United States Department of Transportation
Annual Modal Research Plans FY 2021
Program Outlook FY 2022

Intelligent Transportation Systems Joint Program Office (ITS JPO)

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Chapter 1. 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 mission of the U.S. Department of Transportation (USDOT) is to ensure our Nation has the safest, most efficient and modern transportation system in the world, which improves the quality of life for all American people and communities, from rural to urban, and increases the productivity and competitiveness of American workers and businesses. 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 the USDOTs Strategic Goal on Innovation, which is to "lead in the development and deployment of innovative practices and technologies that improve the safety and performance of the nation's transportation system." 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.

Within the context of the Department's strategic goals and research priorities, the ITS JPO's work specifically focuses on the Innovation Strategic Goal, while also assisting modal partners in meeting the goals for Safety, Infrastructure, and Accountability. To fulfill its mission, the ITS JPO is guided by the ITS JPO Strategic Plan 2020-2025 which 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 greatest public benefit from transportation's increasing technological transformation. The ITS JPO is responsible for coordinating the ITS Program and 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 St. Lawrence Seaway Development Corporation (SLSDC). In addition, close collaboration with current industry and academic leaders in technology and innovation is a cornerstone of the ITS Program. The research builds on and leverages the technology and applications developed across all modes delivering cross cutting research activities and technology transfer that support all modes in the USDOT.

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. The Program will make up to $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 travel needs 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 mobility and congestion-reduction benefits in addition to vehicle-level improvements in safety, comfort, and convenience.

The ITS JPO Automation Program's collaborative and multi-modal research portfolio provides cross-cutting support to the USDOT Research Priorities, including Performance Based Regulations and Safety, Improving the Mobility of Freight, Feasibility of Micro-Transit, and Improving Mobility for Underserved Communities. Through the development of cooperative and standards-based 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 are needed to 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. *USDOT Strategic Plan FY 2018 – 2022* stated that "DOT will encourage the adoption of the National Institute of Standards and Technology (NIST) Cybersecurity Framework by transportation ecosystem stakeholders."

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, Tribal, Territorial and local 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 Cybersecurity Program supports the USDOT cybersecurity research priority. This research maps to the Cybersecurity Research Working Groups team scope and annual goals to close gaps, facilitate information sharing, and the use of common risk models. This research will be coordinated with our modal partners, and includes areas such as the adaptation of the NIST Cybersecurity Framework for the transportation sector. The research will facilitate developing the capacity of our partners and will inform the skilled workforce that the USDOT must support to proactively and effectively investigate and facilitate the implementation of sound 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 of ITS installations and operations Nationwide.

The ITS JPO is uniquely positioned to work across the USDOT with our modal partners to develop and coordinate multimodal projects that are central to cybersecurity research. These efforts should

include 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.

Communications technologies – both wired/fiber and wireless - are critical to the safe, secure, and efficient operations of ITS. Transportation agencies have incorporated communications into their operational environments (i.e., field systems, management centers, and public fleets), and vehicle manufacturers are increasingly including multiple types of wireless communications capabilities on their vehicles. These emerging communications technologies will continue to have significant impacts on the transportation system. The USDOT has an important role to play in pursuing research and analysis around emerging transportation technologies and their use of telecommunications to deliver public benefit. USDOT's role allows State and local agencies to confer with telecommunications experts and to translate use cases and requirements that cross market boundaries and ensure interoperability.

The Emerging and Enabling Technologies Program primarily focuses on identifying, assessing, and implementing new technology such as Artificial Intelligence (AI) in ITS as well as data/computing resources needed to promote AI for further investigation by the ITS JPO and our modal partners. Likewise, communications technologies are critical to the safe, secure, and efficient operations of ITS such as DSRC, C-V2X, and 5G. This research will provide USDOT with a significant understanding of the potential benefits and disruptions these technologies could represent to the transportation system.

Spectrum is a crucial resource needed to facilitate the exchange of vast data quantities that support cutting-edge technologies from autonomous 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, policy, legislation, operations, and economics.[2] Transportation agencies have incorporated communications into their operational environments (i.e., field systems, management centers, and public fleets), and vehicle manufacturers are increasingly including multiple types of communications into their vehicles. These emerging communications technologies will continue to have significant impacts on the transportation system. The USDOT has an important role to play in pursuing research and analysis around emerging transportation technologies and their use of telecommunications to deliver public benefit. USDOT's role allows State and local agencies to confer with telecommunications experts to understand requirements that cross market boundaries and ensure interoperability.

Under the Emerging/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

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

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. In conjunction with research priorities in the U.S. Department of Transportation (USDOT) Strategic Plan (2018-2022)[4], the Intelligent Transportation System Joint Program Office (ITS JPO) is seeking to consider prioritizing R&D research with a focus on AI in ITS as well as data/computing resources need to promote AI per the Executive Order. Moreover, the ITS JPO Strategic Plan[5] has established AI in Intelligent Transportation Systems (ITS) as Emerging and Enabling Technology research area.

The Data Access and Exchanges Program focuses on enabling access to core transportation data across the ITS ecosystem, including data and source code generated through the USDOT's ITS research investments, to accelerate deployment of new ITS technologies, cut the time from research to insight and policy-making, and drive secondary research results. 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 FY2020, the ITS JPO incubated a consultative Research Data Access implementation support team and technical platforms to enhance access to data and source code produced through multi-modal ITS research investments. In FY2021, the ITS JPO will hand off mature capabilities to the appropriate long-term owners within the Department and shift to being users of, and investors in, these capabilities. 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 helping the ITS JPO to reexamine the role of ITS Deployment Evaluation overall, with the express goal of integrating it far deeper into the ITS JPO research program, particularly with our modal partners and across the Department as a whole by expanding, fine-tuning, and focusing the analytical capacity to make this happen.

One example of this is the intent to build evidence-based decision-making capacity both inside and outside of USDOT and accelerate early-stage ITS deployment. The timing is right to support early-stage ITS deployers and build a knowledge-based community of practice to support these efforts to the greatest extent possible and focus on evaluation, performance measurement, and knowledge transfer. This collaboration across USDOT will support evidence-based decision making for ITS across modes, support internal USDOT experts and their stakeholder partner relationships, and provide potential contractor support for certain multi modal efforts.

Another example is the intent of the ITS JPO, through the ITS Deployment Evaluation Program, to not only continue to generate data and analysis related to the benefits, costs, and extent of deployed

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[3] https://www.whitehouse.gov/presidential-actions/executive-order-maintaining-american-leadership-artificial-intelligence/
[4] https://www.transportation.gov/dot-strategic-plan
[5] An internal document which is currently under review for approval so it will be provided at a future date

ITS but, also begin a long-term strategic effort to clearly articulate for our stakeholders the success stories of ITS.

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 undertake an intensive analysis of those data in order to show quantitatively the benefits of proven ITS technologies and guide the ITS JPO on how best to accelerate ITS deployment of newer technologies.

The ITS JPO would start by undertaking a retrospective analysis of the deployment of now-mainstreamed ITS technologies to:

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

It is the intent that, by doing these things, the ITS JPO can tell a clear and compelling story of success to the American public.

The ITS JPO is the USDOT'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 partners 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 partnership. 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, or procurement designs. 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.

Interoperability – allowing transportation systems users to access ITS services anywhere they may travel – is essential to maximize safety and mobility benefits from rapidly advancing ITS technologies. To support interoperability, ITS JPO maintains and evolves a reference system

architecture along with companion software tools and supports the development of ITS standards to enable efficient, safe and secure ITS deployments. ITS JPO cooperates with stakeholders to evolve this architecture reference – currently supporting tailorable implementations of over 130 ITS services – to accommodate, and when appropriate lead, technological evolution. ITS JPO cooperates with stakeholders to develop needed ITS 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. ITS JPO also provides architecture and standards technical support including reference implementations of key standards to assist State, Tribal and Territory as well as local 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 to continue support of cross-border and North American interoperability efforts and to seek to maximize benefits of multi-regional approaches to architecture and standards.

By constantly engaging with the transportation industry and maintaining ties with national and international practitioners, the ITS JPO research efforts identifies transportation problems worth solving and facilitates our engagement within the transportation industry to address market failures including system safety, multimodal improvements, interoperability, underserved populations, and other long-term challenges. The ITS JPO Program Categories align with the USDOT Research Priorities.

