United States Department of Transportation

Annual Modal Research Plans FY 2021
Program Outlook FY 2022

FEDERAL TRANSIT ADMINISTRATION
September 1, 2020
Mary A. Leary, PhD

Chapter 1 – Executive Summary

The mission of the Federal Transit Administration (FTA) is to improve public transportation for America's communities. The FTA's research vision is that the United States (US) has a world-class public transportation system with access and mobility for all. The FTA's research mission is to advance public transportation by accelerating innovation that improves peoples' mobility, enhances public transportation operations, and ensures everyone's safety. The FTA's research activities are authorized by Federal public transportation law (49 U.S.C. § 5312), which states that the Secretary of Transportation: "may make grants and enter into contracts, cooperative agreements, and other agreements for research, development, demonstration, and deployment projects, and evaluation of research and technology of national significance to public transportation, that the Secretary determines will improve public transportation." Consistent with the strategic goals of the U.S. Department of Transportation (DOT), all of FTA's research projects fall within one of three major program areas: safety, mobility innovation, or infrastructure.

This FTA Annual Modal Research Plan (AMRP) for Fiscal Year (FY) 2021, and FY 2022 is consistent with the FY 2020 AMRP. This AMRP continues to support the innovation goals of Federal public transportation legislation; the strategic goals of the DOT and FTA's research program areas of safety, mobility innovation, and infrastructure. The FTA also continues to highlight statutory programs such as the Small Business Innovation Research Program (SBIR), and the Transit Cooperative Research Program (TCRP). Finally, this AMRP discusses FTA's activities to promote research results through Technology Transfer and Performance. There is one major change to this year's plan – a new area of cross-cutting research. The FTA intends to investigate the potential of artificial intelligence and machine learning technologies to improve public transportation across the three research program areas.

The FTA's overarching research goals are to improve operations, enhance the travelers' experience, and drive economic growth in America's communities through research in safety, mobility innovation, and infrastructure. Each research program area also has specific goals:

- **Safety** – to research new technologies, practices and designs to improve safety culture, identify hazards and risk, and assess processes that can help transit agencies operate public systems in a safer manner to reduce injuries and fatalities.
- **Mobility Innovation** – to lead in the development and deployment of new technologies and practices that enhance transit operational efficiency, increase mobility and accessibility, and reduce costs. Core objectives in this research are furthering partnerships to increase mobility, research, collaboration, and coordination.
- **Infrastructure** – to stimulate economic growth and evaluate methods, transit assets, service approaches, maintenance strategies, and practices that hold promise to improve lifecycle maintenance as well as system operations and performance.

The FTA manages TCRP, as authorized by Federal public transportation law (49 U.S.C. § 5312(i)). The FTA also supports the DOT requirement to utilize 3.2% of discretionary research dollars for the SBIR program. Additionally, FTA seeks to improve accountability and ensure research results are available to the public transportation industry through the Technology Transfer and Performance Program.

In addition to the above-mentioned research efforts, FTA requested an additional $8 million of General Funds for "new crosscutting research" in artificial intelligence and machine learning in FY 2021. This new area of inquiry will assess the potential of artificial intelligence and machine learning technologies to improve public transportation. The funding will lead to projects that support both the DOT strategic goals of innovation and infrastructure. Specific research activities will be associated with the Transit Automation and Artificial Intelligence (AI), Machine Learning, and Robotics program under FTA's Mobility Innovation and Infrastructure research priorities. Artificial intelligence and machine learning technologies have the potential to improve reduce costs, increase mobility, and enhance transit asset management.

The FTA understands the importance of a broad constituency of partners. Partners help to extend research, build upon research findings, and reduce duplication. FTA certifies that its research, development and technology (RD&T) activities are non-duplicative with known prior or current projects within FTA (intra-agency duplication). To prevent intra-agency and inter-agency duplication, FTA values collaboration with a large network of internal and external partners. The FTA's close internal DOT partners include the Federal Highway Administration (FHWA), the Intelligent Transportation Systems Joint Program Office (JPO), the National Highway Traffic Safety Administration (NHTSA), the Federal Aviation Administration (FAA), the Federal Motor Carrier Safety Administration (FMCSA), the Federal Railroad Administration (FRA), and the Volpe Center. Examples of research collaboration areas across DOT modes include accessibility research, human factors research, mobility research, and the use of unmanned aerial systems.

The FTA also works closely with external partners. External partners include transportation associations, academic institutions and research centers, nonprofit organizations, consulting firms, and other Federal agencies. Key external association partners include the American Public Transportation Association (APTA); the Conference Of Minority Transportation Officials (COMTO); and the Community Transportation Association of America (CTAA). Academic centers working closely with FTA are the Center for Urban Transportation Research (CUTR) at the University of South Florida; Auburn University; The Ohio State University; the National Transit Institute at Rutgers University, and the Altoona Bus Testing Center at Penn State. Consulting organizations that often partner with FTA are the Center for Transportation and the Environment (CTE) and CALSTART. Another important partner for FTA is the Transportation Research Board (TRB) of the National Academy of Sciences, Engineering, and Medicine (NASEM) – TRB hosts the TCRP program and also provides a yearly opportunity for all transportation sectors across the globe to meet, talk, share, present, and learn from each other through their annual conference. The FTA also benefits from interagency partnerships with the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR); the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) and Vehicle Technology Office; the U.S. Department of Labor (DOL); and the U.S. Department of Homeland Security (DHS). Additionally, FTA works with key nonprofit partners such as the Shared Use Mobility Center (SUMC); and the Transit Center. Finally, the most important external partners for FTA's research are its customers – the public transit agencies, their workforce, and the people they serve. Typically, 70% of FTA's research funds go to demonstration programs that test promising technologies and approaches at public transit agencies. The FTA has a grassroots research approach based on identifying solutions that add value to public transportation's daily activities.

