

**United States Department of Transportation
FY 2020 Annual Modal Research Plans**

Federal Transit Administration

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Vincent Valdes

Federal Transit Administration Modal Research Plan Executive Summary

The mission of the Federal Transit Administration (FTA) is to improve public transportation for America's communities. The FTA's research investments support this vision through research, development, demonstration, and evaluation projects designed to help the over 7,000 public transit systems in the United States (US) grow and adapt to emerging technologies and consumer preferences. The FTA's research vision is that the US has a world-class public transportation system with access and mobility for all. FTA's research mission is to advance public transportation innovation by leading research, development, demonstration, deployment, evaluation, and implementation practices and technologies that enhance effectiveness, increase efficiency, expand quality, promote safety, and ultimately improve the transit rider's experience. The primary customers for FTA's research are transit agencies.

This FTA Annual Modal Research Plan (FTA-AMRP) for FY2020 and FY2021 supports the innovation goals of Federal public transportation legislation; and the strategic plan of the U.S. Department of Transportation (USDOT). All funding levels are aligned with the FY 2020 budget submission, and the USDOT requirement to utilize 3.2 % of discretionary research dollars for the Small Business Innovation Research (SBIR) program. For FY2020 and FY2021, FTA continues its research priorities to improve safety; expand mobility for all travelers through innovative development and deployment; and enhance economic development through infrastructure. FTA's research goals are to improve operations, enhance the travelers' experience, and drive economic growth in America's communities. These goals remain unchanged from previous years, and FTA's research industry group – the Transit Research Analysis Committee (TRAC)¹ convened as a public forum led by the National Academies of Science (NAS) – continues to provide feedback regarding the efficacy of these goals and FTA's research program.

The FTA's research activities are authorized by Federal public transportation law (49 U.S.C. § 5312), which states that the Secretary of Transportation shall provide assistance for projects and activities to advance innovative public transportation research and development. The law specifies research focus areas, including providing more effective and efficient public transportation service; mobility management; system capacity; advanced vehicle design; asset maintenance; construction and project management; environment and energy efficiency; and safety improvements. 49 U.S.C. § 5312 further stipulates a series of research phases that form a pipeline process moving from early research of promising ideas to evaluation and implementation. The FTA's research activities are increasingly data-driven, and focused to address public transportation trends. By any measure, today's public transportation agencies are challenged with trying to find ways to reduce costs and expand ridership. Though private sector firms like Uber and Lyft are increasingly important as choices for travelers, and often transit

¹ FTA funds the National Academies of Sciences to host at least yearly meetings that are open to the public to discuss and assess FTA's research activities through a group of industry leaders selected for their expertise and representative of key types of stakeholders. This committee is called the Transit Research Analysis Committee (TRAC). After each meeting, TRAC shares a letter report with FTA. For more information on this committee and the most recent letter report, please access the following URL: <http://www.trb.org/Research/Blurbs/178076.aspx>

agencies partner with them to extend service hours and geography, trend data suggests that the economies of scale for public transportation demonstrate the utility they provide when present in a city, county, or rural area. Thus, continued investments in research to help transit agencies find ways to expand mobility; reduce costs; and support economic vitality is beneficial, especially when the small level of investment is considered – FTA’s total research budget for FY 2020 is \$36.5 million is .28% of FTA’s total appropriations of \$12.91 billion and only .08% of the \$46.5 billion total operating expenses of the industry noted in the National Transit Database.

Public Transportation Trends

Federal public transportation law (49 U.S.C. § 5302) defines public transportation as: regular, continuing shared-ride surface transportation services that are open to the general public or open to a segment of the general public defined by age, disability, or low income, but does not include school bus, charter, sightseeing, intercity bus transportation or intercity passenger rail transportation, intra-terminal or intra-facility shuttle services; or courtesy shuttle service for patrons of one or more specific establishments. Data from key trends such as ridership; operating costs; vehicle revenue hours; cost per trip; and comparisons between public transportation modes (bus, rail, on demand, etc.) provides a backdrop to understanding the state of public transportation today. FTA gathers this information from transit agencies through the National Transit Database program.