Along with undertaking research and development activities, another major component of USDOTs long term planning is understanding the past and present of ITS in practice, and this understanding has continually been achieved via the ongoing ITS Deployment Tracking Survey. The ITS Deployment Tracking Survey has been conducted since 1997. It was created and administered to track and manage progress toward a ten-year ITS deployment goal set by the Secretary of Transportation in 1995. The Deployment Tracking Surveys have consistently measured ITS Deployment through a set of indicators related to the major functions of ITS infrastructure components, with a separate set of indicators tracking ITS support for interagency integration. These indicators have historically been used to better understand which agencies tended to need additional encouragement in adopting ITS and integrating their deployments with neighboring agencies and jurisdictions. The survey has also been instrumental in understanding trends in deployment technologies and emerging priorities in agencies' deployment plans.

As ITS technologies continue to evolve and adapt in the coming years, the targeted research and development undertaken by the ITS JPO will continue to serve as a proving ground and accelerator for multimodal efficiency, safety, and reliability of surface transportation systems.

To build on our efforts and bridge the ITS policy gap the ITS JPO will support economic analysis to identify trapped value accumulated through years of ITS research and deployment and to highlight the benefits of research into new transportation technologies. Key focus areas for ITS economics analysis include the impact of mobility services and automation on the many facets of transportation.

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 chairs/co-chairs four working groups:

1. Automation (Safety): 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 (Innovation): The goal of this working group is to "Advance the development of emerging/enabling practices and technologies."
3. Data (Accountability): 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 (Innovation): the goal of this working group is to "Develop approaches for maintaining the cybersecurity of the transportation system."

COVID-19 Statement

In light of the coronavirus (COVID-19) pandemic, the mission of ITS JPO has never been more critical. We recognize that an intelligent and effective transportation network is crucial to maintaining the free flow of essential supplies, food, fuel, and medical equipment and personnel. Intelligent transportation technologies are even more relevant in the midst of uncertainty and change. ITS helps our communities continue to adapt and thrive. The ITS JPO's research embodies initiatives that address our country's pandemic response challenges and enable a smarter, stronger, more capable transportation system as specifically outlined below:

Complete Trip- ITS4US

- *Improving Accessibility for transportation underserved communities*: 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 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. COVID-19 is exacerbating the challenges these groups have when using transportation. For example, use

of drive-up testing, reliance on paratransit services, limited service times for transit, and reductions of on-demand mobility services present real hurdles. ITS solutions such as assistive technologies, ride-sourcing, and technology enabled wayfinding and navigation can increase travel independence.

Automation

- *Enabling Contactless Delivery of Goods*: Driverless vehicles could respond to increased demand for home delivery of goods and the simultaneous need for physical distancing. Limited demonstrations of driverless delivery services have been introduced during the pandemic.

Emerging and Enabling Technologies

- *Using Communications and Spectrum for Emergency Vehicles:* The ITS JPO provides the USDOT modal partners and the transportation community with analysis on wireless capabilities for transportation technologies that enable innovative changes related to safety, mobility, and system efficiency of all vehicles. During emergencies, these communications play an important role in enabling the public safety community to respond faster to incidents while increasing their own safety. We are testing the most recent forms of communications (cellular vehicle-to-everything and, when it becomes available, 5G) to determine if they can support transportation needs now and in the future.

- *Understanding New Traffic Patterns:* Artificial intelligence (AI) and machine learning offer new ways to collect and analyze data, allowing us to better and more rapidly understand shifts in travel patterns. Moreover, AI in transportation can offer us better tools to manage shifts and surges in demand due to pandemic safety concerns; address potential safety issues in critical transportation infrastructure; and maintain safe operations during periods of crisis or change.

Cybersecurity for ITS

- *Securing Infrastructure:* We are increasing cybersecurity research on best practices and solutions that can be implemented across broad and diverse ITS deployments. We are identifying appropriate standards to secure critical information flows within the ITS reference architecture and continually improving our products to accommodate expanding user needs.

Accelerating Deployment

- *Analyzing the Impact of COVID-19 and ITS*: The ITS JPO has been collecting data on the benefits, costs, and extent of deployed ITS for over 20 years. Moving forward, JPO data collection and analysis efforts might, over time, offer insights on how the pandemic may or may not have affected agencies' perceived benefits of ITS, and the role the pandemic may have played in agencies' decisions on whether to invest in new ITS deployment.

- *Shifting to Virtual Support:* Already a telework capable office, in response to the COVID-19 required separation, our ITS Professional Capacities Building (PCB) Program has nimbly

shifted planned in-person regional workshops to a series of online workshops. We are also accommodating the increased demand for online training and virtual web rooms for knowledge sharing and technology transfer.

ITS Data Access and Exchanges

- *Analyzing Pandemic Impacts:* Our data program is exploring options for sharing data, analytical results and methodologies among internal and external stakeholders helping us understand pandemic impacts on the transportation system and informing response and recovery decision- making.

The U.S. Department of Transportation is working to keep Americans safe and our nation's transportation systems operating smartly. The ITS JPO research focuses on interrelated ITS concepts applicable across the department. At the ITS JPO, we work closely with our partners to research, develop, demonstrate and accelerate deployment of innovative technologies, ensuring our transportation network continues to serve our communities—helping Americans carry on their daily lives through unprecedented challenges.

Self-certifying Non-duplication

The ITS JPO certifies non-duplication of efforts through two primary multimodal collaborative efforts. As stated previously, utilizing the USDOT topical research working groups we coordinate existing and new research needs across the department to guard against duplication of research efforts, and provide a resource for the modes and DOT leadership on ITS research topics. Also, the ITS JPO actively coordinates the ITS Program and initiatives among 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 St. Lawrence Seaway Development Corporation (SLSDC). This close collaboration includes building awareness of current industry and academic leaders research activity in technology and innovation and is a cornerstone of the ITS Program. The ITS JPO's RD&T activities are non-duplicative with known prior and current projects within the ITS JPO office.

Section 1 – Program Descriptions, FY 2021

FY 2021 RD&T Program Funding Details

RD&T Program Name	FY 2021 Enacted ($000)	FY 2021 Basic ($000)	FY 2021 Applied ($000)	FY 2021 Development ($000)	FY 2021 Technology ($000)
Complete Trip - ITS4US			$9,750		
Automation			$10,665		
Emerging/Enabling Technologies			$9,495		
Cybersecurity for Intelligent Transportation Systems			$5,210		
Accelerating Deployment			$28,820		
Data Access and Exchanges			$6,110		
Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)					$21,000
Small Business Innovation Research (SBIR)			$2,200		
Program Support			$6,750		
Totals	**$100,000**		**$79,000**		**$21,000**

FY 2021 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2021 Enacted ($000)	SAFETY ($000)	INFRA-STRUCTURE ($000)	INNOVATION ($000)	ACCOUNT-ABILITY ($000)
Complete Trip - ITS4US				$9,750	
Automation				$10,665	
Emerging/Enabling Technologies				$9,495	
Cybersecurity for Intelligent Transportation Systems				$5,210	
Accelerating Deployment				$28,820	
Data Access and Exchanges				$6,110	
Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)				$21,000	
Small Business Innovation Research (SBIR)				$2,200	
Program Support					$6,750
Totals	**$100,000**			**$93,250**	**$6,750**

Chapter 2 – FY 2021 Program Descriptions

Complete Trip- ITS4US Deployment Program
Funding Request ($9,750,000)

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 will make up to $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 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.

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.
4. *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.

Anticipated Program Activities:

The Complete Trip-ITS4US Deployment Program intends to fund multiple large-scale, replicable deployments of integrated innovative technologies to address the challenges of planning and executing all segments of a complete trip.

The program is conducting deployments through a phased approach with decision gates at the end of each phase. The program has been conducting program planning and pre-procurement activities including stakeholder engagement and drafting a solicitation for the Phase 1 concept development. Starting in FY21, the program will begin Phase 1 which includes the complete trip concept development and system requirements. In out years, the successful service deployment sites will have an opportunity to move into phase 2 (design and test) subsequently into phase 3 (operations and maintenance) with potential cost sharing.

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.