To conduct its technology transfer (T2) and deployment activities, FTA is establishing a Research to Practice Initiative. The FTA plans to announce a Notice of Funding Opportunity (NOFO) for this initiative in the fall of 2020. The FTA's goal for this initiative is to identify the most effective methods to disseminate lessons learned from FTA funded research projects so public transportation entities are informed and able to implement the findings.

The FTA continues to collaborate with DOT partners to promote good data governance, innovative data management practices, and transparency. Over the course of FY 2021, FTA will:

- Continue to work with the OST to provide recipients of FTA research funds with guidance and technical assistance on public data access requirements and data management plans per DOT's guidance.
- Work with the Bureau of Transportation Statistics to register new research products in a timely manner under the relevant Department catalogs (e.g. ROSA P, research hub, data.transportation.gov).

- Collaborate with the ITS JPO on examining the uses of the Secure Data Commons to store and analyze data related to public transportation research.

The primary anticipated outcomes for FTA's research are the specific objectives noted in each program section in this AMRP. However, at a high level, FTA anticipates that by fielding high quality, timely research, development, deployment, demonstration, and evaluation projects, we will enhance public transportation operations, reduce costs, improve travelers' mobility, and advance the economic vitality of America's communities. The FTA is in the process of finalizing specific measures and targets to assess success on a yearly basis for public transportation innovation research. In FY 2019 and FY 2020, FTA invested in and built out a strong analytical capability through data science techniques, resources, and personnel. The FTA's data scientist is the lead for managing the collection and analysis of data; and monitoring anticipated outcomes.

The FTA will implement a performance measurement framework for its three research program areas: safety, mobility innovation, and infrastructure. The FTA drafted measures of efficiency, effectiveness, and quality for each priority. The performance measures follow FTA's nested research framework approach where the results of specific projects feed into measures for broader research topics. The FTA identified output and outcome measures. The FTA created an inventory of datasets that include transit service provided (i.e. from FTA's National Transit Database – NTD), travel patterns (using data from the Census and the National Household Travel Survey), the location of transit service (using the National Transit Map), and data that relates transit usage to environmental and health outcomes. This inventory may be a source of future performance measures and analysis to identify new research needs or the impact of FTA funded services. The FTA also developed a technology inventory identifying and categorizing the approximately 45 technologies and the implementation status of each technology. Implementation status phases include: the project is started, the demonstration is underway, the demonstration is completed, and the evaluation is completed. The FTA will track the implementation status of our technologies on a quarterly basis. For demonstration programs, FTA is statutorily required to have an independent evaluation of the program within two years of implementation.

The Office of the Assistant Secretary for Research and Technology (OST-R) launched twelve cross-modal topical research working groups to bolster cross-modal coordination, reduce duplication, and leverage related cross-modal research activities. Table 1 provides examples of FTA's participation in these working groups.

Table 1 – FTA Participation in the Topical Research Working Groups

DOT Strategic Goal	Working Group	FTA Participation
Safety	**Automation**: Enable the safe integration of automated vehicles, vessels, and unmanned aerial systems into the transportation system.	FTA is active in this working group as automation is a key area of research for FTA.
	Systemic Safety Approach: Use systemic, performance-based approaches to ensuring transportation system safety.	FTA is actively involved in this working group as safety research is a key area of focus for FTA.
	Human Factors: Ensure the integration of human factors into the design of the transportation system.	A FTA staff member chairs this working group and FTA is building out a cross-cutting human factors research program.
Infrastructure	**State of Good Repair**: Maintain transportation assets in a state of good repair, ensure resilience to natural and man-made threats, and optimize material cost and durability.	FTA is active in this working group as state of good repair is a major area for FTA activities, and publishes a biennial report with FHWA on the conditions and performance of roads, bridges and transit.
	Economic Competitiveness: Stimulate economic growth, productivity, and competitiveness through transportation infrastructure investments.	FTA has not historically been active in this working group.
Innovation	**Emerging/Enabling Technologies**: Advance the development of emerging/enabling practices and technologies.	FTA is active in this working group as enabling technologies such as artificial intelligence and machine learning hold promise for improving public transportation.
	Mobility Innovation: Use innovative business models, partnerships, and private-sector solutions to expand mobility options for travelers, including underserved communities such as people with disabilities and rural residents.	FTA chairs the Mobility Innovation working group and hosts monthly working group meetings. FTA established and maintains a SharePoint site to facilitate communications and information sharing. A standing agenda item of the monthly working group meeting is a USDOT-wide accessibility related topics. Mobility Innovation is one of FTA's three major programs and areas of inquiry.
	Cybersecurity: Develop approaches for maintaining the cybersecurity of the transportation system.	FTA is active in this group through FTA's Office of Transit Safety and Oversight (TSO) who participates in this group.

