the Professional Capacity Building, and technical deployment assistance to help deployers achieve and maintain secure deployments.

Potential Economic or Societal Impacts:
The ITS Cybersecurity Research Program remains critical to assure continued benefits of ITS technologies and avoid safety, mobility impacts of cyber-attacks that risk wide ranging societal and economic impact that might result from surface transportation system disruptions. To effectively realize the full potential of ITS systems and cooperative automation, these systems will have to be trusted and accepted by users, many which are using these systems for the first time. This program's work with Misbehavior Detection (MBD) and Security Credential Management System (SCMS), work to establish a level of trust in ITS communications. Protecting communications from cyber-attacks is one of the necessary steps to get public acceptance and trust in these systems. In addition, every moment that a transportation system is inoperable due to a cyber-attack, travelers' lives may be at risk, and time and money is lost by semi- or non-working systems.

As ITS systems and deployments become more interconnected at the local, regional, State, and national levels (especially as IoT environments flourish), the threat surfaces grow and opportunities for ransomware and other attacks increase. The ITS Cybersecurity Research Program strives to assist ITS operators in mitigating and preventing any potential cyber-attacks by educating agencies, vendors, and users with knowledge and research to do so. This resiliency to cyberattacks could have a massive positive economic impact.

Potential Progress Made Toward Achieving Strategic Goals:
The ITS Cybersecurity Research Program aligns with and supports the following USDOT Strategic goals:

- ***Safety:*** Make our transportation system safer for all people. Work toward a future where transportation-related serious injuries and fatalities are eliminated.
- ***Transformation:*** Design for the future. Invest in purpose-driven research and innovation to meet the challenge of the present and modernize a transportation system of the future that serves everyone today and, in the decades, to come.
- ***Organizational Excellence:*** Strengthen our world class organization. Advance the Department's mission by establishing policies, processes, and an inclusive and innovative culture to effectively serve communities and responsibly steward the public's resources.

This program will accomplish this by continuing projects aimed to protect all travelers, including the vulnerable road users participating in connected vehicle and integrated mobility deployments. This program aims to drive development of emerging CDA technologies to have integrated cybersecurity and safety protection as part of their profiles when they become commercially available. And this program works to prepare SLTT with cybersecurity incident and response management. A byproduct of this work is establishing policies, processes, and lessons learned aligning with **Organizational Excellence.**

A secondary goal of this program aligns with the **Transformation** strategic goal of the USDOT by investing in purpose driven research and innovation to meet the challenges of present and future transportation, resulting in improved security support—an imperative for the success of automation, connectivity and ITS infrastructure research, pilot deployments and implementations in an ongoing connected world.

Collaboration Partners:
By definition, cybersecurity remains a cross-cutting challenge, effectively requiring collaboration across all stakeholders in ITS.

Within USDOT collaboration extends to modal partners with ITS interests as well as security, policy, research, and international programs organizations in the Office of the Secretary of Transportation (OST). Intergovernmental Federal cooperation includes the Department of Homeland Security (including CISA), the National Telecommunications and Information Administration (NTIA), and NIST via direct relationships and well as participation in cybersecurity coordination activities of the National Security Council and the intergovernmental 5G Secure Implementation effort.

IOO cooperation includes collaboration via associations such as AASHTO as well as with individual State/ local ITS deployers. Extensive cooperation is conducted with the ITS Architecture and Standards Program, and their broad stakeholder groups of researchers, deployers, industry, and academia to assure that standards products meet security needs and the reference architecture appropriately encompasses cybersecurity. International cooperation opportunities are leveraged when beneficial to US interests.

Accelerating ITS Deployment
($28,000)

Program Description:
As new Intelligent Transportation Systems (ITS) technologies and systems evolve into market-ready products, the primary goal of the Accelerating Deployment Program is to provide research, analytics, and technical services that support adoption and deployment of ITS technologies. The objectives of the Accelerating ITS Deployment Program are: (1) to speed up the transformation of ITS research and prototypes into market-ready technologies that are commercially viable and adopted by the transportation community, and (2) to provide the ITS community the tools needed for successful and interoperable deployment of ITS technologies and systems across the nation. The Program directly supports advancing ITS research and deployment activities from a full-lifecycle perspective, from initial deployment planning through to actual deployment and eventual assessment in coordination with other stakeholders at the federal, state, regional and local levels.

The Accelerating Deployment Program provides a wide variety of resources and services to assist the ITS community of practice throughout the ITS deployment lifecycle, including:

- Extensive quantitative data on ITS benefits, costs, and levels of deployment, to support data-driven and evidence-based deployment decision making
- Communication and education support to facilitate awareness, understanding, acceptance, adoption, and deployment of ITS technologies across stakeholder groups and to ensure that effective partnerships are fostered and maintained at various levels – executive, program, and project
- Knowledge transfer, technical assistance, training, outreach, and extensive interaction opportunities between and among ITS deployer communities
- Support for the development and use of ITS-related standards and architectures to ensure the interoperability of ITS deployments

The Accelerating ITS Deployment Program includes work in four key areas:

- Professional Capacity Building
- Deployment Evaluation
- Communication and Outreach
- Interoperability (inclusive of ITS Architecture and Standards)

ITS Professional Capacity Building: As Automated Vehicle (AV) and Connected Vehicle (CV) Technologies progress, this Program provides assistance to and shares information from multiple public and private sources and also makes this information available in a

variety of ways to help ITS communities of practice operate more efficiently and with improved knowledge. The PCB Program supports the ITS workforce with new knowledge, skills, and abilities to drive and sustain successful ITS implementations. The PCB Program will continue developing courses and offering opportunities to advance the knowledge of the ITS workforce. The PCB Program will share ITS knowledge and lessons learned from AV/CV deployments, as well as from updated legacy ITS applications and additional new technology deployments, to internal and external stakeholders. This Program supports transportation worker's outreach through a variety of different kinds of webinars, online trainings, fact sheets and other informational or instructional products, workshops, and peer events. These activities are offered both in-person and virtually. The ITS PCB Program supports knowledge and technology transfer in key areas within the USDOT as well as with the National Operations Center of Excellence (NOCoE), Institute of Transportation Engineers (ITE), ITS America (ITSA), National Association of Development Organizations (NADO), Association of Metropolitan Planning Organizations (AMPO), American Public Transportation Association (APTA) and a host of other stakeholders.

The ITS PCB Program also offers the Early Deployer Technical Assistance Cohorts. These cohorts enable communities of practice among active early deployers who opt-in to work iteratively and collaboratively with each other and the U.S. Department of Transportation to make their projects successful while incrementally producing detailed documentation and shared software and data that the broader ITS community can use to deploy their own state-of-the-practice, interoperable solutions. Since September 2018, the ITS PCB Program and the FHWA Office of Operations have held monthly cohort group meetings for Advanced Transportation Technologies and Innovative Mobility Deployment (ATTIMD) Program (formerly Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)) grant recipients. With the success of the peer-championed ATTIMD Group, the ITS PCB Program is looking to form other ITS early deployers cohort groups over the next couple of years. These groups could focus on supporting a variety ITS deployments, including smart communities and rural ITS. In addition, the ITS PCB's Academic Initiatives has a number of working groups underway, that focus on: (1) ITS training in community colleges; (2) educator-employer pathway connections; and (3) specialized ITS trainings at historically black colleges (HBCUs), tribal schools, secondary STEM programs (middle schools and high schools), and educational institutions serving rural and small metro areas.

Deployment Evaluation: Provides full deployment lifecycle, data-driven, and evidence-based information to ITS decision makers of all types, both inside and outside of the Department, to help plan, procure, and assess the effectiveness of ITS investment support to the ITS community. This Program tracks the extent of ITS deployment, disseminates data on benefits, costs, best practices/lessons learned related to deployed ITS, and analyzes

data related to ITS deployment trends. This area is responsible for conducting the ITS Deployment Tracking Survey, acquiring data for ITS benefits/costs databases, and undertaking analytics to support accelerating ITS deployment and market development.

Communications and Outreach: This area provides updates and maintains the ITS JPO website and develops communications channels, including social media, email messaging, meeting planning, website development, trade shows, publications and speaking engagements. It also provides communications support for any ITS JPO-funded research project. This includes presentations, articles, and fact sheets about connected vehicle, automated vehicle and all other ITS activities. These materials are used to educate the public and provide stakeholders with the tools they need to promote deployment of ITS technology. The program also provides communications and outreach support for the Safety Band campaign and automated vehicle policy initiatives sponsored by the OST. A goal of the program is to ensure that the technical research conducted by ITS JPO is easily accessible and understood by stakeholders and the general public through the development of easy-to-understand content that is in plain English.

Smart Community Resource Center: As directed by H.R.3684 - Infrastructure Investment and Jobs Act, Sec. 25002, the ITS JPO will manage the Smart Community Resource Center (SCRC) which will include a compilation of resources and links to resources for States and local communities to use in developing and implementing (1) intelligent transportation system programs; or (2) smart community transportation programs. This new resource center is intended to provide information to people who have a general interest in smart community technologies – including the public, businesses and decision makers in local and state governments. The other main audience for this resource center will include organizations with an interest in applying for or have received USDOT Strengthening Mobility and Revolutionizing Transportation (SMART) Grant Program award. The ITS JPO will ensure the following types of resources are available:

(1) existing programs and resources for intelligent transportation system or smart community transportation programs, including technical assistance, education, training, funding, and examples of intelligent transportation systems or smart community transportation programs implemented by States and local communities, available from:
    a. the Department
    b. other Federal agencies; and
    c. non-Federal sources.
(2) existing reports or databases with the results of intelligent transportation system or smart community transportation programs.
(3) any best practices developed, or lessons learned from intelligent transportation system or smart community transportation programs; and
(4) such other resources as the Secretary determines to be appropriate.