This program also includes continuous outreach and stakeholder engagement activities and technical services support activities providing visioning, program management, project technical

assistance and procurement support. The technical services support work includes assisting in managing and integrating the portfolio of deployment projects ensuring that they produce actionable results while remaining on schedule and on budget, provide program management functions including roadmap development, meeting coordination, quick-response scanning and acquisition expertise for the later phases of the program.

In FY20, the USDOT drafted and is releasing a Broad Agency Announcement (BAA) for procuring the work for the Phase 1 Concept Development. In FY21, the program will conduct work for Phase 1, the structured development of a deployment site concept, to prepare for later phases of activity in which the envisioned system can be systematically designed in detail, built, tested, operated, maintained, and used to support evaluation.

In FY21, the program will continue stakeholder engagement and outreach activities and begin the independent evaluation activity as the deployment teams being concept development.

Technical services activities in FY21 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, validation and verification of other project deliverables, 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 a vital part of ensuring that occurs. Technical services support is envisioned to last the duration of the Complete Trip-ITS4US Deployment Program.

Expected Program Outcomes:
The flagship effort of the Complete Trip Program will be the demonstration of a "Complete Trips for All" for one or more underserved populations. In 2020 the USDOT drafted a Broad Agency Announcement (BAA) for the development of Complete Trip-ITS4US Deployment Concepts addressing the needs of all travelers regardless of location, income, or disability that will be released in the summer of 2020 and awarded in the fall of 2020. An Independent Evaluation of the demonstration will run concurrent with the program.

The goals of the Complete Trip-ITS4US program are to:

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 pilot deployments. High impact, replicable, integrated solutions developed by pilot deployments will reduce the cost of future deployments of these critical personal mobility enhancements.
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.

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.

4. Measure 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.

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.

The Complete Trip Program supports the USDOT mobility/underserved communities research priority. The research maps to the mobility research working group's scope and annual goals to address market failures associated with transportation for all travelers, including travelers with disabilities, travelers from rural areas, and lower income travelers. This research will be coordinated with our modal partners across multiple agency disciplines and will develop the capacity of our partners to make improvements in this often-overlooked area.

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 three new programs: The FTA's Mobility for All Pilot Program, the Inclusive Design Challenge, and this Complete Trip - ITS4US Deployment Program. This effort would also glean 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
Funding Request ($10,665,000)

Program Description:
The ITS JPO, in collaboration with FHWA, NHTSA, FMCSA, FTA, MARAD, and other USDOT modes, as well as State and local public agencies, academia, industry, and other surface transportation stakeholders, will conduct automation research that has the potential to transform safety, mobility, energy, and environmental efficiency; increase productivity; and facilitate freight movement within our nation's transportation system. Many of the activities in this program will be executed by modal partners and some will be jointly funded with them.

The ITS JPO's automation research is a component of the USDOT's vision of supporting the safe, reliable, efficient, and cost-effective integration of automation into the broader multimodal transportation system.

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. To achieve this goal, the research in FY 2021 will support the federal role in automation by funding cross-modal research in vehicle automation safety, infrastructure and interoperability, and policy analysis.

Anticipated Program Activities:
The Automation Program coordinates cross-modal research and builds on FY20 activities to achieve program objectives. It also provides a platform for internal USDOT research coordination and exchange, contributing to better outcomes across the Department.

Safety activities will improve understanding of safe automated vehicle operations and generate actionable data and decision support results for the broader stakeholder community. Human factors research, such as simulator or naturalistic driving studies, is fundamental to safety. The ITS JPO will partner with NHTSA, FHWA, and FMCSA to support this research. Together, we will continue to study automated vehicle safety issues related to transportation system management and operation, highway infrastructure, and vehicles.

Infrastructure and Interoperability activities will support the safe interaction of automated vehicles among themselves, with other road users, and with highway infrastructure. The ITS JPO will partner with FHWA, FMCSA, MARAD, and FTA to develop and test cooperative driving automation (CDA). CDA enables the machine-to-machine sharing of information that will enable roadway and port infrastructure users (e.g., vehicles, traffic signals, and mobile devices) to operate more efficiently and improve safety with a goal of improving transportation system performance and potentially reduce cost of new construction by maximizing current infrastructure capacity limited today by human drivers. This program will support expanded stakeholder collaboration activities to develop and implement industry standards for CDA.

Policy Analysis activities will assess the impacts of automated vehicles on the general public and identify and evaluate critical issues related to automated vehicle adoption. Automated vehicle technology development continues to advance at a rapid pace, requiring a nimble and coordinated approach to policy development. The ITS JPO will lead Departmental research efforts in system dynamics (SD), which allows analysts to use simple causal interactions within a complex system to build a model that can demonstrate and quantify not-so-evident dynamic behavior. SD models are part of the strategic modeling toolbox, as they are aggregate, fast models that can provide essential insights for other strategic planning models. ITS JPO will partner with FHWA and FMCSA to collect field data on CDA and other automated vehicle operations to improve ongoing analysis, modeling, and simulation (AMS) development.

Expected Program Outcomes:
Safety outcomes will include results from driving simulator experiments to better understand the safety issues related to automated vehicle interactions with transportation systems management and operations (TSMO) functions, as well as infrastructure. Simulator and test track research will also provide insights on human machine interface (HMI), driver engagement, and accessibility in ADAS and ADS-equipped vehicles.

Infrastructure and Interoperability outcomes will demonstrate the benefits of automated driving technology combined with connectivity to enable CDA. This will include collection and analysis of results from test track and field test results from CARMA, Traffic Optimization on Signalized Corridors (TOSCo), and truck platooning projects conducted in partnership with FHWA.

Policy Analysis outcomes will include the necessary data to support development of modeling capabilities that will enable AMS tools to assess the changes in traffic that will occur as automated vehicles and CDA-capable vehicles enter the fleet. The program will also deliver SD models that address the underlying decision-making processes on the part of both service providers and consumers. It can help to identify market failures and how policy makers can respond. The analyses, coordination, and outreach will inform cross-modal policy development.

Collaboration Partners:
The ITS JPO facilitates multimodal automation research in collaboration with the Office of the Secretary and Operating Agency partners, including NHTSA, FHWA, FTA, FMCSA, and MARAD. Responding effectively to automation requires a cross-modal effort, as the expertise on various aspects of automation—both regarding technology and transportation systems impacts—resides in many parts of the Department. Cross-cutting tools such as evaluation methods, data access and exchanges, and development of other decision-making tools support these three areas.

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 is able to improve the quality and comprehensiveness of 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 /Enabling Technologies
Funding Request ($9,495,000)

Program Description:

The Emerging/Enabling Technologies Program focuses on cultivating the next generation of transportation systems. As the scale of Intelligent Transportation Systems (ITS) increases, 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), Cellular-Vehicle-to-Everything (C-V2X) technologies, and 5G communication networks, all of which have the potential to greatly impact transportation networks. As such, there is a need to determine technological, market, and demographic trends throughout the globe and across industries to seek, evaluate and sometimes incubate emerging capabilities that demonstrate the potential to transform transportation. As this happens, the USDOT will be positioned and engaged as a partner to guide research, development, and technology adoption in a systematic manner. Through multi-modal coordination, the ITS JPO works to avoid duplicative ITS work and to ensure the efficient allocation of ITS resources.

Program Objectives:

This research program focuses on cultivating 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.

This research program will build on the collaborative partnership initiated in 2018 between the ITS JPO and the Ford Motor Company to conduct performance testing of the C-V2X communications to determine its potential to provide benefits to the transportation system. This research will also analyze and provide input to the evolution of cellular communications from LTE to 5G networks in order to assess the impacts on 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. There are three proposed research objectives that will concern the USDOT moving into the future:

A. *Institutional adoption of next generation communications technologies:*
- Promote adoption with State and local agencies by gathering needs, analyzing impacts, and coordinating transition planning.
- 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.

B. *Safety and security framework development:*
- Develop and maintain a set of transportation communications threshold requirements associated with safety against which any new technology can be assessed and tested.

- Analyze, develop, and demonstrate approaches to test for interference or other harms to existing operations.
  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 domestic (SAE, IEEE) and international (ITU, 3GPP) standards development organizations to ensure that the transportation needs are represented in each next generation communications systems.