DOT Strategic Goal	Working Group	FTA Participation
Accountability	**Technology Transfer/Deployment**: Facilitate the deployment and adoption of DOT research products into the transportation system.	FTA is active in this working group and is building a strong research to practice initiative.
	Evaluation/Performance Measurement: Monitor and evaluate the contribution of research, development and technology activities toward the achievement of DOT strategic goals and objectives.	FTA is active in this working group sharing how FTA implements demonstration evaluations.
	Data: Ensure access to high-quality data to support data-driven technologies, operations, and decision making.	FTA is active in this working group providing input through new data science activities, and helped to lead several joint data science information sharing meetings.

In FY 2021, FTA will conduct research activities to help public transit agencies respond to the challenges of the COVID-19 public health emergency. FTA expects to field research activities in three key areas:

1. Vehicle, Facility, Equipment, and Infrastructure Cleaning and Disinfection – research best practices and advanced technologies for bus, station, and rail car sanitation and decontamination including assessing the potential of new ventilation systems to decontaminate en-route and reduce the potential for disease transmission;
2. Exposure Mitigation – continue to help transit agencies identify promising contactless and cashless payment systems and develop contact tracing mechanisms; and
3. Increase Public Confidence – aid public transit agencies in their understanding of human factors issues related to the pandemic, and ways to incentivize workers and travelers to practice healthy behaviors such as wearing masks and maintaining social distance. Additionally, research will look at the use of social media/crowd-sourcing and other outreach mechanisms to educate travelers and inform them of any dangers, identify less crowded public transit routes/vehicles, and implement preventative strategies to keep transit workers safe.

The FTA will also evaluate the efficacy of unmanned aerial systems (UAS) and robotics to enhance maintenance services in support of COVID-19 sanitation. FTA will build upon other modes' experiences with UAS.

Additionally, FTA recipients of research projects will be asked to incorporate COVID-19 and infectious disease prevention into their projects where applicable. An example is the Bus Compartment Redesign Program projects. This research will support the development of new transit bus operator compartment designs that protect operators from assault and improve their

view of the road while ensuring they can still interact with passengers. Given what transit agencies are learning about the danger of operator exposure to COVID-19, this program will also develop solutions that protect bus operators and riders from the spread of infectious diseases.

Currently, FTA is conducting the "Transit Bus Operator Temporary Barrier for COVID-19 best practice" study under the Standards Program, funded under FTA's Technical Assistance and Workforce Development (U.S.C. 49 § 5314). Transit agencies across the US have taken temporary measures to reduce the number of close interactions (within six feet) between transit bus operators and passengers due to COVID-19. A potential short-term solution to protect bus operators and passengers is the implementation of a physical barrier that creates unidirectional flow or positive pressure around the bus operator workstation and front section of the bus. Introducing such unidirectional flow from the front to rear of the bus, as opposed to circular flow, could improve the health of bus operators and passengers. The goals of this effort are to (1) demonstrate the feasibility of a temporary physical barrier while maintaining both positive pressure around the bus operator compartment and unidirectional flow of air in the bus, and (2) document potential impacts to Heating, Ventilation, and Air Condition (HVAC) system and/or modifications needed and provide guidance document to the industry.

In summary, COVID-19 research will lead to new FTA research partners and demonstrations with public transit agencies that can enhance many other areas of public transportation innovation activities.

FY 2021 RD&T Program Funding Details

RD&T Program Name	FY 2021 Enacted FAST Act Extension (Rebaseline) ($000)	Basic ($000)	Applied ($000)	Development ($000)	Technology ($000)
Mobility Innovation	12,416		5,000	3,416	4,000
Infrastructure	6,736			3,000	3,736
Safety	4,208			3,000	1,208
Technology Transfer and Performance	1,000		1,000		
Small Business Innovation Research (SBIR)	640		640		
Transit Cooperative Research Program (TCRP)	5,000		5,000		
Totals	**30,000**	**0**	**11,640**	**9,416**	**8,944**

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

RD&T Program Name	FY 2021 Enacted FAST Act Extension (Rebaseline) ($000)	SAFETY ($000)	INFRASTRUCTURE ($000)	INNOVATION ($000)	ACCOUNTABILITY ($000)
Mobility Innovation	12,416			12,416	
Infrastructure	6,736		6,736		
Safety	4,208	4,208			
Technology Transfer and Performance	1,000				1,000
SBIR	640			640	
TCRP	5,000		5,000		
Totals	**30,000**	**4,208**	**11,736**	**13,056**	**1,000**

Chapter 2 – FY 2021 RD&T Programs

Safety
$4,208,000

Program Description:

The FTA's Safety research program will continue to provide leadership and vision in the development and management of initiatives that improve the safety of passengers, employees, emergency responders, and all others who encounter the public transportation system. The FTA will continue to support research on technologies and practices that can reduce fatalities and injuries, improve safety culture, identify hazards and risk, and assess processes that can help transit agencies operate public systems in a safer manner to reduce injuries and fatalities.