Interoperability: This area provides a reference system architecture (known as the Architecture Reference for Connected Intelligent Transportation, or ARC-IT—the National ITS Architecture) along with voluntary technical standards, tools, and deployment support. These efforts guide safe, secure, efficient, and interoperable deployment of infrastructure, connected, and automated ITS technologies. The ITS reference architecture (www.arc-it.net) provides IOOs and deployers access to options for deploying more than 130 ITS public-benefit services and applications. The ITS reference architecture is accompanied by software tools for developing and customizing regional and project architectures to meet local needs while also ensuring necessary nationwide interoperability. The reference architecture identifies interfaces for standardization and recommends suitable ICT and ITS standards – identifying and enabling multiple suitable technology choices whenever viable. The standards portion of the Accelerating ITS Deployment Program through interoperability, supports the development of needed ITS-specific standards as well as evaluation; and when beneficial, customization of ICT standards to most effectively meet ITS deployment needs. Under interoperability, the Accelerating ITS Deployment program also conducts extensive technical and implementation support along with systems engineering and architecture implementation workshops to State and local customers nationwide. Additionally, foundational research is funded that advances ITS reference architectures, standards, cybersecurity options, and human factors guidelines that support safe, secure, and interoperable large-scale deployments of ITS; and support regulatory decision-making. Included in this is direct support to and exchanges with the next generation wireless research program as communications and their standards are key enablers of successful ITS deployments. Furthermore, the Interoperability area provides support to deployment test beds and pilot deployments.

Each of these four "key areas" (ITS Deployment Evaluation, ITS Professional Capacity Building, Communications and Outreach, and Interoperability) are considered individual Programs themselves under the Accelerating Deployment Program Area.

Major Program Objectives:
The objectives of the Accelerating ITS Deployment Program are to provide the research, analytics, products, tools and services to enable more rapid, interoperable deployment of ITS technologies and services to maximize public benefits. The intent is to define and improve evidence-based decision making, collaboration, harmonization, standardization, and communication mechanisms and targets to encourage public and private investment in ITS; to develop comprehensive training and analytic tools that allow deployers to understand the financial and operational benefits and costs of new technologies and systems; and to establish the tools that deployers can use to help make more informed investment and planning decisions regarding ITS deployment.

Anticipated Program Activities:
__Professional Capacity Building Activities FY 2023:__
The ITS JPO's Professional Capacity Building (PCB) Program is the primary mechanism for educating the current and future transportation workforce about ITS. One of the ITS JPO's PCB teams' primary objectives is to promote technology transfer and education to accelerate deployment of ITS research and technologies. The ITS PCB Program will continue coordinating with Federal program offices, educational organizations, and professional associations, and active state, regional, and local public agencies, and continue reaching out to build the community. In FY2023, the ITS PCB Program will continue delivering multimodal ITS learning opportunities through:

1. Webinars (e.g. Talking Technology and Transportation (T3) Webinars – approximately 18 per year)
2. Workshops (e.g. ITS State Chapter Workshops – 10 to 14 per year)
3. Online Training Modules (e.g. 91 ITS Standards modules, ITS microlearning vignettes)
4. Technical Assistance (e.g. Connected Vehicle Deployment Technical Assistance (CVDTA) Cohorts Program, other Cohort groups, CVDTA Equipment Loan Program, ITS Help Line, ITS PCB Peer Program)
5. Classroom / Courses (e.g. National Highway Institute's ITS courses)
6. Educational Materials (e.g. ITS Knowledge Resources Databases, 16 ITS ePrimer online modules)
7. Academic Support (e.g. ITS University and Community College Workshops and Academic Communities of Practice projects, Academic Speakers' Bureau, ITS case studies, ITS project and career profiles, student research webinars, educator-student-employer connections and sustainable pathways)

In FY23, the ITS PCB Program will expand the online, on-demand training offerings for both the internal and external transportation workforce. Expanding the topics and types of offerings available will reach a broader audience. Working with the National Highway Institute (NHI), academic community, professional associations, and other training partners, activities will include converting in-person ITS workshop materials and existing courses to online opportunities in a variety of formats (i.e. microlearning). Expanding the online presence of the ITS PCB Program will increase learning opportunities for the current and future transportation workforce including student, rural, and tribal audiences.

The ITS PCB Program seeks to provide training and educational products that do not conflict with and should enhance Department priorities. Safety is always a topic intertwined with most or all PCB products. Many of the ITS applications, such as automated vehicles and transit management systems, have climate improvement benefits. Climate and sustainability are also topics incorporated in many ITS PCB teaching and educational products. The training and education products also focus on many

technologies and applications that are used to improve transportation system operations, which supports the Economic Strength and Global Competitiveness goal of the present USDOT Strategic Plan. Ensuring that all products (or events) are free and the majority are accessible through the ITS PCB website supports the equity priority. The ITS PCB's Academic Initiatives likewise target educational institutions that serve underserved populations or areas (HBCUs, tribal schools, rural-based academic institutions).

Over the last five years, the ITS PCB Program has been directly training staff from FHWA, FTA, FMCSA, and other federal offices on federal policies and programs (including relevant funding sources), and technologies associated with automated vehicle and vehicle connectivity. This internal training effort enables staff from program and field offices to increase their expertise in these current, high-visibility subjects and be more responsive to the public agency grantees. Consistent with the goal of Organizational Excellence, direct training of federal staff on prominent and timely ITS subjects will continue in FY23. Finally, the nature of ITS encompasses transformational technologies, networks, or applications. The ability to intertwine knowledge sharing current products on the new transportation technologies with efforts to make the material available to a wide audience work to cover all Department priorities.

ITS Deployment Evaluation Activities FY 2023:

<u>Benefits/Costs Databases:</u> The Deployment Evaluation Program will continue to improve the operation and content of the benefits/costs/lessons learned databases and experiment with new, innovative ways to present these data to the public. This would include:

- Obtaining ITS deployment benefit, costs, and best practices data from new sources;
- Addressing ITS benefit and cost data gaps (particularly in the areas of climate change and equity); and
- Continuing to develop compelling data visualization products and decision-making and planning tools to support ITS stakeholders in their efforts to make evidence-based decisions about ITS investments at all stages of the ITS deployment lifecycle.

<u>ITS Deployment Tracking Surveys:</u> The Program completed its most recent ITS Deployment Tracking Survey in CY 2020-2021. The results have been published and are publicly available on ROSA-P and the Deployment Evaluation Program website as of mid-FY2022. The Program is also planning the next major ITS Deployment Tracking Survey (expected in CY 2023-24) and in FY2023 will continue process of reviewing the survey instruments and list of survey recipients, as well as reviewing the current survey methodology. Further, in FY2023 the Program will continue its deployment tracking analytics work using longitudinal ITS deployment data.

Strategic Priorities: The Deployment Evaluation Program is continuing its long-term effort to provide data-driven and evidence-based products and services to the ITS stakeholder community. The Deployment Evaluation Program's strategic priorities are:

- Putting communities and people first by addressing a full spectrum of stakeholder needs related to the foundational elements of successful ITS deployment and the full ITS deployment lifecycle
- Developing visually appealing and engaging products and tools to (1) serve as a launch point for more engagement with the data, thereby enabling successful, effective, and interoperable ITS deployments and (2) demonstrate that ITS deployment is a sound investment
- Taking maximum advantage of existing data assets for evidence-based decision support for the ITS community
- Providing resources and tools to support effective and meaningful evaluations of ITS deployments, pre- and post-investment.

Communication and Outreach Activities FY 2023:

University Transportation Centers (UTC) Guest Speaker program: The objective of this program is to increase awareness among college student to help them better understand opportunities in the ITS field. The task will require that the contractor identify colleges and universities where USDOT staff and/or contractors can serve as guest speakers. This task differs from the PCB program in that it does not involve training, workshops and other events designed in improving the workforce skills development. It also does not involve developing lesson plans and other materials for teachers.

Event Planning: This task will be used provide program support for major events where USDOT will have a major presence. This includes large events such as SXSW (March 2023), or CES (January 2023) and the ITS World Congress (September 2022 in Los Angeles, 2023 in Suzhou, China). By participating in these events, USDOT is able to connect with non-traditional stakeholders that are outside of the ITS community. This additional outreach will help USDOT to develop new partnership relationships with technology firms and advocacy groups.

New ITS JPO Video: This is a new video that will be on the homepage of the ITS JPO website. It will explain what ITS Technology is and how it impacts the daily lives of the average American. It will also focus on the six areas of the current ITS Strategic Plan.

Smart Community Resource Center: In FY23 the ITS JPO will be responsible for the development and deployment of the Smart Community Resource Center. Activities will include the coordination of the timing and content in advance of the OST-R SMART Grant Notice of Funding Opportunity (NOFO). The ITS JPO will work collaboratively with the other Modal Administration to identify the best internal and external resources to be

included in the SCRC and will identify internal stakeholders to serve as stakeholders. Working in coordination with the ITS JPO, these internal stakeholders will serve as working partners in the review of wireframes, mockups and beta testing activities.

Interoperability Activities FY 2023:

In FY23, interoperability activities will include continued evolution in the content of the ITS reference system architecture and ITS standards. This evolution will reflect advances in key technologies emerging within the ITS marketplace, including vehicle automation, alternative connectivity services, and new ICT technologies such as 5G. Cooperating internationally, further work will be undertaken to specify access controls for ITS environments for effective cybersecurity; and to develop and evolve voluntary technical standards and candidate system architectures to support the secure communication of road signage and regulatory information to automated and connected vehicles (i.e., digital infrastructure and message authentication). Interface standards to support V2X and cooperative automation are underway and will be continued. Standards for improved connectivity services, including those needed for Roadside Units (RSU) as well as the interoperable broadcast of traffic signal phase and timing (SPaT) information, are expected to be evolved to address validation of initial guidance along with initial analyses to support improving security of legacy ITS infrastructure equipment installations. Work will also be conducted to develop interoperable guidance that deployment agencies and the connected vehicle community can utilize to ensure the safe and interoperable deployment of work zone data nationwide. Program efforts will continue to be informed by extensive collaboration with stakeholder groups and Standards Development Organizations (SDO) to assure that products that are developed meet stakeholder needs in broadly acceptable way to facilitate voluntary deployments.