Anticipated Program Activities:

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. The U.S. government elevated AI as one of its key priority science and technology areas. The ITS JPO and its modal partners have been leaders, collaborating on fundamental problems in mobility, safety, and equity by leveraging emerging technologies such as connected vehicles (CV), automated vehicles (AV), shared mobility services, and accessible transportation capabilities.

In ITS, AI can be used to replace or augment actions of field, handheld and remote sensing devices, connected and autonomous 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 and support decision-making. 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 identified 11 categories of AI for potential research including: 1. Advanced Driver Assistance Systems & connected and Automated Vehicles, 2. Cybersecurity, 3. Accessible Transportation, 3. Traveler Decision Support Tools, 5. Transportation Systems Management and Operations (TSMO), 6. Commercial Vehicle and Freight Operations, 7. Transit Operation and Management, 8. Emergency Management, 9. Air Traffic Management, 10, Remote Sensing, and 11. Asset Management, and Rodway Construction and Maintenance. USDOT investments in R&D and demonstrations of the benefits AI applications for addressing transportation problems come with risks and challenges that are common across the 11 categories. In developing our research initiatives, we are looking at technology neutral approaches to support fair market competition, understand the liability implications, consider privacy, bias and ethics, and impacts on the workforce.

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 LTE-C-V2X, dual-mode, or 5G NR technologies 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 they can perform potential interactions with existing technologies which currently support these systems. Based on evolving industry standards, there is a need to assess the commercially available off-the-shelf (COTS) devices and 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.

Communication technologies are evolving at an increasingly rapid pace with the emergence of AI, Cellular-Vehicle-to-Everything (C-V2X) technologies, and 5G communication networks, as well as other communications protocols, all of which have the potential to greatly impact transportation networks. As such, there is a need to determine the impact of technological, market, and demographic trends throughout the globe and across industries to seek, evaluate and sometimes incubate emerging capabilities that demonstrate the potential to transform transportation. This research will also analyze and provide input to the evolution of cellular communications from 802.11 and LTE to 5G networks in order to assess the impacts on the transportation system. While much research has been conducted with Wi-Fi, Dedicated Short Range Communications (DSRC), cellular, and satellite communications, there are emerging communications technologies such as Cellular-Vehicle-to-Everything (C-V2X), 5G and even 6G, which might impact transportation systems. For example, the 5G capabilities are relatively undefined at this time and it is not clear if transportation needs and requirements are being taken into consideration especially the needs of rural communities.

Given the magnitude of impacts that transitioning to the next generation communications can have on transportation, the ITS JPO could accelerate its focused connectivity research initiative. There are three proposed research objectives that will concern the USDOT moving into the future, 1) institutional adoption of next generation communication technologies, 2) safety and security framework development, and 3) public sector representation.

Expected Program Outcomes:
In regards to AI in ITS, the primary program outcome is to assess the state of real-world, existing and/or planned Artificial Intelligence (AI) with focus on Intelligent Transportation Systems (ITS). There are several real-world applications of AI that are being deployed within particular modes across State and local transportation agencies. The ITS JPO seeks to understand the landscape of how AI in transportation is currently being leveraged, and how potential investment in the future can help address transportation challenges. This objective will be used to assist ITS JPO in prioritizing research and development investment in transportation.

Communication technologies are evolving this research will analyze and provide input to the evolution of cellular communications from 802.11 and LTE to 5G networks in order to assess the

impacts on the transportation system. It will support past research conducted with Wi-Fi, Dedicated Short Range Communications (DSRC), cellular, and satellite communications looking towards other potential emerging communications technologies such as Cellular-Vehicle-to-Everything (C-V2X), 5G and even 6G, which might impact transportation systems. The outcomes will address three proposed research objectives 1) institutional adoption of next generation communication technologies, 2) safety and security framework development, and 3) public sector representation.

Collaboration Partners:

Most of the on-going research into next generation communications is funded by the private sector and is focused on enhancing technical performance of existing equipment or development of new radios. The private sector, academia, and governments around the world have formulated questions associated with whether these new communications technologies can enable safety-critical applications, provide crash avoidance, and support automation. 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.

For the existing communications technologies in use with transportation today, USDOT, modal partners, and stakeholder partners (e.g., Federal Communications Commission and National Telecommunications and Informational Administration) have invested in a wide range of research and analyses including:

- Development of a band plan for the 5.9 GHz part of the spectrum.
- Comparison of cellular, Wi-Fi, and satellite capabilities and costs to deliver interoperable, low-latency messages.
- Assessment of out-of-band and adjacent channel interference in the 5.9 GHz spectrum.

One of the lessons learned 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 can cause interference. This unique requirement imposes high frequency and reliability requirements. 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 State, regional and local 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 and what transportation agencies will procure in near future as well as their longer-term investment planning.

The ITS JPO expects to continue to partner with private sector firms, modal partners, and stakeholder partners (e.g., Federal Communications Commission and National Telecommunications and Informational Administration) in a manner that provides technical contributions with a financial value. For instance:

- ITS JPO has partnered with automotive companies in a pre-competitive forum to assess the impacts of new communications technologies on vehicles as well as to study interference associated with proposals for spectrum sharing. This was accomplished with a 20% cost share through a cooperative agreement.
- ITS JPO is partnering with automotive firms, tier one suppliers, and chipset manufacturers to form an understanding of new communications innovations through testing and data analyses. The private sector firms are providing prototypes as well as sharing their test approaches with USDOT as a means of forming consensus on the level of rigor and depth appropriate to assessing their new technology for safety and other features critical for the transportation environment. This is being accomplished through a partnership agreement.

Cybersecurity for Intelligent Transportation Systems (ITS)
Funding Request ($5,210,000)

Program Description:

The USDOT cooperates across a diverse range of stakeholders to address ITS cybersecurity research 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 interoperable, safe, effective and efficient Nationwide ITS deployments. In order to support secure, nationwide interoperable ITS deployments, the USDOT ITS cybersecurity research program supports research needed to facilitate adaption and implementation of information and communications technology (ICT) cybersecurity best practices across diverse ITS infrastructures, such as connectivity and automation focused deployments. USDOT leadership is uniquely positioned to support needed research and coordinated stakeholder-driven development and implementation of best practices. These efforts can then in-turn be adopted by the diverse community of Infrastructure Owner Operators (IOO) including State, Tribal, territorial and local 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 the development and implementation of best practices. This is very complex challenge - ITS system architectures are complex 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.

The *USDOT Strategic Plan FY 2018 – 2022* stated that "DOT will encourage the adoption of the National Institute of Standards and Technology Cybersecurity Framework by transportation ecosystem stakeholders." Current research continues to translate the National Institute for Technology and Standards (NIST) Cybersecurity Framework into the ITS environment. The tenets of cybersecurity that relate to transportation operations and equipment include: identify, protect, detect, respond, and recover. The NIST Framework provides a process that assists entities in understanding their cybersecurity risk and what can be done to mitigate them.

Cybersecurity considerations are an essential part of good engineering practice, and thus should be taken into account in any research, development and deployment activity. The ITS Cybersecurity Research Program seeks to address those needs that are crosscutting and/or uniquely associated with cybersecurity, allowing well-engineered systems to be combined into the complex system of systems needed to maximize the public benefits of ITS.

Program Objectives:

The overall objectives for the USDOT's ITS Cybersecurity research program are to support the widespread implementation of cybersecurity best practices, and to provide the capabilities 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 in order to recover from attacks and other disruptions.

The National Institute of Standards and Technology (NIST) has developed and maintained a Cybersecurity Framework along with other guidance documentation on securing ICT system. Many Standards Development Organizations (SDO) have developed standards products that support secure ICT systems; the USDOT ITS Program will continue to support the development, adaption and specification of standards appropriate for securing ITS. ITS supporting infrastructure, including connectivity and automation support physical systems where failures can have severe consequences, requiring a greater level of care to both maximize public benefit and to minimize the risk of harm.

The long-term goal of this research is to establish a multimodal intelligent-transportation system that is both resistant to cyber-attacks and resilient to those cyber-attacks that occur. ITS JPO will undertake and support cross-modal research to identify and create an improved awareness of good cybersecurity practices and translate these practices to the ITS environment to develop a cyber-resilient ITS system.