As FTA builds its program to conduct safety oversight, the FTA Research office has been a participant in developing and honing the safety program over time by providing for critical safety research and demonstration projects and supporting the development of safety standards. Though the safety standards program is funded under a different statute, there is a close interplay between safety standards and safety research – both activities inform the other. The Safety Research and Demonstration (SRD) program and the safety standards research work strives to provide the transit industry with innovative tools and practices to operate transit systems in a safer manner and with an improved safety culture. The FTA's safety standards research projects have contributed to closing several National Transportation Safety Board (NTSB) recommendations, including in areas on NTSB's Most Wanted List, provided critical research and analysis on how transit agencies can address and mitigate safety hazards in their system to lower their safety risk contributing to the production of their Agency Safety Plans (49 C.F.R. Part 673), and provided a mechanism for FTA to engage closely with stakeholders, standards development organizations (SDOs), and industry standards working groups. As transit agencies across the country finalize their initial Agency Safety Plans and begin to implement their Safety Management System, FTA will continue to coordinate with the transit industry in adopting new or revised voluntary safety standards, guidelines, and best practices developed through the safety research program.

Program Objectives:

1. To operate systems in a safer manner through improved:
   o Application of advanced technologies and innovative practices
   o Safety cultures
   o Human factors

2. To reduce injuries and fatalities by using:
   o Innovative technologies to improve worker safety
   o Innovative technologies to improve rider safety

Anticipated Program Activities:

1. *Safety Research and Demonstration (SRD):* Continue the data collection, evaluation and publication of the FY 2016 SRD Program Evaluation Report in the areas of collision avoidance technology demonstrations and wayside worker protection demonstrations. Award and provide oversight for demonstration projects for the FY 2020 SRD program in the area of trespassing and suicide demonstrations and shared corridor operational safety for rail, including highway-rail grade crossings. Conduct knowledge transfer activities for SRD Projects and programs through industry venues such as APTA conferences, TRB, industry magazines, workshops and conferences.
2. *Innovations in Transit Public Safety*: Funds innovative projects that assist transit agencies with identifying and adopting specific measures to address public safety in transit systems, including crime prevention, human trafficking, and operator assault.
3. *Integrated Safety Systems Innovation:* Evaluate the lessons learned from the SRD that provided technical and financial support for transit agencies to pursue innovative approaches to eliminate or mitigate safety hazards. Assist in determining how to best integrate emerging technological solutions to improve safety for public transportation.

Expected Program Outcomes:

- Continue to collect data to assess the safety efficiency and effectiveness measures to track the program's performance.
- Advanced technologies, innovative practices and industry standards, as well as, improved safety culture development and human factors.
- Improve transit capital and operational efficiency while supporting improved transit system safety to reduce injuries and fatalities by using innovative technologies, practices and standards that improve worker and rider safety.
- Use data to improve transit agency safety policies and practices.
- FTA monitoring of safety trends that FTA's research and demonstration projects seek to mitigate: injuries and fatalities resulting from bus collisions with pedestrians and bicyclists, injuries and fatalities involving track workers, and injuries and fatalities from suicides and trespassers on fixed guideway systems.

Collaboration Partners:

- Internal partners: OST-R, FHWA, NHTSA, FMCSA, FRA, the Volpe Center, and the JPO.

- External partners: the Transit Research Analysis Committee (TRAC), the Transit Advisory Committee for Safety (TRACS), the Transportation Research Board (TRB), APTA, and other trade associations, academia, and private consulting firms.

Mobility Innovation
$12,416,000

Program Description:

The FTA's Mobility Innovation research program will continue to strengthen the capacity of transit agencies and communities to navigate the dynamic, evolving landscape of personal mobility. The FTA will continue to leverage emerging and innovative technologies and will continue to facilitate public-private partnerships to allow for a user-centric approach that improves mobility options for all travelers, including travelers with disabilities, travelers from rural areas, lower income travelers, and goods and services.

Program Objectives:

1. To improve transit operations and reduce costs by leveraging public and private assets and technologies.
2. To improve personal mobility by identifying and promoting seamless transportation models that engage all modes – public and private - for enhanced mobility of all travelers.

Anticipated Program Activities:

1. *Mobility on Demand (MOD):* Complete MOD Sandbox demonstrations and publish project final report and independent evaluation reports. Complete and publish Mobility Performance Metrics (MPM) report based on metrics validation and field test results. Engage in technology and knowledge transfer activities to promote wide deployment of proven MOD practices in transit.
2. *Transit Bus Automation Research:* Manage the Automated Driving System Demonstration Grants and coordinate with other operating administrations as appropriate. Manage transit bus automation demonstration projects for automated advanced driver assistance systems and automated shuttles (part of the Integrated Mobility Innovation (IMI) demonstrations). Engage in DOT-wide automation research activities and discussions representing public transportation perspectives.
3. *Accessible Transportation Technologies Research Initiative (ATTRI):* Conduct complete trip research and coordination activities in partnership with FHWA. Conduct integrated demonstrations of selected ATTRI technologies.
4. *Mobility Payment Integration (MPI):* Award and manage mobility payment integration demonstrations (part of IMI demonstrations). Conduct MPI technology scan and enabling research.
5. *Integrated Mobility Innovation (IMI):* Manage and independently evaluate selected IMI demonstration projects. Through partnership with Michigan DOT (MDOT), conduct independent evaluations on selected MDOT Mobility Challenge projects.