Potential Program Outputs, Outcomes and Impacts:
The Accelerating Deployment Program supports a variety of efforts related to evidence-based decision making and focuses on questions of investment choices, value, and awareness of technologies and their application in the real world. The Accelerating Deployment program cuts across all aspects the ITS JPO's research agenda and supports all the programs in the ITS JPO.

Professional Capacity Building Program: Training and educating current and future transportation professionals is an ongoing task that lends it efforts to ever-changing outputs, outcomes, and impacts as the users change and the technologies and systems evolve. The ITS PCB Program has identified FY23 outputs that modify ways to obtain peer support and thus increase the speed of ITS deployments or improve the ITS product being implemented. FY23 outcomes aim to increase the scope and reach of the Program, meaning more practitioners are educated on a wider ITS topics, once again leading to

improved ITS products or transportation operations. The addition of new courses, as well as the conversion of existing courses, workshops and training materials to an online delivery format will make the training resources available to the larger transportation workforce community. Longtime popular on-demand resources such as the standards training modules and the ITS ePrimer continue to be updated with the assistance of ITE. Updating on-demand training resources afford users the flexibility to access the training at a time convenient for them.

The ITS PCB Academic Team has a robust catalog of training resources. Over the last decade, there has been increased collaboration with university, college and community college professors and instructors as well as transportation agency hiring officials who regularly participate in the ITS PCB Academic Workshops. Leveraging ITS PCB Community College Working Groups and Workshops and partnering with the Turner-Fairbank Highway Research (TFHRC) ensure that materials, resources and prototypes (i.e. the CAVe-in-a-Box instructional benchkit) developed will be of value to professors and instructors at a variety of levels educational levels. Both the ITS PCB Community College Discussion Forum and the CAVe-in-a-Box project are a direct result of the work done in previous years. Through the Academic Team, the program will continue to collaborate with this larger group to best identify the most useful resources for professors and students, aiding in increased ITS interest in transportation careers and enhancing the capabilities of future transportation professional.

Deployment Evaluation Program:

Outputs include:

- Benefits, costs and lessons learned databases, online and available to the public 24/7. The databases are constantly updated with recent publicly available evaluation data and are fully searchable.
- ITS Deployment Tracking Survey Data Repository, where raw data and survey instruments for every ITS Deployment Tracking Survey since 1999 are online and available to the public for download 24/7.
- Decision Support Resources site, where the Program provides data visualizations, interactive cost data plots, and case studies.
- Executive Briefings developed annually and posted on the website.

Outcomes: Outcomes of this program include providing the data resources, tools and analytics to support data- driven and evidence- based ITS deployment investment. Making these data available to anyone, anywhere in the world, is another key outcome of this Program. The Deployment Evaluation Program's efforts to support ongoing Department-

wide activities that will accommodate innovation in evidence-based decision-making is another positive outcome that can result in:

- A focus on data-driven support for stakeholders that addresses the full lifecycle of ITS deployment to accelerate and improve stakeholder investment in ITS technologies, applications, and services.

- Assistance for stakeholders that will help them to make better quantitative and qualitative decisions regarding investing in and deploying ITS - from pre-deployment/investment planning through to performance measure setting, data collection and management, evaluation, and transfer of results and best practices.

Impacts: The ITS Deployment Evaluation Program's long-term impact will be to accelerate the deployment of ITS technologies that work to improve the nation's safety, mobility, economic competitiveness, and environment in a measurable way.

Communications and Outreach Program has a number of outputs, outcomes and impacts in FY23 that are designed to increase the profile of the ITS JPO. Outcomes include:
1. Creation of a new ITS video that will explain what ITS technology, provide examples of how the technology is used in the everyday life of Americans and how ITS improves safety and mobility.
2. Establishing USDOT's booth presence at the large events such as the Consumer Electronics Show *or* SXSW.
3. Development of the UTC Guest Speaker program.
4. Smart Community Resource Center expected outcomes include the development and deployment of the SCRC, along with internal and external resources for States and local communities to use in developing and implementing of intelligent transportation system programs and smart community transportation programs.

Interoperability: Expected outcomes of the interoperability-related efforts include continued success of effective, interoperable, and safe ITS deployments due to the availability of an evolving reference system architecture and software toolsets, updated to accommodate additional automation-related services; new and enhanced ITS standards that support greater security; and enhanced cybersecurity practices; along with deployment support to developers of regional and project architectures. New and updated standards products will support secure evolution of legacy ITS equipment, standardized ITS connectivity equipment (including roadside units as well as interoperable Signal Phase and Timing (SPaT) broadcast services) along with additional cooperative automation standards content. The existing family of ITS standards will be further updated to meet evolving needs, the architecture reference will be updated to reflect appropriate uses of evolving 5G and other ICT standards. These interoperability standards and toolsets will

enable more secure, safer, and interoperable deployments across the nation (and North America). They further provide the world with leading-edge standards that can be adopted by other Nations and help ensure harmonization for ITS technologies in a manner that opens global markets to American transportation technology manufacturers.

Potential Economic or Societal Impacts:
The potential socio-economic impact of the Accelerating Deployment Program is best expressed in (1) the positive economic value that accrues to local communities as ITS investment funding is spent locally and with a good return on investment and (2) the positive socio-economic impact of improvements in peoples' safety and mobility (and improvements in a community's economic competitiveness) as businesses and citizens experience reduced traffic congestion and improved road safety, and associated improvements in quality of life and economic development are realized.

The goals of the Accelerating Deployment Program are to (1) provide research, analytics, and services that support adoption and deployment of ITS technologies, (2) speed up the transformation of ITS research and prototypes into market-ready technologies that are commercially viable and adopted by the transportation community, and (3) provide the tools needed for interoperable deployment of ITS technologies and systems across the nation. These three goals can have a tremendous societal and economic impact leading to more secure, safe, and interoperable deployments across North America increasing the confidence and rate of adoption of ITS technologies. Additionally, as a result of harmonization and interoperability work and research, the marketplace for these technologies will broaden the marketplace both domestically and abroad allowing US vendors to become competitive in foreign markets.

In particular, under the ITS PCB Program's Academic Initiatives, the ITS PCB Program has reached out to Historically Black Colleges and Universities (HBCUs) and tribal schools to expand ITS training into these underserved academic communities. The ITS PCB Program has also linked with the Conference of Minority Transportation Officials (COMTO) to cooperatively expand ITS knowledge sharing to its members and member organizations (especially HBCUs and tribal schools). This cooperative effort will continue and expand in FY23 (and beyond).

Potential Progress Made Toward Achieving Strategic Goals:
The Accelerating Deployment Program is a crosscutting program and, as such, supports many goals of the ITS JPO, FHWA, OST-R, and the USDOT as a whole, including safety and mobility, economic strength and global competitiveness, transformation, climate, and equity. The extent to which ITS deployments are proven to address each of these strategic

priorities is evidence that supporting the acceleration of ITS deployment in local communities contributes to achievement of these strategic Departmental goals. The Accelerating Deployment Program also supports USDOT's goal of organizational excellence via its important role in addressing elements of government-wide requirements related to evidence-based decision-making.

The Accelerating Deployment Program aligns with and supports the following USDOT goals:

- **Safety***:* Make our transportation system safer for all people. Work toward a future where transportation-related serious injuries and fatalities, equity, transformation are eliminated.
- ***Economic Strength and Global Competitiveness:*** Grow an inclusive and sustainable economy. Invest in our transportation system to provide American workers and businesses reliable and efficient access to good-paying jobs, resources, and markets.
- ***Transformation:*** Design for the future. Invest in purpose-driven research and innovation to meet the most obvious goals impacted through the challenge of the present and modernize a transportation system of the future that serves everyone today and, in the decades, to come.

Accelerating Deployment program has several points of impact on transportation safety, economic strength and global competitiveness, and transformation. Through the ITS PCB Program, for example, safety is shared through knowledge transfer and lessons learned from AV/CV deployments to internal and external stakeholders. The Deployment Evaluation area provides resources, tools and analysis to support data- driven and evidence-based research and deployment investment. The Deployment Tracking data provide snapshots of how ITS deployment is occurring in the US and allows analysis relating to market development, economic impact, performance assessment, feasibility assessment, and impact assessment. The communication and outreach area creates new resources and mediums to explain and educate the uses and benefits of ITS technology. Finally, Interoperability initiatives (1) drive innovation, safety, and economic and global competitiveness, climate and sustainability, and organizational excellence are likewise supported by expanding the marketplace through competition between vendors, (2) enable safe, secure, and interoperable large-scale deployments of ITS through foundational research that advances ITS reference architecture and standards, cyber security options, and human factors guidelines, and (3) support regulatory decision-making.

Collaboration Partners:
Each of the elements of the Accelerating Deployment Program area are crosscutting and, as such, have at their core the objective of reaching out to all types of stakeholders, and across all modes.

To ensure that these stakeholders and communities of practice are given necessary data, knowledge sharing, and technology sharing support, the Program works in partnership with the USDOT surface modes, professional associations, universities, state, regional and local public agencies, standards development organizations, and others to engage the broad technical and organizational expertise needed to accelerate ITS deployment.