Anticipated Program Activities:
The Cybersecurity for ITS 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 Cybersecurity Best Practices and the NIST Cybersecurity Framework (CSF) to ITS: ITS infrastructure, connectivity and automation service represent a complex system of systems which must remain secure in order to provide the safety and mobility benefits promised by rapidly ITS technologies. Recently completed efforts include using the NIST CSF to develop candidate cybersecurity profile for the connectivity needed to support V2X. An effort to apply the CSF to the much more complex and diverse ITS infrastructure environment began in FY20 and will continue through FY21. These IOO ITS environments vary greatly across jurisdictions, with differing approaches to cybersecurity in general, along with extraordinarily diverse uses of wired, fiber and communications technologies along 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 will be 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 will be 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 cooperation Nationally and across borders in such a way that IOO and overall system security needs will be further explored to identify efficient, effective candidate for large-scale interoperable deployments of rapidly advancing ITS infrastructure, connectivity and automation technologies.

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 training organizational preparedness 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 will facilitate 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 will 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 cybersecurity concepts, best practices and available tools applicable to ITS across the deployer community. In particular, 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.'

Expected Program Outcomes:
The desired outcome of the USDOT ITS Cybersecurity Research Program, in cooperation with the efforts of the broad stakeholder community is a secure nationally interoperable ITS system that allows 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. 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 along with the professional capacity building and deployment support needed to help them achieve and maintain secure deployments.

Collaboration Partners:

By definition, cybersecurity is 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 and NIST via direct relationships and well as participation in cybersecurity coordination activities of the National Security Council.

IOO cooperation includes collaboration via associations such as AASHTO as well as with individual State/ local ITS deployers. Extensive cooperation is conducted with 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.

Accelerating ITS Deployment
Funding Request ($28,820,000)

Program Description:
As new Intelligent Transportation Systems (ITS) technologies and systems evolve into market-ready products, the ITS Accelerating Deployment Program provides products and services that support expedited adoption and deployment of advanced ITS technologies. The goal of the Accelerating ITS Deployment Program is to speed up the transformation of ITS research and prototypes into market-ready technologies that are commercially viable and adopted by the transportation community to provide the tools needed for interoperable deployment. The Accelerating ITS Deployment Program includes several sub-Programs, including:

- Professional Capacity Building
- Deployment Evaluation
- Communication and Outreach
- Interoperability (formally known as "Architecture and Standards")

This Program provides communication and education support to facilitate awareness, understanding, acceptance, adoption, and deployment of ITS technologies across stakeholder groups; and ensures effective partnerships are fostered and developed at various levels – executive, program, and project. The ITS JPO seeks to spur adoption of technology, and help stakeholders and localities deploy maturing ITS systems. The Program provides knowledge transfer, and supports technical assistance, training, outreach, program evaluation, and other stakeholder engagement. The Program supports advancing ITS research, to initial adoption, and subsequently on to wider scale deployment in coordination with other stakeholders at the federal, state, regional and local levels. The Program's key areas are discussed in the following:

- Professional Capacity Building: As Automated Vehicles and Vehicle Connectivity Technologies progress, the workforce will need new knowledge, skills, and abilities to drive implementation. The ITS Professional Capacity Building (PCB) Program will continue developing courses and offering opportunities to advance the ITS workforce. The PCB Program will share ITS knowledge and lessons learned from CV deployments to internal and external stakeholders. This Program supports transportation worker's outreach through a variety of different kinds of webinars, online trainings, 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, Institute of Transportation Engineers (ITE), ITS America (ITSA), National Association of Development Organizations 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. There are currently two cohorts meeting on a regular basis: Connected Vehicle Pilots (meets bi-weekly) and the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Grant Recipients (meets monthly).

- The ITS Deployment Evaluation Program: (1) provides information to decision makers of all types, both inside and outside of the Department, to help plan, procure, and assess effectiveness of ITS investments (both current and future investments); and (2) support future deployment by tracking the extent of ITS deployment, disseminating data on benefits, costs, best practices/lessons learned related to deployed ITS, and analyzing data related to deployment trends, adoption trends, and effectiveness of ITS JPO/government interventions. This Program is responsible for conducting the ITS Deployment Tracking Survey and the population of the ITS benefits/costs databases.

- The Communications and Outreach Program 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 CARMA program, the Safety Band campaign and automated vehicle policy initiatives sponsored by the OST.

- The Interoperability Program provides a reference system architecture framework along with voluntary technical standards, tools and deployment support to guide safe, secure and efficient interoperable deployment of infrastructure, connected and automated ITS technologies. The ITS reference architecture (www.arc-it.net) provides IOO and mobile deployers access to a reference system architecture covering more than 130 ITS services along with software tools to support regional and project architectures customized to meet local needs while providing necessary nationwide interoperability. The reference architecture identifies interfaces for standardization and recommending suitable ICT and ITS standards – identifying and enabling multiple suitable technology choices whenever viable. The standards portion of the program 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. The program also conducts extensive implementation support activity, providing technical support along with systems engineering and architecture implementation workshops to State and local customers Nationwide. The Program funds key technical research to advance ITS architecture and standards, cyber security, certification/testing and human factors guidelines that support efficient, secure large-scale deployment of ITS technologies and regulatory decision-making. Interoperability programs support test beds and pilot deployments and serve to assure a

broad, competitive marketplace for ITS equipment and services. The goal of this research is to ensure effective connectivity from the device level to the transportation system level.

Program Objectives:
The objectives of the Accelerating ITS Deployment Program overall, are to provide the products, tools and services to enable rapid, interoperable deployment of advancing ITS infrastructure, connectivity and automation technologies to maximize safety and mobility 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 (Research); to develop comprehensive training and analytic tools that allow deployers to understand the financial and operational benefits of new technologies and systems (Development); and to establish the tools that early deployers can use to help make more informed investment and planning decisions regarding ITS deployment (Adoption).

Anticipated Program Activities:
Professional Capacity Building Activities FY 2021
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 continue reaching out to build the community. In FY2021, 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. 77 ITS Standards modules)
4. Technical Assistance (e.g. Connected Vehicle Deployment Technical Assistance (CVDTA) Cohorts Program, 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, ITS ePrimer online modules)
7. Academic Support (e.g. ITS University and Community College Workshops and Academic Communities of Practice projects, ITS case studies)

In FY21, the ITS PCB Program will 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.

ITS Deployment Evaluation Activities FY 2021

First, the ITS Deployment Evaluation Program is continuing to modernize, and make more efficient, how the benefits/costs/lessons learned databases operate and are presented to the public. The program is also gearing up for the next major ITS Deployment Tracking Survey and actively seeking stakeholder input into new questions and topics. The Program is also conducting its activities in very close coordination with the ITS PCB Program to leverage partnerships and ensure continued value of these data resources. Further, the Program will continue its analytics work using longitudinal and new ITS deployment data, and continue to populate the databases and manage the online presence of these data.

Deployment Evaluation and Partner Collaboration: The Program is reexamining the role of ITS Deployment Evaluation overall with the objective of integrating it far deeper into the ITS JPO research program, particularly with our modal partners and across the Department as a whole – and fine-tuning the Technology Transfer techniques and opportunities to make this happen.

The ITS Evaluation Program will also begin a long-term strategic effort to clearly articulate for our stakeholders the success stories of ITS.

The ITS Evaluation Program 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 undertake an intensive analysis of those data in order to show quantitatively the benefits of proven ITS technologies and guide the ITS JPO on how best to accelerate ITS deployment of newer technologies.

The ITS Evaluation Program would start by undertaking a retrospective analysis of the deployment of now-mainstreamed ITS technologies to:

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

In 2020, the focus of the ITS Deployment Evaluation Program was to revamp and modernize how the ITS JPO collects various types of data on ITS deployments nationwide, and also how it might work more extensively with ITS JPO's modal partners to advance true innovation in management of the performance of deployed ITS projects across the nation, especially with early ITS adopters. The extensive and growing pipeline of these projects have the potential to be a major driver of the US economy in the future, and cover all areas of the country from urban areas to rural environments.

Therefore, in 2021, the ITS JPO will continue to support accelerating ITS deployment through building evidence-based decision making capacity in the ITS JPO and with our modal partners, and by supporting early-stage ITS deployments.