6. *Accelerating Innovative Mobility (AIM):* Establish AIM technical assistance networks. Award and manage AIM Challenge Grants. Launch AIM incubator inaugural activities.
7. *Transit Automation and Artificial Intelligence (AI), Machine Learning, and Robotics:* Start the study on the application of AI, machine learning, and robotics to public transit.

Expected Program Outcomes:

- Improve the efficiency, effectiveness, and quality of public transportation services through adaptation to new mobility options by public transportation providers.
- Identify promising services and practices in the evolving mobility marketplace and help transit agencies make the shift to being managers of personal mobility.
- Empower smart travelers who make optimal mobility decisions.
- FTA monitoring of mobility innovation trends where our investments are a contributing factor: the number and change in transit agencies that partner with transportation network companies, and the extent to which autonomous transit vehicles are being deployed in cities around the country.

Collaboration Partners:

- Internal partners: OST offices, FHWA, NHTSA, FMCSA, FRA, FAA, the Volpe Center, and the JPO.
- Other Federal partners: DOL, NIDILRR and the U.S. Department of Energy's Vehicle Technology Office.
- External partners: Shared Use Mobility Center, APTA, CTAA, Mobility on Demand Alliance (MODA) by Intelligent Transportation Society of America (ITSA), CUTR, and private sector consulting firms.

Infrastructure
$6,736,000

Program Description:

The FTA has a successful history of supporting transformative public transportation infrastructure research and demonstration projects to include those assets that are used to directly support and provide public transportation service. The FTA will explore advances in technology to enhance public transportation operations across all aspects of system services – from the design of buses, to effectively maintaining and managing important transit assets, and ensuring state of good repair. The FTA will leverage cross-modal and cross-agency relationships to identify the most promising new technologies capable of transforming public transit operations.

Program Objectives:

1. Utilize innovative approaches to improve asset management and state of good repair.
2. Promote economic growth and bus operator health and wellness through better bus designs.
3. Enhance public transit operational effectiveness and efficiency through new technologies such as unmanned aerial systems, artificial intelligence and robotics.
4. Using simulation and modeling, explore new energy technologies and innovative bus designs in partnership with the Department of Energy.

Anticipated Program Activities:

1. *Bus Compartment Redesign Program Phase I:* Announce project awards to grant recipients. Begin efforts of Phase I objectives to conduct a study and draft designs on the redesign of the transit bus operator compartment. Prepare and advertise solicitation package for external reviewers to aid FTA in analyzing Phase I efforts.
2. *Unmanned Aerial Systems (UAS):* Study the application of unmanned aerial systems.
3. *Asset Management and Asset Innovation:* Demonstrate techniques to monitor the "health" of transit assets using advanced technologies including sensors, innovative construction techniques, and Nano-technology.
4. *Artificial intelligence, modeling, simulation, robotics to enhance public transportation systems and infrastructure:* Start the study on the application of AI, machine learning, and robotics to public transit.

Expected Program Outcomes:

- Change in infrastructure solutions demonstrated.
- Change in infrastructure technologies deployed that were sponsored by FTA.
- Growth of private sector businesses leveraged by FTA's investments.

- FTA monitoring of infrastructure improvements where our investments are a contributing factor, including the change in share of transit agency fleets that consist of advanced propulsion vehicles (such as battery operated, fuel cell, electric and other non-traditional vehicles).

Collaboration Partners:

- Internal partners: OST-R, FHWA, NHTSA, FMCSA, FRA, and the JPO
- Other Federal partners: Department of Energy, DHS and Volpe Center,
- External partners: The Ohio State University, Auburn University and organizations like CALSTART, CTE, and CUTR.

Transit Cooperative Research Program (TCRP)
$5,000,000

Program Description:

TCRP is authorized in Federal public transportation law (49 U.S.C. § 5312(i)) and operated through TRB. TCRP provides applied research with near-term, practical results addressing key challenges facing the public transportation industry. Recently published research reports address critical issues such as public-private partnerships, value-capture financing, shared use mobility, rail transit safety, emergency response, and multiagency electronic fare payment systems. The TCRP Oversight and Project Selection (TOPS) Commission is monitored and supported through a panel of expert practitioners from the industry and managed by TRB staff.

Program Objectives:

1. Identify transit problems in need of research and development (R&D) investigation; and to establish a priority ranking for them.
2. Provide an opportunity for transit operators, local government officials, and many other constituents - including construction organizations, financiers, real estate developers, and community representatives - to identify problems and participate in developing appropriate solutions.
3. Improve communications, technical information transfer, and dissemination.
4. Provide a means of addressing a variety of near-term transit problems in cooperation and in coordination with Federal public transportation research.