Each of these Federal program offices, educational organizations, or professional associations also act as a sounding board from which the Accelerating Deployment Program receives information on ITS community needs related to supporting ITS deployment, and also as distribution channels through which the Accelerating Deployment Program disseminates various products and services. Creating, maintaining, and expanding effective partnerships will remain a critical component of the Program's strategy.

Within USDOT collaboration extends to modal partners with ITS interests as well as security, policy, research and international programs organizations in the Office of the Secretary of Transportation (OST). Intergovernmental Federal cooperation includes the Department of Homeland Security and NIST via direct relationships and well as participation in standards coordination activities of the National Security Council.

Stakeholder cooperation includes activities via associations such as AASHTO as well as with individual SLTT ITS deployers. Extensive cooperation is conducted with other ITS JPO Programs as well.

The Interoperability Program and their broad stakeholder groups of researchers, deployers, industry and academia to assure that standards products meet security needs and the reference architecture appropriately encompasses cybersecurity. International cooperation opportunities are leveraged when beneficial to US interests via intergovernmental cooperation as well as cooperation via SDOs.

Data Access and Exchanges Program
($6,500)

Program Description:
This research area facilitates effective generation, acquisition, governance, management, and analysis of ITS data and code across all modes to advance the state of multimodal ITS research and enable deployment of innovations in operations. This, in turn, increases return on federal investment in research and demonstration projects and accelerates multi-modal, data-driven, trusted evaluations of potential safety, mobility, and other benefits to inform future policy and investment decisions. While enabling broader ITS research and deployment activities, these investments drive implementation of various Federal and USDOT directives on increasing access to data, source code, and federally funded research results.

Major Program Objectives:
Consistent with the ITS JPO Strategic Plan, this research area will continue to help identify, prioritize, monitor, and – where necessary – address multi-modal data exchanges across traditional organizational boundaries.

Anticipated Program Activities:
Assets and Governance (sub-program area) **–** The ITS JPO remains committed to providing access to data and source code generated through its investments, including the various projects described throughout this and past AMRPs, in accordance with the Department's public access guidance. In FY2023, the ITS JPO will continue to refine its data and source code policies, drive implementation among JPO-funded projects in various modes, advise program managers on project-specific data requirements and best practices, promote the availability of JPO-funded data and source code for analysis and reuse, and generate best practices for the broader research and deployment communities. The ITS JPO will also contribute to the broader USDOT research, policy, and technology communities through existing internal and external multi-modal forums and collaborative intermodal projects. The Assets and Governance sub-program will pay for ITS JPO-funded projects' use of the assets described below, including use by modal partners managing ITS JPO-funded projects, and work with any shared service providers to define and deliver ITS JPO-specific requirements that meet the needs of the ever-evolving ITS research portfolio.

The Assets and Governance sub-program area will manage and/or fund the following systems and teams in FY2023:

- ITS DataHub. ITS DataHub provides a single access point for USDOT's ITS research data via integration with the Department's open data portal (data.transportation.gov) and repository and open science access portal [ROSA-P]

(rosap.ntl.bts.gov), and augments these shared services with cloud storage (ITS Data Sandbox) to support more advanced ITS research requirements, such as large volumes of data and data formatted in a non-tabular way. The ITS DataHub user interface is a simple web portal that could be replicated by other groups within the Department and the source code is available on ITS CodeHub.

- ITS CodeHub. ITS CodeHub provides a single access point for USDOT's ITS source code and enables code collaboration and re-use. In FY2022, ITS JPO began the process of streamlining how the source code is stored within repositories and that work is expected to continue into FY2023. The ITS CodeHub user interface is a simple web portal that could be replicated by other groups within the Department and the source code is available on ITS CodeHub.

- USDOT Secure Data Commons (SDC). The SDC enables collaborative research and analysis involving moderate sensitivity level datasets, and currently hosts ITS JPO-funded project data containing personally identifiable or confidential business information. Originally developed by the ITS JPO, the Office of the Chief Information Officer took over as SDC manager in FY2021 and ITS JPO continues to provide funding for ITS JPO-funded projects using this shared service.

- Public Access Implementation Support Team. To enhance access to results from the Department's research investments, including data, source code, and reports, this team provides consultative support to USDOT program managers and project delivery teams at key parts of the program design, procurement, execution, and close-out processes. In FY2023, the National Transportation Library (NTL) – the implementing organization for the Department's Public Access Plan – will start providing templates and trainings tailored to the needs of high value, high risk projects such as those funded by the ITS JPO.

- ITS JPO's Professional Capacity Building (PCB). The *Assets and Governance* sub-program will also work with the ITS JPO's PCB program to develop publicly available knowledge and technology transfer materials, such as a training module on the ITS JPO Data Management Plan template, as well as other core data and code management and governance documents that deployers would benefit from creating, whether they are USDOT or locally funded project.

Additionally, in FY2023, the Data Access and Exchanges Program expects to perform gap analyses, including internal and external stakeholder outreach efforts, around the need to collect and document a high-value dataset to support cutting edge ITS research, like the highly successful Next Generation Simulation (NGSIM) efforts conducted in the early 2000s that transformed transportation modeling. This effort will be coordinated with modal partners to ensure that this effort will help to support their relevant research priorities and goals.

Data Exchanges (sub-program area) – ITS JPO continues to help the OST offices and modes identify, prioritize, monitor, and – where necessary – address multi-modal data exchanges across traditional organizational boundaries to accelerate safe and efficient deployment of new technologies in the transportation system. Between FY2018 and FY2020, the ITS JPO's multi-modal *Data for Automated Vehicle Integration* (DAVI) program (transportation.gov/av/data) drove shared understanding of data exchange priorities for AV integration and incubated the multi-modal Work Zone Data Exchange (WZDx) project as an example for addressing data exchanges collaboratively with data producers and users. In FY2021, the Federal Highway Administration took over WZDx deployment (ops.fhwa.dot.gov/wz/wzdx/demonstration_grants.htm), while ITS JPO has continued to heavily support management and evolution of the WZDx specification. ITS JPO continues to maintain transportation.gov/av/data in a limited way. In FY2023, ITS JPO expects to transfer on-going development and management of the specification to an SDO.

In FY2023, the ITS JPO will continue to extend the DAVI/WZDx model to other emerging USDOT priorities and triage other potential data exchange needs. Internal and external stakeholder outreach will be conducted to determine priority areas where exchanges can support multi-modal operations. The FY2023 efforts will also include the identification of critical use cases and requirements for the next data exchange once the first priority area has been determined.

Potential Program Outputs, Outcomes and Impacts:
Outputs: ITS JPO expects that the following outputs will be produced by the Data Access and Exchanges program in FY2023. These outputs can be leveraged by modal administrations and other offices to accelerate their own public access efforts.

- Updated data access guidelines for ITS JPO-funded projects and related templates, such as Data Management Plan (DMP) and Privacy Management Plan (PrMP)
- Updated source code access guidelines for ITS JPO-funded projects and related templates, such as source code management plans
- Updated procurement language examples for contracts and grants to ensure public access to ITS JPO-funded research products
- PCB course for data management, with a specific focus of data management plans and privacy management plans.

Outcomes: ITS JPO expects these investments will result in faster access to higher quality data and source code from the Department's ITS research portfolio. This will increase the quality and timeliness of project evaluations and other analyses which support decision-making within the Department and in the deployment community, and enable external researchers to perform their own analyses, driving additional knowledge-building and economic activity. It will also enable greater re-use of source code generated through the

Department's ITS research portfolio, which will reduce costs while improving interoperability and accelerating deployment. These investments will also increase access to data in the deployment community by lowering barriers to voluntary data exchanges.

The Data Access and Exchanges Program supports USDOT research areas. The development of data systems to support data-driven technologies and decision making in real time is one of the overarching themes of USDOT RD&T efforts.

Impacts: Advances in data processing are enabling governments, transportation operators, and private companies alike, to improve the safety, mobility, efficiency, and resiliency of the transportation network and better target investments. These improvements will enhance the safety of the Nation's surface transportation system, in addition to reducing the transportation system's impact on the climate.

Potential Economic or Societal Impacts:
The Data Access and Exchanges Program will generate positive economic and societal impacts through fewer roadway crashes and enhanced efficiency of the existing transportation network. The technology-focused solutions developed by the Program leverage existing resources without the adverse environmental impacts of construction of new roadways or widenings.

Potential Progress Made Toward Achieving Strategic Goals:
The Program is likely to make progress on USDOT's strategic goal of **making our transportation system safer for all people**, especially for roadway workers through continued development of the WZDx specification and its future inclusion of worker presence information and raising traveler awareness of work zones where they should take extra care to drive slower and safer.

The Program will also result in progress on **Transformation: Designing for the future**. The *Asset and Guidance*, as well as the *Data Exchanges*, sub-program areas are intended to accelerate research and innovative practices in the field, followed by knowledge transfer activities to ensure the broader application of these beneficial breakthroughs.

Collaboration Partners:
The Data Access and Exchanges program depends on active engagement with partners inside and outside the Department who help iteratively prioritize the work to be done and implement preliminary research solutions to help evaluate effectiveness. This approach helps the ITS JPO ensure that technical and policy tools meet the needs of real users – whether they are federal program managers, external project delivery teams, policy or research analysts, or deployers in the public and private sectors. Engaging users and institutional partners from the earliest stages of projects also accelerates the product development lifecycle, and technical transfer at the end of projects. For example, ITS JPO

has enabled multiple software projects to be handed off to users in the deployment community for long-term maintenance and sparked the collaborative development of new open data exchange specifications between public sector roadway operators and private sector automotive mapping companies. Specific technical transfer partners include, but are not limited to, the ITS JPO's Professional Capacity Building Program, OCIO, NTL, FHWA's Turner Fairbank Highway Research Center and Every Day Counts Program, and external groups such as the Work Zone Data Working Group and various Standards Development Organizations.