These expanded activities are expected to include: coordination with all modes to provide integrated and leveraged ITS evaluation support for early adopters of ITS technologies (including the development of playbooks, toolkits, best practices documents, and analysis to show quantitatively and qualitatively the Return on Investment (ROI) of ITS deployments and technologies. The Program will engage with the modes to ensure the best possible evaluation techniques and performance measures are developed and supported. Evaluation efforts throughout the Department will be leveraged so that all modes benefit from this renewed focus on performance assessment and evaluation.

This effort is particularly important for the early deployer segment of ITS. There is a large pipeline of ITS grantees currently beginning CV and AV projects across the United States. These projects are located in a wide variety of locations, involve a wide variety of situations, and address a wide variety of problems and issues. This presents an opportunity for the ITS Deployment Evaluation Program to address the following critical issues:

- The Department does not yet currently have a robust, or clearly articulated, mechanism to compare information and results across ITS deployment projects; there currently exists no true way to, for example, compare the results of a deployment in (as a hypothetical example) Indianapolis to one in Anchorage even if they are essentially deploying the same types of technologies to address similar problems. It is likely that they are looking at different KPIs, or even if there are similar KPIs, each might be using different data or methodologies to address them. This makes it exceedingly difficult to compare results with accuracy.

- There is no efficient way to compare and contrast performance metrics/measures, evaluation methodologies, or the relative success of similar (yet subtly different) uses of technologies and applications. For example, if two sites are both deploying a similar application, but use different methods of deploying it, those different methods make it difficult to parse differences in performance results.

- There is not yet a common set of integrated best practices that the Department can currently offer early connected vehicle or automated vehicle deployers and future deployers, making deployment activities much more challenging, time consuming, and costly for them, and thereby potentially needlessly discouraging deployment and/or reducing the performance and benefit of those deployments.

A more integrated, and leveraged, approach to the evaluation lifecycle of deployment projects will provide value to the Department (and the stakeholder community) by supporting an integrated way to facilitate the meaningful analysis and development of common performance measures as part of a common core set of data, methods, approaches, best practices and guidance developed by and facilitated by the ITS JPO and its modal and Departmental partners. This core set could include:

- Core set of performance metrics that deployers can focus on, in addition to more localized measures, that will enable comparison and dashboarding;

- Core guidance and best practices on methodologies for evaluation, based at the micro-level – for example, best practices for data identification and collection related to specific performance measures and hypotheses;

- Core standards and performance specifications for a variety of technologies typically used in deployments; and

- Core targets for level of benefits a deployment might expect for specific Key Performance Indicators (KPIs).

- Leveraging the activities and artifacts of the ITS JPO Data Access and Exchanges program such as:

  o Core documentation related to basic data acquisition strategies and methods, data management, data storage, data security, data sharing, data maintenance, and data quality control/ independent verification and validation (IV&V);

  o Assistance with development of recommendations on minimum data sets for a CV/AV evaluation – vehicle data, operating data, cost data, financial data, institutional data, socio-economic data, etc.;

The expectation is that the modes will participate/lead in the development, maintenance and technology transfer of the "core" elements. The effort is expected to mesh well with and bolster the performance-based approach of the Department overall, and also integrate closely with the Data Access Program area. The ITS JPO Data Access and Exchanges program is expected to provide the ITS Deployment Evaluation Program with consistent access to data, source code, and results from ITS research to support evidence-based decision-making, as well as best practices for data access, management, and analysis. The ITS Deployment Evaluation Program will help funnel user feedback from the deployment community to the Data Access and Exchanges program to improve future data products and services.

Communication and Outreach Activities FY 2021:

- College 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 SXSW, CES and the ITS World Congress. 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.

Interoperability Program Activities FY 2021:

In FY21, the Interoperability Program will continue to evolve the content of the ITS reference system architecture to accommodate automation, additional connectivity services and advancing ICT technologies such as 5G which are becoming available in the marketplace. Cooperating internationally, further work will be undertaken to specify access controls in support of cybersecurity programs as well as 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 cooperative automation will be initiated. Stands 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 completed along with initial analyses to support improving security of legacy ITS infrastructure equipment installations. 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.

Expected Program Outcomes:
This research program aligns with the USDOT strategic goal for Innovation:

- **Innovation:** The Program supports the strategic goal of innovation by working to accelerate and expand the deployment of new technologies and practices across the Nation to enable safety benefits to be realized rapidly.

To the extent that 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 program can be said to touch on most, if not all, of these research priority areas. Cost/benefit data are cornerstones of any analysis relating to economic impact, performance assessment, feasibility assessment, and impact assessment. Mobility improvements associated with the deployment of technology are also assessed via evaluation.

The ITS PCB Program has identified FY21 outcomes aimed at increasing the scope and reach of the Program. 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 ePrimer will 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 four years, these have been developed in close coordination 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 Discussion Forum and partnering with the Turner-Fairbank Highway Research (TFHRC), will ensure that materials, resources and prototypes (i.e. the CAV in a Box) 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 CAV 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.

The Communications and Outreach Program has a number of outcomes in FY 21 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 Consumer Electronics Show 2021 and SXSW 2021.
3. Development of the new College Guest Speaker program.

USDOT Collaboration. The goal is to support an approach within the Department on activities that will accommodate innovation in management of the performance of deployed ITS projects with a focus on evidence-based decision- and policy-making for transportation technology deployment as follows:

- Focus on an integrated, leveraged project-lifecycle approach to accelerating and improving stakeholder investment in ITS technologies, applications, and services via evidence-based decision making, information acquisition/management, evaluation, and tech transfer.

- Assist stakeholders with making quantitative and qualitative decisions from pre-deployment/investment planning through to performance measure setting, data collection and management, evaluation, and transfer of results and best practices.

The initial scope will incorporate the priorities and needs of ITS JPO partners across all modes in the USDOT.

Expected outcomes of Interoperability Program efforts include the continued availability of an evolving reference system architecture and software toolsets, updated to accommodate additional automation-related services, enhanced cybersecurity along with other user-identified needs along with deployment support to developers of regional and project architectures. Additional 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.

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 identified audiences are given necessary knowledge sharing and technology sharing support, the Program works in partnership with professional associations, universities, state, regional and local public agencies, and the training programs of USDOT modal administrations to engage the broad technical and organizational expertise needed to develop and deliver ITS learning. Specific partners include:

- Federal Highway Administration (FHWA)
  - Office of Infrastructure
  - Office of Innovative Program Delivery – Center for Transportation Workforce Development
  - Office of Operations
  - Office of Planning, Environment, and Realty
  - Office of Research, Development, and Technology (RD&T)
  - Office of Safety
  - Office of Safety Research and Development (R&D)
  - National Highway Institute
  - Resource Center
- Federal Transit Administration (FTA)
- Maritime Administration (MARAD)
- American Planning Association (APA)
- American Public Transportation Association (APTA)
- Institute of Transportation Engineers (ITE)
- International Municipal Signal Association (IMSA)
- ITS America (ITSA)
- National Association of Development Organizations (NADO)
- National Network for the Transportation Workforce (NNTW)
- National Operations Center of Excellence (NOCoE)
- National Transit Institute (NTI)
- International Partners (Canada Mexico, European Commission (EC) and Transport Certification Australia (TCA))

Each of these Federal program offices, educational organizations, or professional associations act as a sounding board from which the ITS PCB Program receives information on educational and training needs and also as a distribution channel through which the ITS PCB Program disseminates various ITS educational materials or training courses developed. The ITS PCB Program will continue to enhance coordination efforts with all USDOT modal partners. In FY21, The ITS PCB Program will develop a new *ITS PCB Strategic Plan* based on the new *ITS JPO Strategic Plan.* The Program will continue its mission to prepare transportation industry professionals (both current

and future) for an ITS and connected automated transportation system. 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.

IOO cooperation includes via associations such as ASSHTO as well as with individual State/ local ITS deployers. Extensive cooperation is conducted with 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.

Data Access and Exchanges
Funding Request ($6,110,000)

Program Description and Objectives:
This research area focuses on enabling access to core transportation data across the ITS ecosystem, including data and source code generated through the DOT's ITS research investments, to accelerate deployment of new ITS technologies, cut the time from research to insight and policy-making, and drive secondary research results. 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. 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.