Anticipated Program Activities:

1. *Solicit research ideas from practitioners and the public:* Issue a broad call to public transportation and related industries for members of the public to identify challenges common in practice.
2. *Research Project Selection:* Screening Committee conducts an initial review of proposed projects. Those that merit further consideration move to the TOPS Commission for final review, ranking, and selection.
3. *Research Project Panel Development and request for proposals from research organizations:* TRB staff solicit volunteers to serve on expert practitioner panels and identify liaisons from FTA.
4. *Conduct Research:* Research project panelists review proposals and select contractors to produce individual research deliverables.
5. *Dissemination:* TRB and partners share research results through bulletins, webinars, and email blasts in cooperation with key partners.

Expected Program Outcomes:

- Efficiency Measures
  - Percent of new panels formed within 6 months of project selection
  - Percent of new projects under contract within 12 months
  - Percent of research projects completed on schedule
- Effectiveness Measures
  - Percent of problem statements rated 3.5 or higher by the screening panel and TOPS
  - Percent of increase in total downloads and by TCRP product type since 2017
  - Percent of increase in number of webinar participants: NTI and TRB
  - Percent satisfactory score (only TRB)
  - Percent increase in the number of social media posts (TRB and APTA)
  - Presentations on TCRP deliverables at conferences and meetings with estimated number of attendees
- Diversity
  - Panel diversity and inclusiveness by gender and race
  - Percent of panelists representing public transportation agencies
- Quality
  - Panel satisfaction with participation in TCRP
- Impact
  - Customer satisfaction with TCRP deliverables (follow-up survey to download)

Collaboration Partners:

- Internal partners: FTA program and regional offices and FTA Office of the Administrator. FTA's Research office informally shares information about TCRP with other DOT modes as appropriate.
- Other Federal partners:
- External partners: APTA, COMTO, and NTI.

Small Business Innovation Research Program (SBIR)
$640,000

Program Description:

The FTA's SBIR program is federally mandated by the Small Business Innovation Development Act of 1982 (Pub. Law 97-219, amending 15 U.S.C. § 638) and reauthorized through FY 2022 by the National Defense Authorization Act for FY 2017 (Pub. Law 114-328, § 1834). The goal of FTA's SBIR program is to help small businesses grow by funding product development research in strategic areas such as safety, infrastructure, mobility, and other topics important to transit. The program helps invest in promising early-stage innovations that may otherwise be too high of a risk for private investors.

Program Objectives:

The FTA's SBIR program objectives align with the overall SBIR program objectives to:

1. Stimulate technological innovation.
2. Meet Federal research and development needs.
3. Foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons.
4. Increase private-sector commercialization of innovations derived from Federal research and development funding.

Anticipated Program Activities:

The SBIR program is administered by each individual agency with guidelines established by Federal law. The FTA designates R&D topics for annual solicitations and accepts proposals from small businesses through a competitive review process. The FTA's SBIR program is structured into two phases: In Phase I, FTA works with the small business as they develop a proof-of-concept and commercial potential for one of FTA's strategic areas or other topics important to transit. Phase I grants do not exceed $150,000 and cover six months. Phase I anticipated activities include:

- Proof-of-concept for Phase I project on Cost Allocation Technology for Non-Emergency Medical Transportation.
- Submission of Phase II proposal for Cost Allocation Technology will be reviewed by FTA research panel.

In Phase II, the small business further refines and develops a successful Phase I-funded product or solution. For Phase II investments, FTA expects the small business will derive future

revenues, and a lucrative commercially available product or solution. Phase II grants are typically around $750,000 and usually have a duration of two years. Phase II anticipated activities include:

- Pedestrian and Cyclist Detection Devices for Transit Buses Phase II Final Report and Pilot Test on Transit Bus.
- Agile Development of Guided Augmented Independence Travel Aid (GAIT-Aid)
- Ethnographic studies and data will be collected by GAIT-Aid research team and analyzed.
- Evaluations will take place with both GAIT-Aid V1.0 and V2.0 to evaluate the impact of the tool on the ability of those with functional limitations to travel independently.

Expected Program Outcomes:

- For Phase I Cost Allocation Technology research, FTA expects a proof-of-concept to be developed that clearly establishes technical merit, feasibility, and commercial potential. The FTA evaluates the quality of performance of the small business prior to determining whether the small business will receive Federal support for Phase II.
- For Phase II GAIT-Aid, the small business will continue Research/Research and Development (R/R&D) efforts initiated in Phase I by refining and materializing the proof-of-concept developed in Phase I. It is expected that a User-centered solution will be developed that demonstrated effective support of independent travel for individuals with functional limitations. The GAIT-Aid solution will provide not only a tool to impact everyday independent travel of individuals with functional limitations, but the GAIT-Aid technology will be used as a research platform to evaluate the impact of various Augmented Reality (AR solutions). The FTA expects the small business will derive future revenues and a lucrative commercially available product or solution that meets transit industry needs.

Collaboration Partners:

- Internal partners: OST-R, FRA, NHTSA, FHWA, JPO, and the Volpe Center
- Other Federal partners: Small Business Administration
- External Partners: Transit agencies and other industry stakeholders

Technology Transfer and Performance
$1,000,000

Program Description:

The purpose of this program is to develop a framework through which the implementation of research and technology developed, with FTA research funds, and that advances the interests of public transportation is disseminated throughout the US. This program will also monitor, report on, and improve outreach efforts to drive bringing research to practice. Additionally, it will enhance the ability of transit agencies to deploy the results of research and technology investments, and assess any governance barriers identified in demonstration programs.