As the ITS JPO's implementation arm for federal and USDOT data and source code policies, the Data Access and Exchanges program also collaborates closely with technology leaders in the Office of the Secretary (policy, research, CIO, general counsel) and modes (FHWA, FTA, FMCSA, NHTSA, FAA, and others). The Program also collaborates with other Federal inter-agency groups, as directed by OST. These collaborative relationships help the ITS JPO to understand and build upon more general technology policies and provide practical feedback and use cases to these partners.

In addition, the private technology sector and some leading-edge public agencies, federal innovation centers, and academic programs have well-tested approaches to managing modern technology projects, including data and source code management. The ITS JPO will continue to engage these partners to bring proven innovations into the transportation enterprise and enable the government workforce to procure and manage projects that use these practices. In FY 2022 through FY 2024, the Data Access and Exchanges Program will host a series of external stakeholder forums to gather these partners. The ITS JPO will also continue to monitor the emergence of data exchanges and adoption of technical data standards in the public and private sectors to avoid duplication of existing, successful efforts.

Advanced Transportation Technologies and Innovative Mobility Deployment (ATTIMD)
($21,000)

Program Description:
The ATTIMD is statutorily required in the Infrastructure Investment and Jobs Act (IIJA) Section 13006, 23 U.S.C. 503(c)(4). The ATTIMD grants are managed by FHWA and the ITS JPO contributes a mandated percentage of funding through FHWA to annually satisfy the requirement.

The USDOT provides a total of $60,000,000 for ATTIMD, with $39,000,000 coming from FHWA and $21,000,000 from the ITS JPO.

The language provided here duplicates the language provided in the FHWA AMRP for consistency.

The Advanced Transportation Technologies and Innovative Mobility Deployment (ATTIMD) Program is intended to provide funding for eligible entities to develop model deployment sites for large scale implementation and operation of a diverse set of technologies in various geographic regions. As the program is aimed at the rapid deployment of advanced technologies, limited expenditures for infrastructure construction is anticipated in grant application. The stated purpose is to reduce costs and increase return on investments; deliver environmental benefits through increased mobility; enhance transportation system operations; improve safety; improve collection and dissemination of real-time information; monitor transportation assets; deliver economic benefits; and accelerate deployment of connected and automated vehicle technologies. Successful proposals will contain quantifiable system performance objectives, use innovative technologies and strategies, and a plan for long term operation and maintenance of the deployed technologies. The U.S. Department of Transportation (USDOT) encourages partnering among the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders.

Major Program Objectives:
The USDOT's vision for the ATTIMD initiative is the deployment of advanced technologies and related strategies to address issues and challenges in safety, mobility, efficiency, system performance, intermodal connectivity and infrastructure return on investment that are confronted by transportation systems owners and operators. The advanced technologies are integrated into the routine functions of the location or jurisdiction and play a critical role in helping agencies and the public address their challenges. Management systems within transportation and across other sectors (e.g., human services, energy, and logistics) share information and data to communicate among agencies and with the public.

These management systems provide benefits by maximizing efficiencies based on the intelligent management of assets and the sharing of information using integrated technology solutions. USDOT shares the advanced technology solutions and the lessons learned from their deployment with other locations, scaled in scope and size, to increase successful deployments and provide widespread benefits to the public and agencies.

Anticipated Program Activities:
In FY23, the ATTIMD program will request proposals for new grant awards, completed the awards under the previous solicitation, and managed the existing grant awards made through the formerly named Advanced Transportation and Congestion Management Technologies (ATCMTD). Additionally, the program published the ATCMTD annual report as mandated by the FAST Act.

Key FY23 ATTIMD Program Activities.

Activity	Period of Performance
Selection of FY23 grant awards and timely implementation of projects.	2023
Continue award of FY22 grants and manage FY16-21 projects.	On-Going
Publish ATCMTD annual report as mandated by the FAST Act.	2023

Potential Program Outputs, Outcomes and Impacts:
Outcomes: The ATTIMD Initiative will develop model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, mobility, efficiency, system performance, intermodal connectivity, and infrastructure return on investment. Each ATTIMD project will consist of model technology deployments to help demonstrate how emerging transportation technologies, data, and their applications can be effectively deployed and integrated with existing systems to provide access to essential services and other destinations. This also includes efforts to increase connectivity to employment, education, services and other opportunities; support workforce development; or contribute to increased mobility, particularly for persons with visible and hidden disabilities and elderly individuals.
Outputs: Each grantee is required to submit a report that that describes:
- deployment and operational costs of the project compared to the benefits and savings the project provides; and
- how the project has met the original expectations projected in the deployment plan submitted with the application, such as-
  - data on how the project has helped reduce traffic crashes, congestion, costs, and other benefits of the deployed systems;
  - data on the effect of measuring and improving transportation system performance through the deployment of advanced technologies;
  - the effectiveness of providing real-time integrated traffic, transit, and multimodal transportation information to the public to make informed travel decisions; and

o lessons learned and recommendations for future deployment strategies to optimize transportation mobility, efficiency, multimodal system performance, and payment system performance.

Impacts: Grants may be awarded for various types of deployments, but it is anticipated that each will have one or more of the following impacts:

- reduced traffic-related fatalities and injuries;
- reduced traffic congestion and improved travel time reliability;
- reduced transportation-related emissions;
- optimized multimodal system performance;
- improved access to transportation alternatives;
- improved integration of payment systems;
- provided the public with access to real-time integrated traffic, transit, and multimodal transportation information to make informed travel decisions;
- provided cost savings to transportation agencies, businesses, and the traveling public; or
- provided other benefits to transportation users and the general public

Potential Economic or Societal Impacts:

Potential economic and societal impacts will be achieved individually be each of the ATTIMD grantees. Examples of impacts will include the improvement of mobility and goods; improvement of the durability and life of transportation infrastructure, reduction in costs and improved returns on investment; protection to the environment; reductions in the severity of traffic crashes; increases to safety, improved use of real-time data, and broad economic benefits related to reductions in delays, improvement of system performance and efficient and reliable movement of goods and services for all Americans.

Potential Progress Made Toward Achieving Strategic Goals:

Since 2017 the ATTIMD (formally ATCMTD) Program has provided grants to eligible entities to deploy, install, and operate advanced transportation technologies to improve safety, mobility, efficiency, system performance, intermodal connectivity, and infrastructure return on investment.

Collaboration Partners:

ATTIMD is not a research program, rather it is a discretionary grant program established in the Infrastructure Investment and Jobs Act, however, public and stakeholder input is considered in the development of the annual Notice of Funding Opportunity (NOFO).

To be selected for an ATTIMD award, an applicant must be an eligible applicant. Eligible applicants are State or local governments, transit agencies, metropolitan planning organizations (MPO) or other political subdivisions of a State or local government (such as publicly owned toll or port authorities), or a multijurisdictional group or consortia of research institutions or academic institutions. Partnership with the private sector or public agencies, including multimodal and multijurisdictional entities, research institutions,

organizations representing transportation and technology leaders, or other transportation stakeholders, is encouraged.

Typically, a consortium is a meaningful arrangement with all members involved in planning the overall direction of the group's activities and participating in most aspects of the group; the consortium is a long-term relationship intended to last the full life of the grant. Any application submitted by a sole research or academic institution and that is not part of a consortium will not be considered for selection.

USDOT encourages partnerships with the private sector or public agencies, including multimodal and multijurisdictional entities, research institutions, organizations representing transportation and technology leaders, or other transportation stakeholders. Numerous ATTIMD awardees include non-governmental partners that traditionally have provided non-Federal matching funds in the form of technical services, hardware, and software.

Program partners (both government and non-government), benefits derived from partnerships, and partner contributions are summarized in in the table below.

Benefits of Partnership and Partner Contributions to FHWA ATTIMD Program.

Partner Organization	User Perspective on Needs	Industry Perspective	Standard / Goal Setting	Field Trials	Deployment	Research Collaboration	Specialized Expertise or Capabilities	Donation of Material or Services	Funding	Stakeholder Advice	Education and Awareness
ATTIMD partners are the individual grant recipients (benefits of partnerships are identified in IIJA Section 13006 and 23 U.S.C. 503(c)(4)). Benefits of partnership and partner contributions are detailed in IIJA-mandated Secretary's report.					X				X		

Small Business Innovation Research (SBIR)
($2,200)

Program Description:
The SBIR program is administered by the Volpe Transportation Center and managed by the FHWA with funding from the ITS JPO. The SBIR activity is a highly competitive, awards-based activity that encourages domestic small businesses to engage in R&D addressing high-priority research areas within USDOT. SBIR favors research that has the potential for commercialization through products and applications sold to the private sector transportation industry, State DOTs, USDOT, or other Federal agencies. Funding amounts for SBIR activities are established by law, as noted in the Defense Reauthorization Act (Sec. 5102(a)(1)). Each year, Federal agencies with extramural R&D budgets at the Department level that exceed $100 million are required to allocate 3.2 percent of their R&D budget to these programs.

The SBIR Program Office publishes one or two solicitations each fiscal year for proposals on specific research topics of interest to USDOT operating administrations.

Major Program Objectives:
The objective of the SBIR Program is to encourage small businesses to engage in research and development (R&D) that has the potential for commercialization and meets federal R&D objectives. The SBIR program is uniquely positioned to support both the interests of the USDOT as well as the small business. In this respect, the SBIR programs aims to provide essential funding to small businesses with aim toward commercialization of products that align with ITS JPO, FHWA and Departmental Strategic goals. Given that the SBIR program is available to all ITS JPO and FHWA RD&T programs, all USDOT Strategic goals are supported as a result.