Anticipated Program Activities:

Research Data Access **–** ITS JPO remains committed to providing near-real-time access to data and source code generated through its investments, including the various projects described throughout this and past AMRPs. In FY2021, 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, evangelize the availability of JPO-funded data and source code, and generate best practices for the broader research and deployment communities. Through these activities, the Research Data Access program will help the Center for Highly Autonomous Systems Safety Center of Excellence, policy and research analysts and evaluators, and other users transform ITS project data into insights for decision-makers. The ITS JPO will also contribute to the broader USDOT research, policy, and technology communities through the Data Access Task Force and other multi-modal forums. The Research Data Access program will pay for JPO-funded projects' use of the Department-wide shared services described below, including use by modal partners managing JPO-funded projects, and work with the shared service providers to define and deliver JPO-specific requirements that meet the needs of the ever-evolving ITS research portfolio.

Between FY2018 and FY2020, the ITS JPO incubated a consultative Research Data Access implementation support team and multiple technical platforms to enhance access to data and source code produced through multi-modal ITS research investments. In FY2021, the ITS JPO will hand off mature capabilities to the appropriate long-term owners within the Office of the Secretary and Federal Highway Administration who will operationalize these capabilities as Department-wide shared services. Once these handoffs are complete, ITS JPO will continue to be involved in funding, using, and helping advance these services via its Research Data Access program (see above). The shared services that ITS JPO anticipates will be operationalized in FY2021:

- 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 FY2021, the National Transportation Library (NTL) – the implementation arm of 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.
- DOT Secure Data Commons (SDC). The SDC enables collaborative research and analysis involving moderate sensitivity level datasets, and is the default system for ITS JPO-funded project data containing personally identifiable or confidential business information as well as shared resources like the Department's Waze data archive. The Office of the Chief Information Officer will take over as SDC manager in FY2021.
- 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), repository and open science access portal (rosap.ntl.bts.gov), and Secure Data Commons, and augments these shared services to support more advanced ITS research requirements. The Office of the Chief Information Officer will take over as ITS DataHub manager in FY2021.
- ITS CodeHub. ITS CodeHub provides a single access point for USDOT's ITS source code and helps projects manage source code repositories and enable code collaboration and re-use. The Office of the Chief Information Officer will take over as ITS CodeHub manager in FY2021 to support broader implementation of the Department's source code policies.
- Field Operational Test Data Architecture (FOTDA). The FOTDA enables the efficient movement of data from field operational tests to an environment where it can be analyzed for status and quality assurance, transformed as needed, and transferred to a research analysis environment such as the SDC. The Federal Highway Administration, which stood up this service for CARMA and Spectrum testing via ITS JPO funding in FY2020, will operationalize this shared service to support broader USDOT research in FY2021.

Data Exchanges – 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. Through this work, ITS JPO also support the development and implementation of Department-wide policies and best practices for establishing data trusts and other critical data exchange enablers. 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 exemplar for addressing data exchanges collaboratively with data producers and users. In FY2021, the Federal Highway Administration will take over WZDx deployment while ITS JPO continues to maintain transportation.gov/av/data, extends the DAVI model to other emerging USDOT priorities, and triages other potential data exchange needs.

Expected Program 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 all USDOT research priority areas. The development of data systems to support data-driven technologies and decision making in real time is one of the overarching themes of the USDOT RD&T Strategic Plan. Advances in data processing are enabling governments, and private companies alike, to improve transportation services and better target investments. Expected outcomes include positive impacts on Innovation, Accountability, and Safety:

- **Innovation:** accelerates incorporation of innovative practices and methodologies into the transportation enterprise that are foundational to the next generation of ITS projects, and accelerates deployment of innovative technologies in the transportation sector.

- **Accountability:** improves oversight and return on investment of federally-funded research and demonstration projects.

- **Safety:** supports evaluation of the safety benefits of new technologies in the transportation system and accelerates their safe deployment.

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 serve as beta users for products and services. This approach, and a commitment to agile- and open-source-by-default, 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, sparked the collaborative development of new open data exchange specifications between public sector roadway operators and private sector automotive mapping companies, and incubated multiple shared services to be handed off to long-term owners elsewhere in the Department. Specific technical transfer partners include, but are not limited to, the ITS JPO's Professional Capacity Building Program, OCIO, NTL, FHWA 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), modes (FHWA, FTA, FMCSA, NHTSA, FAA, and others), and inter-agency groups run through the General Services Administration and White House Office of Science and Technology Policy. These collaborative relationships help the ITS JPO to understand and build upon more general technology policies, and provide practical feedback and exemplars 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. 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 and Congestion Management Technologies Deployment (ATCMTD)
Funding Request ($21,000,000)

Program Description:

The ATCMTD is statutorily required in the FAST Act Section 6004, 23 U.S.C. 503(c)(4). The ATCMTD 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 ATCMTD, 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 and Congestion Management Technologies Deployment Initiative (ATCMTD) 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 autonomous 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 (DOT) encourages partnering among the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders.

Program Objectives:

The DOT's vision for the ATCMTD initiative is the deployment of advanced technologies and related strategies to address issues and challenges in safety, mobility, sustainability, economic vitality, and air quality 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 FY21, the ATCMTD 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 first ATCMTD annual report as mandated by the FAST Act.

Key FY21 ATCTMTD Program Activities.

Activity	Period of Performance
Selection of FY20 grant awards and timely implementation of projects.	2021
Continue award of FY19 grants and manage FY16-18 projects.	On-Going
Publish first ATCMTD annual report as mandated by the FAST Act.	On-Going

Expected Program Outcomes:

The ATCMTD Initiative will develop model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment. Each ATCMTD 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.

Collaboration Partners:

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

To be selected for an ATCMTD award, an applicant must be an eligible applicant. Eligible applicants are State or local governments, transit agencies, metropolitan planning organizations (MPO) representing a population of over 200,000, 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.

DOT 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 ATCMTD 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 ATCMTD 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
ATCMTD partners are the individual grant recipients (benefits of partnerships are identified in FAST Act Section 6004 and 23 U.S.C. 503(c)(4)). Benefits of partnership and partner contributions will be detailed in FAST Act-mandated Secretary's report, which is due May 2020.					X				X		

Small Business Innovation Research (SBIR)
Funding Request ($2,200,000)

Program Description

The SBIR program is a highly competitive, awards-based program that encourages domestic small businesses to engage in research and development addressing high priority research areas within USDOT. The SBIR program 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.

The program is administered by the Volpe Transportation Center. The SBIR Program Office publishes one or two solicitations each fiscal year for proposals on specific research topics of interest to USDOT operating administrations, including the FHWA.

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 FHWA 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 FHWA and Departmental Strategic goals. Given that the SBIR program is available to all 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 FY21 the FHWA 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 FY21, 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 FHWA SBIR program will continue with the Technology Readiness Level (TRL) Assessments at the end of Phase II.

Key FY20 FHWA SBIR Program Activities

Activity	Period of Performance
Technology Readiness Level (TRL) Assessments	2021
Annual Solicitation of Topics	2021

Expected Program Outcomes:

FHWA aims to advance technologies and make problem-solving innovations available to the end user. FHWA will accomplish 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. The Federal Government advances their strategic goals by

investing in promising innovations; the small businesses benefit from the ability to pursue a good idea through Federal seed-funding and, if successful, the sale of their innovative products and solutions; and the public benefits from new innovations in the marketplace that enhance the travel experience.

Collaboration Partners:

The FHWA 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.

Benefits of Partnership and Partner Contributions to FHWA SBIR 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
USDOT				X	X	X					

Chapter 3 – FY 2022 Program Descriptions

Complete Trip- ITS4US Deployment Program

Program Description/Activities/ Objectives:

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 will make up to $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.

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 FY22, the program will continue to conduct work for Phase 1, the structured development of a deployment site concept, to prepare for later phases of activity in which the envisioned system can be systematically designed in detail, built, tested, operated, maintained, and used to support evaluation.

In FY22, the program will continue stakeholder engagement and outreach activities and begin the independent evaluation activity as the deployment teams being concept development.

Technical services activities in FY22 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, validation and verification of other project deliverables, 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.

Automation Program

Program Description:

The ITS JPO, in collaboration with FHWA, NHTSA, FMCSA, FTA, MARAD and other USDOT modes, as well as State and local public agencies, academia, industry, and other surface transportation stakeholders, will continue to conduct automation research that has the potential to transform safety, mobility, energy, and environmental efficiency; increase productivity; and facilitate freight movement within our nation's transportation system. Many of the activities in this program will be executed by modal partners and some will be jointly funded with them. The ITS JPO's automation research is a component of the USDOT's vision of supporting the safe, reliable, efficient, and cost-effective integration of automation into the broader multimodal transportation system.