Program Objectives:

1. Enable public transit agencies to effectively utilize promising research findings in their operations.
2. Enhance FTA communication with the public transportation industry regarding FTA research projects and findings.
3. Finalize a yearly scorecard that shares the strategic impacts of FTA's research investments.

Anticipated Program Activities:

1. *Information Dissemination Project:* Produce FTA final reports and publications and ensure they are 508 compliant and accessible to the public transportation industry and the public.

Expected Program Outcomes:

- Use the framework to increase the public transportation market penetration of FTA research funded projects and new innovations.
- Ensure research reports are published on FTA's website and in ROSA-P and the findings are marketed through appropriate means.
- Track and report the deployment of new innovations.

Collaboration Partners:

- Internal partners: FTA program offices, OST-R, and the National Transportation Library (NTL).
- External partners; APTA, CTAA, TRB, and CUTR.

Chapter 3 – FY 2022 RD&T Programs

Safety

Program Description:

The FTA considers safety to be the first priority. The Safety program builds from the experiences learned from previous years. In FY 2022, FTA's Safety research program will continue to provide leadership and vision in the development and management of initiatives that improve the safety of passengers, employees, emergency responders, and all others who encounter the public transportation system. The FTA will continue to support research on new technologies and practices that can reduce fatalities and injuries, improve safety culture, identify risks, and assess processes that can help transit agencies operate public systems in a safer manner to reduce injuries and fatalities.

Program Objectives:

1. Operate systems in a safer manner through improved:
   o Application of advanced technologies and innovative practices
   o Safety cultures
   o Human factors
2. Reduce injuries and fatalities by using:
   o Innovative technologies to improve worker safety
   o Innovative technologies to improve rider safety

Anticipated Program Activities:

1. *Safety Research and Demonstration (SRD):* Complete the data collection, evaluation and publication of the FY 2016 SRD Program Evaluation Report in the areas of collision avoidance technology demonstrations and wayside worker protection demonstrations. Finalize FY 2020 SRD Program Interim Evaluation Report. Continue the knowledge transfer activities for both FY 2016 and FY 2022 SRD Projects and programs through industry venues such as APTA conferences, TRB, industry magazines, workshops and conferences.
2. *Integrated Safety Systems Innovation:* Evaluate the lessons learned from the SRD that provided technical and financial support for transit agencies to pursue innovative approaches to eliminate or mitigate safety hazards. This research will help determine how to best integrate emerging technological solutions to improve safety for public transportation.

Mobility Innovation

Program Description:

The FY 2022 Mobility Innovation program will build upon the findings of prior years. It will continue to strengthen the capacity of transit agencies and communities to navigate the dynamic, evolving landscape of personal mobility. The Mobility Innovation program will continue to strengthen the capacity of transit agencies and communities to navigate the dynamic, evolving landscape of personal mobility.

Program Objectives:

1. Improve transit operations and reduce costs by leveraging public and private assets and technologies.
2. Improve personal mobility by identifying and promoting seamless transportation models that engage all modes – public and private - for enhanced mobility of all travelers.

Anticipated Program Activities:

1. *Transit Bus Automation Research:* Conduct research activities according to the 5-year Strategic Transit Automation Research (STAR) Plan, including selected demonstrations, and strategic partnerships. Transition selected automation projects from planning phase to demonstration phase.
2. *Accessible Transportation Technologies Research Initiative (ATTRI):* Publish findings and lessons learned resulting from integrated ATTRI demonstrations.
3. *Mobility Payment Integration (MPI):* Transition selected MPI projects from planning phase to demonstration phase.
4. *Integrated Mobility Innovation (IMI):* Transition selected IMI projects from planning phase to demonstration phase. Engage in technology and knowledge transfer activities to promote wide-deployment of proven IMI practices in transit.
5. *Accelerating Innovative Mobility (AIM):* Complete construct of AIM incubators to include additional agencies and related activities. Conduct activities as prescribed in the 5-year AIM Research Plan. Enhance engagement with innovative mobility industry through established and new networks, such as Shared Use Mobility Center, Mobility on Demand Alliance, and APTA, etc.
6. *AI-enhanced Smart Mobility:* Conduct global technology and practice scan on AI applications in the public transportation industry. Identify promising AI applications (e.g., transit agencies, AI suppliers and practitioners, etc.) and conduct selected AI-enabled smart mobility demonstrations that address both system operations and users/travelers.
7. *Transit Automation and Artificial Intelligence (AI), Machine Learning, and Robotics:* Start the study on the application of AI, machine learning, and robotics to public transit.

Infrastructure

Program Description:

In FY 2022, FTA will build upon the results of previous research projects, and continue new investments in innovations in bus design, transit system operations, real-time asset management, artificial intelligence, modeling/simulation, robotics, and the use of unmanned aerial systems to enhance public transportation systems across the United States.