The SBIR program offers unique services to the small businesses to aid in their technical and commercial development. Specifically, the SBIR program offers a Commercialization Assistance Program to provide consulting services to the SBIR participants to help conduct market research, commercialization plans, and other services. In addition, in FY23 the SBIR program will continue with a Technology Readiness Level (TRL) assessment program to help the Small Businesses conduct an independent assessment of the technological status of the innovations developed through the SBIR program.

Anticipated Program Activities:
In FY23, the Small Business Innovation Research program will participate in the annual solicitation of topics and support current Phase I, II, and IIB projects. Additionally, the SBIR program will continue with the Technology Readiness Level (TRL) Assessments throughout Phase II and IIB projects.

Key FY23 SBIR Program Activities

Activity	Period of Performance
Technology Readiness Level (TRL) Assessments	2023
Annual Solicitation of Topics	2023

Potential Program Outputs, Outcomes and Impacts:

USDOT strives to advance technologies and make problem-solving innovations available to the end user. The SBIR Program will work towards accomplishing this by identifying the most promising new innovations, advancing Phase I and Phase II projects that have a clear path to commercialization, and focusing on market-driven needs. This creates a win-win-win opportunity for the Federal Government, the small business, and the traveling public.

Potential Economic or Societal Impacts:

The SBIR activity provides economic opportunities for domestic small businesses by providing seed funding to invest in the development of innovations that will benefit the traveling public. It is often difficult for small businesses to establish themselves in the crowded transportation R&D market because of the high startup costs and the lack of nontechnical resources such as commercialization support and business services. The SBIR activity offers critical support in these areas and provides dedicated funding streams to alleviate some of the initial risk.

Potential Progress Made Toward Achieving Strategic Goals:

The SBIR activity provides opportunities to support all of the USDOT strategic goals. The selection of topics and projects is driven by the opportunity to advance the Department's goals. In particular, the SBIR activity leads to transformation through investment in innovations that can also improve safety, advance economic strength, ensure equity, support climate sustainability, and develop organizational excellence.

Collaboration Partners:

The SBIR program is coordinated internally within USDOT and methods and practices are shared with other modes through the Volpe center, which administers the SBIR programs for USDOT.

Chapter 2 – FY 2024 RD&T Programs

The AMRP FY 2024 outlook year chapter in the annual plan is not developed in alignment with the President's budget request of the same year due to the AMRP development schedule per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning.

Complete Trip- ITS4US Deployment Program

Program Description:

The Complete Trip - ITS4US Deployment Program is a multimodal effort led by the Intelligent Transportation Systems Joint Program Office (ITS JPO) with support from the Office of the Secretary of Transportation (OST), Federal Transit Administration (FTA), and Federal Highway Administration (FHWA). The Program makes $40 million available to enable communities to showcase innovative business partnerships, technologies, and practices that promote independent mobility for all travelers. The Program leverages innovative technologies and facilitates public private partnerships to allow for a traveler-centric approach that improves mobility options for all travelers, including travelers with disabilities, travelers from rural areas, and lower income travelers.

Building from the USDOT's previous and ongoing foundational research work in concert with emerging technologies, practices and other critical inputs gathered from all sources, the Complete Trip - ITS4US Deployment Program is designed to bring publicly and privately sponsored research together to create large-scale, replicable deployments that generate increased multimodal mobility options for all travelers regardless of location, income, or disability.

In order to address transportation needs of all travelers, and specifically travelers of transportation underserved communities, the entire trip from conception and planning to execution and from origin to destination must be considered. The USDOT has defined the Complete Trip Concept to capture the idea that a trip can be composed of several parts or segments and any individual traveler must be able to execute every part of their trip from origin to destination regardless of location, income, or disability. A complete trip can be made up on any combination of trip segments such as: trip planning, outdoor navigation, intersection crossing, boarding and using vehicles, transferring between vehicles, modes and payment services, using stops and stations, indoor and outdoor transitions, indoor navigation and completing travel to destination. The different segments the trip may have unique challenges that can be addressed to support a successful complete trip. If the infrastructure is not available or in a state of good repair or if one segment of the trip is inaccessible, unreliable or inefficient, then access to subsequent segments is broken, and

the trip cannot be completed. This Program will have local partners develop and deploy integrated mobility solutions to achieve complete trips for all travelers.

Major Program Objectives:
The Complete Trip - ITS4US Deployment Program aims to solve the mobility challenges of all travelers, regardless of location, income, or disability, in accessing jobs, education, healthcare, and other activities. The objective of this program is to develop multiple large-scale, replicable, real-world deployments of integrated innovative technologies to address the challenges of planning and executing complete trips.

- **Vision:** Innovative and integrated complete trip deployments to support seamless travel for all users across all modes, regardless of location, income, or disability.
- **Mission:** Facilitate the integration and deployment of emerging technologies, along with innovative and replicable, traveler-centric partnerships, business models and practices to foster reliable, spontaneous, independent, safe, affordable, accessible, and efficient mobility options for all travelers.

Anticipated Program Activities:
In FY24, the program will conclude Phase 2: Design and Testing., and successful Phase 2 teams will be eligible to move to Phase 3 for operations and evaluation. Phase 2 will be the designing, building, and testing phase and it is expected to take up 24 months. Phase 2 also includes the planning for evaluation of the deployment. The sites will focus on testing and operational readiness, and planning for maintenance and operations, as well as conducting training for staff and participants. In anticipation of Phase 3, sites will be fine tuning performance measurement and working with the IE. Teams will continue with active participation in Technical Roundtables to discuss and share technical issues and solutions. Other Roundtables will be scheduled and conducted to support cross-team sharing and discussion. Many of the sites are using open standards and are required to openly share code developed with federal funds. Sites will be participating in standards development organizations. In FY24, the program will continue stakeholder engagement and sites will continue outreach activities

Technical services activities in FY24 will include assisting USDOT in managing and integrating the portfolio of deployment projects ensuring that the projects produce actionable results while remaining on schedule and on budget. This includes, but not limited to, performing technical program management functions, including roadmap development, meeting coordination and note taking, quick-response scanning and on issues and challenges, assistance in stakeholder coordination and collaboration, developing technical templates and trainings (as required), validation and verification of other project deliverables, white paper development, drafting responses to data calls, and procurement life-cycle support. For FY24, a key effort will be observing testing and providing review and

feedback on test results to support the ITS JPO. This technical services support is needed to assist in oversight and management due to the complex technical nature of this program. If the program is going to be successful, additional technical services support is vital part of ensuring that occurs. Technical services support is envisioned to last the duration of the Complete Trip-ITS4US Deployment Program.

Independent Evaluation efforts will continue in FY24 with the IE focusing on five main efforts: reviewing site lessons learned logbooks; conducting performance results assessment; conducting interviews and questionnaires with the site teams and the USDOT staff supporting the program; conducting financial and institutional assessments of each site; and working on the national replication estimate. The USDOT program leadership and technical services support will provide review and comment on the reports.

Automation Program

Program Description:
Driving automation is one of the major transportation industry trends of this decade. Through close collaboration and monitoring of current industry and academic technology innovators and leaders in automation, the ITS JPO continues the pursuit of an automation program that will support the safe deployment of an automated future. Advanced Driver Assistance Systems (ADAS) with automation of lateral or longitudinal controls are widely available in passenger vehicles, although their development and refinement continue. Automated Driving System (ADS)-equipped vehicles are being piloted in passenger vehicles, commercial motor vehicles, and transit buses. While driving automation research has been, to some degree, mainstreamed across the Department's Operating Administrations, research needs are evolving alongside the technology. The technological and practical challenges of translating research breakthroughs into daily transportation are significant and often are not fully understood at the outset. Many foundational questions around ADS and ADAS cannot be resolved until more and better data are available. The ITS JPO Automation Program's collaborative and multi-modal research portfolio provides cross-cutting support across the USDOT.

Major Program Objectives:
Automation is a key component of the ITS JPO's Strategic Plan. The Program's goal is to enable safe, efficient, and equitable integration of automation into the transportation system. Research in FY24 will continue to support the federal role in automation by funding cross-modal research to facilitate the planning and execution of research on topics that span the information needs, capabilities, and interests of multiple operating administrations, as well as topics that are important to USDOT as a whole, but may not fit cleanly into the mission of a single agency.

Anticipated Program Activities:
Building on the FY23 research, the Automation Program will continue to coordinate automated vehicle cross-modal research in the following:

- Business Intelligence and Emerging Issues Analysis on Automated Driving System Testing and Deployment Tracking and Emerging Issue Analysis

- Research Coordination and Information Exchange through Automation Research Working Group Facilitation and Management, Research Product Dissemination, and External Engagement.

- Cross-Modal Research on Advanced Driver Assistance Systems (ADAS), Commercial Vehicle Automation Research, Work Zones, Vulnerable Road User Safety and Complete Streets, and Connectivity.

Emerging and Enabling Technologies Program

Program Description:
The Emerging and Enabling Technologies Program focuses on cultivating the next generation of transportation systems. As the scale of Intelligent Transportation Systems (ITS) increases and expands to become part of other industry IoT environments (i.e., smart cities), vehicle manufacturers, infrastructure providers, innovators, and entrepreneurs discover new opportunities to use technology and the data that will be generated. These technological advances, along with new functionality, new applications, new operational concepts, and disruptive innovations, need to be tracked and planned for by the USDOT. Current examples of these Emerging/Enabling technologies include Artificial Intelligence (AI), Next Generation Wireless Communications, Quantum computing, Blockchain, and others. All of these technologies have the potential to greatly impact transportation operations and create positive outcomes that are aligned with USDOT goals in *Safety*, *Economic Strength and Global Competitiveness*, *Equity, Transformation*, and *Climate and Sustainability*. In particular, this program recognizes the interdependence among the Department's strategic goals with respect to the introduction of new technologies. For example, this program addresses issues related to climate change and resilience by leveraging past and current research into new opportunities for technological innovation in this critical area. As such, there is a need to determine technological, market, and demographic trends across the globe and across industries to seek, evaluate and sometimes incubate emerging capabilities that demonstrate the potential to transform transportation. Moreover, it will be critical to evaluate potential risks posed by these emerging technologies, including where risks and/or benefits may inequitably impact citizens of different racial groups, socioeconomic backgrounds, or other demographic characteristics.