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 FY22 will continue to support the federal role in automation by funding cross-modal research in safety, infrastructure and interoperability, and policy analysis.

Anticipated Program Activities:

Building on the FY21 research, the Automation Program will continue to coordinate automated vehicle cross-modal research in the areas of safety, infrastructure and interoperability, and policy analysis. The Program will also continue to provide a platform for internal research coordination and exchange, contributing to better outcomes across the Department.

Emerging /Enabling Technologies

Program Description:
The Emerging/Enabling Technologies Program focuses on cultivating the next generation of transportation systems. As the scale of Intelligent Transportation Systems (ITS) increases, 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), Cellular-Vehicle-to-Everything (C-V2X) technologies, and 5G communication networks, all of which have the potential to greatly impact transportation networks. As such, there is a need to determine technological, market, and demographic trends throughout the globe and across industries to seek, evaluate and sometimes incubate emerging capabilities that demonstrate the potential to transform transportation. As this happens, the USDOT will be positioned and engaged as a partner to guide research, development, and technology adoption in a systematic manner. Through multi-modal coordination, the ITS JPO works to avoid duplicative ITS work and to ensure the efficient allocation of ITS resources.

Program Objectives:
This research program focuses on cultivating 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.

This research program will build on the collaborative partnership to determine potential benefits to the transportation system. This research will also analyze and provide input to the evolution of cellular communications from LTE to 5G networks in order to assess the impacts on 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.

Three 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, and 3) public sector representation.

Anticipated Program Activities:
In ITS, AI can be used to replace or augment actions of field, handheld and remote sensing devices, connected and autonomous 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 and support decision-making. 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.

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 LTE-C-V2X, dual-mode, or 5G NR technologies 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 they can perform potential interactions with existing technologies which currently support these systems. Based on evolving industry standards, there is a need to assess the commercially available off-the-shelf (COTS) devices and 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.

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.

Cybersecurity for Intelligent Transportation Systems (ITS)

Program Description:
USDOT cooperates across a diverse range of stakeholders to address ITS cybersecurity research needs, support secure ITS deployments and 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 interoperable, safe, effective and efficient Nationwide ITS deployments. The USDOT ITS cybersecurity research program supports research needed to support adaption and implementation of ICT cybersecurity best practices across diverse ITS infrastructure, connectivity and automation deployments in order to support secure nationwide interoperable ITS deployment. USDOT leadership is uniquely positioned to support needed research and coordinated stakeholder-driven development and implementation of best practices that can in-turn be adopted by the diverse community of Infrastructure Owner Operators (IOO).

Program Objectives:
The overall objective for USDOT ITS Cybersecurity research is to make available, and support widespread implementation of the means to assure that ITS deployments remain secure, which is a necessary precondition for their efficient, effective and safe operation. ITS systems need to be both resistant to cyber-attacks and resilient, to allow quick recovery from cyber-attacks that are not prevented.

Anticipated Program Activities:
FY2022 research will continue to focus on key ITS cybersecurity, with technical focus areas evolving with the advancement of ICT and ITS technology along with evolving stakeholder needs and an evolving and unpredictable threat landscape:

- 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.
- Conducing 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 and adaption of ITS and 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 ITS Accelerating Deployment Program is addressing questions associated with adoption and deployment. The goal of the Accelerating Deployment Program is to speed up the transformation of ITS research and prototypes into market-ready technologies that are commercially viable and adopted by the transportation community. This Program provides communication and education support to facilitate awareness, understanding, acceptance, adoption, and deployment of ITS technologies across stakeholder groups; and ensures effective partnerships are fostered and developed at various levels – executive, program, and project. The ITS JPO seeks to spur adoption of technology, and help stakeholders and localities deploy maturing ITS systems. The Program provides knowledge transfer, and supports technical assistance, training, outreach, program evaluation, and other stakeholder engagement. The Program supports advancing ITS research, to initial adoption, and subsequently on to wider scale deployment in coordination with other stakeholders at the federal, state, regional and local levels.

Program Objectives:
The objectives of the Accelerating Deployment Program are to define and improve evidence-based decision making, collaboration and communication mechanisms and targets to encourage public and private investment (Research); to develop comprehensive cost benefits and analytic tools that allow deployers to understand the financial and operational benefits of new technologies and systems (Development); and to establish the tools that support the new user base (Adoption). 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 (Development); 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 (Development); 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 (Adoption); and to facilitate availability of testing and certification processes and procedures

Anticipated Program Activities:
In FY22, 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.

The ITS Deployment Evaluation Program will continue to modernize, and make more efficient, how the benefits/costs/lessons learned databases operate and are presented to the public. The Program will conduct its activities in very close coordination with the ITS PCB Program to leverage partnerships and ensure continued value of these data resources. Further, the Program will continue its analytics work using longitudinal and new ITS deployment data, and continue to populate the databases and manage the online presence of these data. The Evaluation Program will continue to integrate deeper into the ITS JPO research program, particularly with our modal partners and across the Department as a whole – and fine-tuning the Technology Transfer techniques and opportunities to make this happen.

Planned activities in in the Interoperability Program include further development of the reference architecture to accommodate emerging connectivity and automation technologies, additional IOO needs as well as to further integrate advancing cybersecurity research results into the architecture reference and toolsets. ITS standards development activity planned includes development of interface standards to support cooperative automation as well further connectivity and infrastructure standards development to take advantage of research results to support interoperable Nationwide ITS deployments. Efforts will continue to identify and specify means to best leverage advancing 5G and other technologies or ITS use, including updating the reference architecture and appropriately participating in relevant ICT standards development activity.

Data Access and Exchanges

Program Description and Objectives:
This research area focuses on enabling access to core transportation data across the ITS ecosystem, including data and source code generated through the DOT's ITS research investments, to accelerate deployment of new ITS technologies, cut the time from research to insight and policy-making, and drive secondary research results. 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. 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.

Anticipated Program Activities:
Research Data Access – ITS JPO anticipates that activities in FY2022 will be analogous to activities in FY2021, with the number of projects requiring data and source code management support increasing while the cost of supporting each project decreases due to improved efficiencies and economies of scale. Whether an increase in funding for new shared services and features is needed in FY2022 will depend on the nature of the research projects launched in FY2021 and planned for FY2022, since new types of research may produce novel forms of data and source code. Funding and activities will also depend on planned activities in FY2021 such as shared service handoffs and establishment of new, related Centers of Excellence elsewhere in the Department. Specific funding levels and activities will be developed in collaboration with the ITS research program managers and shared service partners.

Data Exchanges – ITS JPO anticipates that activities in FY2022 will be analogous to activities in FY2021, though new data exchange identified in FY2021 could result in new projects to address those data exchange needs in FY2022.

Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)

Program Description:

The ATCMTD is statutorily required in the FAST Act Section 6004, 23 U.S.C. 503(c)(4). The ATCMTD 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 and Congestion Management Technologies Deployment Initiative (ATCMTD) 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 autonomous 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 (DOT) encourages partnering among the private sector, public agencies, research institutions, technology leaders, and other transportation stakeholders.

Program Objectives:

The DOT's vision for the ATCMTD initiative is the deployment of advanced technologies and related strategies to address issues and challenges in safety, mobility, sustainability, economic vitality, and air quality 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 FY22, the ATCMTD 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 first ATCMTD annual report as mandated by the FAST Act.

Small Business Innovation Research (SBIR)

Program Description:

The SBIR program is a highly competitive, awards-based program that encourages domestic small businesses to engage in research and development addressing high priority research areas within USDOT. The SBIR program 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.

The program is administered by the Volpe Transportation Center. The SBIR Program Office publishes one or two solicitations each fiscal year for proposals on specific research topics of interest to USDOT operating administrations, including the FHWA.

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 FHWA 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 FHWA and Departmental Strategic goals. Given that the SBIR program is available to all 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 FY21 the FHWA 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 FY22, 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 FHWA SBIR program will continue with the Technology Readiness Level (TRL) Assessments at the end of Phase II.