Program Objectives:

1. Utilize innovative approaches to improve asset management and state of good repair.
2. Promote economic growth and bus operator health and wellness through better bus designs.
3. Enhance public transit operational effectiveness and efficiency through new technologies such as unmanned aerial systems, artificial intelligence and robotics.
4. Using simulation and modeling, explore new energy technologies and innovative bus designs in partnership with the U.S. Department of Energy.

Anticipated Program Activities:

1. *Bus Compartment Redesign Program Phase II:* Based upon the results of Phase I, Phase II will be deployed in close partnership with the Department of Energy.
2. *Unmanned Aerial Systems (UAS) Use Case Development and Demonstration*: Establish the period of performance, program milestones, and expected deliverables for the UAS demonstration program.
3. *Infrastructure Modeling and Simulation Laboratory:* Invest in the development of or a partnership with another agency for a modeling and simulation laboratory for advanced propulsion systems to improve bus quality, durability, maintainability, and infrastructure state of good repair.
4. *Study on the Efficacy of Bus Testing Modalities for Software Systems deployed in bus fleets:* Identify testing methods necessary to ensure secure, safe, reliable, and maintainable software solutions associated with infrastructure systems used in the deployment of public transportation services.

Transit Cooperative Research Program (TCRP)

Program Description:

This statutory program will remain unchanged in FY 2022. TCRP will continue to provide applied research with near-term, practical results addressing key challenges facing the public transportation industry. TCRP will continue to publish research reports to address critical issues such as public-private partnerships, value-capture financing, shared use mobility, rail transit safety, emergency response, and multiagency electronic fare payment systems. The TCRP Oversight and Project Selection (TOPS) Commission is monitored and supported through a panel of expert practitioners from the industry and managed by TRB staff.

Program Objectives:

1. Identify transit problems in need of R&D investigation; and to establish a priority ranking for them.
2. Provide an opportunity for transit operators, local government officials, and other constituents - including construction organizations, financiers, real estate developers, and community representatives - to identify problems and participate in developing appropriate solutions.
3. Improve communications, technical information transfer, and dissemination.
4. Provide a means of addressing a variety of near-term transit problems in cooperation and in coordination with Federal public transportation research.

Anticipated Program Activities:

- Efficiency Measures
  - Percent of new panels formed within 6 months of project selection
  - Percent of new projects under contract within 12 months
  - Percent of research projects completed on schedule
- Effectiveness Measures
  - Percent of problem statements rated 3.5 or higher by the screening panel and TOPS
  - Percent of increase in total downloads and by TCRP product type since 2017
  - Percent of increase in number of webinar participants: NTI and TRB
  - Percent satisfactory score (only TRB)
  - Percent increase in the number of social media posts (TRB and APTA)
  - Presentations on TCRP deliverables at conferences and meetings with estimated number of attendees
- Diversity
  - Panel diversity and inclusiveness by gender and race
  - Percent of panelists representing public transportation agencies

- Quality
  - Panel satisfaction with participation in TCRP
- Impact
  - Customer satisfaction with TCRP deliverables (follow-up survey to download)

Small Business Innovation Research Program (SBIR)

Program Description:

The SBIR program is a federally mandated, highly competitive program coordinated by the Small Business Administration that encourages small businesses (no more than 500 employees) to conduct research and development that has potential for commercialization. In FY 2022, the SBIR program will build on the momentum of previous research and seek out new and innovative solutions for public transportation's most pressing needs in safety, mobility, innovation, and infrastructure. FTA's SBIR program will continue to help invest in promising early-stage innovations that may otherwise be too high of a risk for private investors.

Program Objectives:

The FTA's SBIR program objectives align with the overall SBIR program objectives to:

1. Stimulate technological innovation.
2. Meet Federal research and development needs.
3. Foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons.
4. Increase private-sector commercialization of innovations derived from Federal research and development funding.

Anticipated Program Activities:

The SBIR program is administered by each individual agency with guidelines established by Federal Law. The FTA designates R&D topics for annual solicitations and accepts proposals from small businesses through a competitive review process. The FTA's SBIR program is structured into two phases: In Phase I, FTA works with the small business as they develop a proof-of-concept and commercial potential for one of FTA's strategic areas or other topics important to transit. Phase I grants do not exceed $150,000 and are six month grants. In Phase II, the small business further refines and develops a successful Phase I-funded product or solution. For Phase II investments, FTA expects the small business will derive future revenues, and a lucrative commercially available product or solution. Phase II grants are typically around $750,000 and typically have a duration of two years.

Technology Transfer and Performance

Program Description:

This program will build from results and lessons learned from previous years. For FY 2022, the program will continue to facilitate the implementation of research and technology development and to advance the interests of public transportation; monitor, report on, and improve outreach efforts to drive research to practice; enhance the ability of transit agencies to deploy the results of research and technology investments, and assess any governance barriers identified in demonstration programs; and develop a framework through which the implementation of research and technology development that advances the interests of public transportation is disseminated throughout the nation.

Program Objectives:

1. Determine the rate of technologies and research findings implemented in transit agencies across the US.
2. Continue to enable public transit agencies to effectively utilize promising research findings in their operations.

Anticipated Program Activities:

Industry Research Implementation: Implement the results of Research to Practice Initiative into the research department's processes beginning FY 2022.

[END]