The USDOT will partner with the public, private and academic sectors to guide research, development, and technology adoption in a systematic manner. The USDOT recognizes the need to advance the adoption and use of emerging practices and technologies for transportation—particularly, where they play a key role in providing public benefits to Americans. The ITS JPO will coordinate and conduct investigations and exploratory research into emerging technologies across government, academia, and the private sector. This research will provide the USDOT with a significant understanding of the potential benefits and disruptions these technologies could represent to the transportation system. Through multi-modal coordination, the ITS JPO will work to avoid duplicative ITS work and to ensure the efficient allocation of ITS resources.

Major Program Objectives:
Artificial Intelligence: The AI for ITS Program's goal is to cost effectively build and deploy AI for ITS capabilities in real-world modal use. The objectives of the program are to:

- Engage stakeholders to assess current capabilities, gaps and needs, ongoing research and innovations, and impacts and effectiveness of leveraging AI.
- Foster research and innovation in AI techniques for transportation.
- Conduct small-scale demonstrations of early prototypes in real-world settings.
- Deploy high value use cases in real-world operational environments.
- Measure impacts of the prototype demonstrations and deployments.
- Identify policy issues and provide inputs and insights into AI-related policy development.
- Assess needs for AI-related standards and provide inputs to standards developing organizations.
- Facilitate collaboration among AI researchers and deployers.
- Disseminate insights, lessons learned, and potential benefits, to accelerate adoption of AI by agencies to advance next generation transportation systems and services.

Next Generation Wireless Connectivity/ Spectrum: This research program focuses on advancing the next generation of transportation systems. As emerging technologies offer the potential to enter the transportation environment, ITS JPO will evaluate their fit in meeting transportation needs and work with agency modes to extend resulting benefits from these technologies across the transportation system.

Given the magnitude of impacts that transitioning to the next generation communications can have on transportation, the ITS JPO proposes the establishment of a focused research initiative. Four proposed research objectives will continue to guide the program into the future, (1) institutional adoption of next generation communication technologies, (2) safety and security framework development, (3) public sector representation., and (4) climate change.

Anticipated Program Activities:
Artificial Intelligence: The ITS JPO's AI for ITS Program will continue to advance next generation transportation systems and services by leveraging trustworthy, ethical AI (including ML) for safer, more efficient, and accessible movement of people and goods. The AI for ITS Program will identify, develop, implement, evaluate, and coordinate technology and policy research to advance the contextualization and integration of AI (including ML) into all aspects of the transportation system. The AI for ITS Program will continue to cost effectively build and deploy AI for ITS capabilities in real-world modal use. The anticipated program activities in FY24 include:

- **Building and testing next generation ITS, leveraging mature AI-enabled ITS applications** to demonstrate the potential of AI for ITS in the short term. The goal is

to pilot transferable, scalable mature solutions that can be replicated and speed broader deployment across the nation.

- **Prototyping AI for ITS innovations** to support emerging AI for ITS capabilities for the longer term. This initiative will create the R&D foundation on which future, long-term deployments may be built.

Wireless Connectivity/ Spectrum: USDOT monitors and assesses wireless technologies and available devices to determine their capabilities to support a wide range of transportation system communications requirements regarding safety, effectiveness, and other capabilities. These technical research and assessment activities provide data-driven inputs to the USDOT policy decision-makers. In FY2024, the ITS JPO will have acquired the first set of 5G V2X prototypes and will be testing them. Notably, 5G is enabling the V2X communications to be delivered through a broader set of technologies and processes including the use of multi-access edge computing (MEC), public infrastructure network nodes (PINNs), new robotics, and other evolutions on the vehicle-to-vehicle and vehicle-to-infrastructure exchanges. ITS JPO expects that the industry partners creating these varying, emerging beta-version technologies will seek participate in the 5G V2X laboratory and field testing, giving the USDOT and deployers a broader set of options regarding how connectivity might be defined for transportation.

In developing our emerging technology research initiatives, we will continue looking at technology neutral approaches to support fair market competition, understand the liability implications, consider privacy, bias and ethics, and impacts on the workforce.

Environment/Climate Change: Based on the strategic priorities outlined by the Office of the Secretary, development and testing of innovative and transformational transportation technologies to address climate change goals will also be a focus of this program.

Cybersecurity for Intelligent Transportation Systems (ITS) Program

Program Description:
The USDOT cooperates across a diverse range of stakeholders to conduct research to address ITS cybersecurity needs. In addition, the USDOT works to support secure ITS deployments and to develop the necessary cybersecurity culture among deployers that is essential for secure and resilient ITS deployments.

Security and resiliency are a necessary precondition to deploy and maintain societal benefits of interoperable, safe, effective and efficient ITS operations. To facilitate secure, nationwide interoperable ITS, the USDOT ITS Cybersecurity Research Program supports research needed to facilitate adaption and implementation of cybersecurity best practices across diverse ITS infrastructure deployments. These efforts can then in-turn be adopted by the diverse community of Infrastructure Owner Operators (IOO) including SLTT agencies, private and public-private facility operators as well as vehicles and other mobile participants in the transportation system. Individual IOOs often have limited capabilities in this area; USDOT led collaboration can facilitate bringing options to stakeholders to use in their planning and operations of their system as well as any recovery needed from a cyber-attack. This remains a complex and evolving challenge - ITS system architectures are systems of systems that vary greatly across jurisdictions, with diverse current approaches to security and a broad range of equipment in service – some new, some decades old. Cybersecurity considerations are an essential part of good engineering practice, and thus should be included in any transportation systems deployment. The ITS Cybersecurity Research Program seeks to address ITS cybersecurity needs, supporting the development and deployment of secure, well-engineered ITS systems that maximize the public benefits of ITS.

Major Program Objectives:
The overall objectives for the USDOT's ITS Cybersecurity Research Program are to advance the research and assessment into emerging cybersecurity technologies to evaluate their suitability and effectiveness within a transportation environment. The Program will also work with the Federal Highway Administration and SLTT stakeholders to develop measures of effectiveness in order to compare and assess SLTT cyber posture. In addition, the program will continue to support the widespread implementation of cybersecurity best practices, and to provide the capabilities for deployers to assure that ITS deployments remain secure. This security is a necessary precondition for their efficient, effective and safe operation. ITS systems need to be both resistant to cyber-attacks and resilient, allowing for a quick recovery from cyber-attacks that are not prevented. Complex Information and Communications Technology (ICT) systems, of which ITS is one example, require extensive and adaptive technical and institutional solutions to remain both

appropriately secure and sufficiently resilient to recover from attacks and other disruptions.

Anticipated Program Activities:
The Cybersecurity for ITS Research Program will continue to adapt and leverage ICT best practices to benefit the unique requirements of ITS, identify and fill-in gaps including completing an investigation into 5G V2X cybersecurity capabilities among other technologies, and support implementation of best practices across ITS deployments:

- Conducting research needed to adapt evolving cybersecurity best practices to ITS infrastructure, connectivity, and automation deployments and to develop and make available tools and deployment support to enable secure ITS deployments.
- Conducting Professional Capacity Building, outreach and deployment support needed to help IOO and other ITS deployers apply cybersecurity best practices to their own ITS deployments and to evolve an appropriate cybersecurity culture and needed internal capabilities.
- Developing end-to-end reference implementations for secure delivery of key ITS services to support large scale replication and implementation along with candidate approaches to manage secure Nationwide interoperability.
- Continuing to support the development of ITS standards along with identification and adaption of ICT standards and to meet the evolving threat landscape.
- Evolving the ITS reference architecture to expand security-related content and to remain consistent with evolving cybersecurity best practices and available standards.

The program will continue to be executed in cooperation with the broad stakeholder community and will remain flexible to meet unanticipated needs and changing priorities.

Accelerating ITS Deployment

Program Description:
As new Intelligent Transportation Systems (ITS) technologies and systems evolve into market-ready products, the primary goal of the Accelerating Deployment Program is to provide research, analytics, and services that support adoption and deployment of ITS technologies. The objectives of the Accelerating ITS Deployment Program are: (1) to speed up the transformation of ITS research and prototypes into market-ready technologies that are commercially viable and adopted by the transportation community, and (2) to provide the ITS community the tools needed for successful and interoperable deployment of ITS technologies and systems across the nation. The Program directly supports advancing ITS research and deployment activities from a full-lifecycle perspective, from initial deployment planning through to actual deployment and eventual assessment in coordination with other stakeholders at the federal, state, regional and local levels.

The Accelerating Deployment Program provides a wide variety of resources and services to assist the ITS community of practice throughout the ITS deployment lifecycle, including:

- Extensive quantitative data on ITS benefits, costs, and levels of deployment, to support data-driven and evidence-based deployment decision-making
- Communication and education support to facilitate awareness, understanding, acceptance, adoption, and deployment of ITS technologies across stakeholder groups and to ensure effective partnerships are fostered and developed at various levels – executive, program, and project.
- Knowledge transfer, technical assistance, training, outreach, and extensive interaction opportunities between and among ITS deployer communities
- Support for the development and use of ITS-related standards and architectures to ensure the interoperability of ITS deployments

Major Program Objectives:
The objectives of the Accelerating Deployment Program are to define and improve data driven and evidence-based decision making, collaboration and communication mechanisms to encourage public and private investment; to develop comprehensive cost benefits and analytic tools that allow deployers to understand the financial and operational benefits of new technologies and systems; and to establish the tools that support the new user base. The Program is also tasked to develop and evolve a comprehensive National ITS reference system architecture to support large scale interoperable ITS infrastructure, connected vehicle, and connected automation deployments across the nation – especially across borders with Canada and Mexico; to develop and maintain an inventory of candidate interfaces for standardization and support standards development efforts for interfaces

where there is greatest public interest and benefit, including those interfaces required to support regulatory activity; to cooperate internationally, leveraging common interests to reduce US resource requirements, access broader expertise, speed development and harmonize architecture and standards to support an international marketplace for US vendors; and to facilitate availability of testing and certification processes and procedures. A final goal of the program is to ensure that the technical research conducted by ITS JPO is easily accessible and understood by stakeholders and the general public through the development of easy-to-understand content., which relies both upon the ITS outreach and communications efforts as well as the ITS Professional Capacity Building program efforts.

Anticipated Program Activities:
In FY24, the ITS PCB Program will continue to expand the online, on-demand training offerings for both the internal and external transportation workforce. Expanding the offerings available will reach a broader audience. Working with the National Highway Institute, academic community, and other training partners, activities will include converting in-person ITS workshop materials and existing courses to online opportunities in a variety of formats (i.e. microlearning). Expanding the online presence of the ITS PCB Program will increase learning opportunities for the current and future transportation workforce including student, rural, and tribal audiences. The ITS PCB Program will continue to build community building efforts in that additional cohorts are developed, and peer exchanges are offered for the purpose of information exchange and a forum in which to provide technical assistance.

In FY2024, the Deployment Evaluation Program will continue to improve the operation and content of the benefits/costs/lessons learned databases and experiment with new, innovative ways to present these data to the public. This would include continuing to create and develop compelling data products and decision-making and planning tools to support ITS stakeholders in their efforts to make evidence-based decisions about ITS investments at all stages of the ITS deployment lifecycle. The Deployment Evaluation Program will complete the FY2023 Deployment Tracking Survey and begin analysis of and reporting on the results of that survey.

The Deployment Evaluation Program will also continue its long-term strategic effort to provide data-driven and evidence-based products and services to the ITS stakeholder community and continue to address a full spectrum of stakeholder needs related to the foundational elements of successful ITS deployment and the full ITS deployment lifecycle

Planned activities in the areas of communications and outreach include a return to in-person meetings and events, and the kickoff of a new transportation technology educational program aimed at today's college students.

Planned activities in in the Interoperability Program Area of Accelerating Deployment include building from the 9.1 release in 2022 of the National ITS reference system architecture to more fully accommodate the emerging automation technologies, additional connectivity services, new viewpoint formats to speed SLTT design of their regional and project architectures, new automated tools that produce system-engineered ITS detail-requirements and specifications, new tools for SLTT to develop verification and validation plans, and incorporation of new or evolved standards based on advances in new ICT technologies such as 5G which are becoming available in the marketplace. Cooperating internationally, further work will be undertaken to specify access controls for ITS environments to meet cybersecurity needs; and to develop voluntary technical standards and candidate system architectures to support the secure communication of road signage and regulatory information to automated and connected vehicles. Interface standards to support V2X and cooperative automation plus digital infrastructure initiatives will be continued. Standards for improved connectivity services will also improving security and connectivity options of legacy ITS infrastructure equipment installations. Additionally, standards updates to address changes in wireless spectrum policy are expected. Program efforts will continue to be informed by extensive collaboration with stakeholder groups and Standards Development Organizations (SDO) to assure that products that are developed meet stakeholder needs in broadly acceptable way to facilitate voluntary deployments.

Data Access and Exchanges Program

Program Description:
This research area facilitates effective generation, acquisition, governance, management, and analysis of ITS data and code across all modes to advance the state of multimodal ITS research and enable deployment of innovations in operations. This, in turn, increases return on federal investment in research and demonstration projects and accelerates multi-modal, data-driven, trusted evaluations of potential safety, mobility, and other benefits to inform future policy and investment decisions. While enabling broader ITS research and deployment activities, these investments drive implementation of various Federal and USDOT directives on increasing access to data, source code, and federally funded research results.

Major Program Objectives:
Consistent with the ITS JPO Strategic Plan, this research area will continue to help identify, prioritize, monitor, and – where necessary – address multi-modal data exchanges across traditional organizational boundaries.

Anticipated Program Activities:
Assets and Governance (sub-program area) – ITS JPO anticipates that activities in FY2024 will be analogous to activities in FY2023. Whether an increase in funding for data and code storage and storage capabilities is needed in FY2024 will depend on the nature of the research projects launched in FY2021 - FY2023, since new area types of research may produce novel forms of data and source code.

The program will continue to work with the ITS JPO PCB program to develop additional courses and modules necessary to support implementation of the Department's public access requirements, as well as building a transportation workforce knowledgeable in best practices for data and code management, particularly in emerging areas of application to the transportation industry.

Additionally, in FY2024, the Data Access and Exchanges Program will prepare for and release a procurement to collect and document a high-value dataset to support cutting edge ITS research, like the highly successful Next Generation Simulation (NGSIM) efforts conducted in the early 2000s that transformed transportation modeling. This effort will be coordinated with modal partners to ensure this will help to support their relevant research efforts and goals.

Data Exchanges (sub program area) – ITS JPO anticipates that activities in FY2024 will be analogous to activities in FY2023. The new data exchange identified in FY2023 use cases and requirements development work will likely result in a new project to develop an initial

version of a specification or a significant update or extension to an existing standard or specification to address those use cases and requirements in FY2024.

Advanced Transportation Technologies and Innovative Mobility Deployment (ATTIMD)

Program Description:
The ATTIMD is statutorily required in the Infrastructure Investment and Jobs Act, Section 13006, 23 U.S.C. 503(c)(4). The ATTIMD grants are managed by FHWA and the ITS JPO contributes a mandated percentage of funding through FHWA to annually satisfy the requirement.
The language provided here duplicates the language provided in the FHWA AMRP for consistency.

The Advanced Transportation Technologies and Innovative Mobility Deployment Initiative (ATTIMD) Program is intended to provide funding for eligible entities to develop model deployment sites for large scale implementation and operation of a diverse set of technologies in various geographic regions. As the program is aimed at the rapid deployment of advanced technologies, limited expenditures for infrastructure construction is anticipated in grant application. The stated purpose is to reduce costs and increase return on investments; deliver environmental benefits through increased mobility; enhance transportation system operations; improve safety; improve collection and dissemination of real-time information; monitor transportation assets; deliver economic benefits; and accelerate deployment of connected and automated vehicle technologies. Successful proposals will contain quantifiable system performance objectives, use innovative technologies and strategies, and a plan for long term operation and maintenance of the deployed technologies. The U.S. Department of Transportation (USDOT) encourages partnering among the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders.

Major Program Objectives:
The USDOT's vision for the ATTIMD initiative is the deployment of advanced technologies and related strategies to address issues and challenges to safety, mobility, efficiency, system performance, intermodal connectivity, and infrastructure return on investment that are confronted by transportation systems owners and operators. The advanced technologies are integrated into the routine functions of the location or jurisdiction, and play a critical role in helping agencies and the public address their challenges. Management systems within transportation and across other sectors (e.g., human services, energy, and logistics) share information and data to communicate among agencies and with the public. These management systems provide benefits by maximizing efficiencies based on the intelligent management of assets and the sharing of information using integrated technology solutions. USDOT shares the advanced technology solutions and the lessons learned from their deployment with other locations, scaled in scope and size, to increase successful deployments and provide widespread benefits to the public and agencies.

Anticipated Program Activities:

In FY24, the ATTIMD program will request proposals for new grant awards, complete the awards under the previous solicitation, and manage the existing grant awards.

Additionally, the program will publish the ATTIMD annual report as mandated by the IIJA.

Small Business Innovation Research (SBIR)

Program Description:

The SBIR program is administered by the Volpe Transportation Center and managed by the FHWA with funding from the ITS JPO. The SBIR activity is a highly competitive, awards-based activity that encourages domestic small businesses to engage in R&D addressing high-priority research areas within USDOT. SBIR favors research that has the potential for commercialization through products and applications sold to the private sector transportation industry, State DOTs, USDOT, or other Federal agencies. Funding amounts for SBIR activities are established by law, as noted in the Defense Reauthorization Act (Sec. 5102(a)(1)). Each year, Federal agencies with extramural R&D budgets at the Department level that exceed $100 million are required to allocate 3.2 percent of their R&D budget to these programs.

Major Program Objectives:

To encourage small businesses to engage in research and development (R&D) that has the potential for commercialization and meets federal R&D objectives. The SBIR program is uniquely positioned to support both the interests of USDOT as well as the small business. In this respect, the SBIR programs aims to provide essential funding to small businesses with aim toward commercialization of products that align with ITS JPO, FHWA and Departmental Strategic goals. Given that the SBIR program is available to all ITS JPO and FHWA RD&T programs, all USDOT Strategic goals are supported as a result.

The SBIR program offers unique services to the small businesses to aid in their technical and commercial development. Specifically, the SBIR program offers a Commercialization Assistance Program to provide consulting services to the SBIR participants to help conduct market research, commercialization plans, and other services. In addition, in FY24 the SBIR program will continue with a Technology Readiness Level (TRL) assessment program to help the Small Businesses conduct an independent assessment of the technological status of the innovations developed through the SBIR program.

Anticipated Program Activities:

In FY24, the SBIR program will participate in the annual solicitation of topics and support current Phase I, II, and IIB projects. Additionally, the SBIR program will continue with the Technology Readiness Level (TRL) Assessments at the end of Phase II.

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