The FTA’s National Transit Database FY2017 Summary and Trends Report notes public transportation ridership at 10.1 billion trips with total operating expenses of \$46.5 billion – expenses were relatively unchanged from FY2016, however ridership declined from about 10.4 billion (roughly a .3 billion ride drop over the same period). 8.6% of trips were reported by rural agencies – about .9 billion trips.

In FY2020, FTA was appropriated \$12.91 billion. If transit systems’ operating costs remain flat, this equates to a Federal investment in public transportation of about 28%. Other funding sources – fare revenue, state/local community investment, make up the bulk of the 72% remaining funds. This is consistent with the historic purpose of FTA funding to primarily support major capital investments while agencies use revenue sources for operating expenses. FTA’s legislation underscores this relationship with operating expenses requiring a 50% match from an entity and capital requires a 20% match. Though expenses have remained relatively constant, transit agencies’ vehicle revenue hours (VRH) continue to grow. VRH in FY2015 were 303.3, and in FY2017, that number grew to 315.1 – an increase of approximately 4%. VRH is useful to understanding transit operating costs. While ridership has decreased, transit operating costs remained relatively flat – even accounting for increases in fuel, capital, and other operating expenses. In that context, increased VRH as a measure shows that public transit agencies are leveraging their assets for a longer period of time.

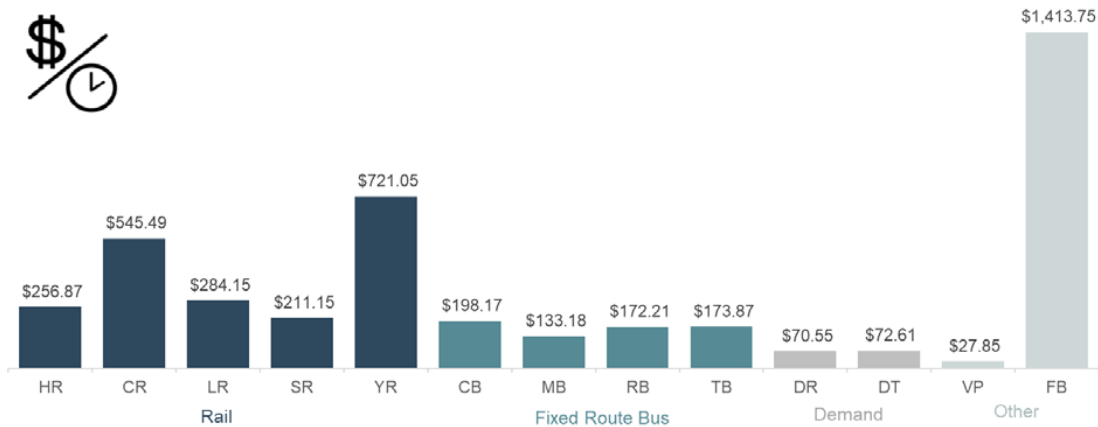


Figure 1. Cost per Vehicle Revenue Hour – Various Modes of Public Transportation – see Appendix A for definitions of the various modes²

Figure 1 shows the various costs for VRH by public transportation mode, and this is a useful comparison of modal operating costs. Commuter rail (CR) at \$546/VRH is almost twice the cost of other forms of rail on average \$250/VRH – while various fixed route bus modes average \$169/VRH. Demand response (DR), including taxis (DT) average \$72/VRH. By contrast, demand-based modes (demand response (DR) and demand response taxi (DT)) — which frequently provide single-passenger trips for individuals who meet the requirements of the Americans with Disabilities Act (ADA) — are relatively inexpensive per vehicle hour. However, because less service is consumed, the ultimate cost per passenger trip on these modes is higher than other transit modes.



Figure 2. 2017 Cost per Unlinked Passenger Trip

² Data is from the NTD Summary Trends 2017 Report, p. 8. Retrieved 3-28-2019 from URL: <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ntd/130636/2017-national-transit-summaries-and-trends.pdf>

Finally, a comparison of unlinked passenger trips to VRH in Figure 2 costs the cost per unlinked passenger trip³ and Figure 3 shows how many people are served per mode. This data shows that public transportation is a cost-effective and inexpensive mode of travel.

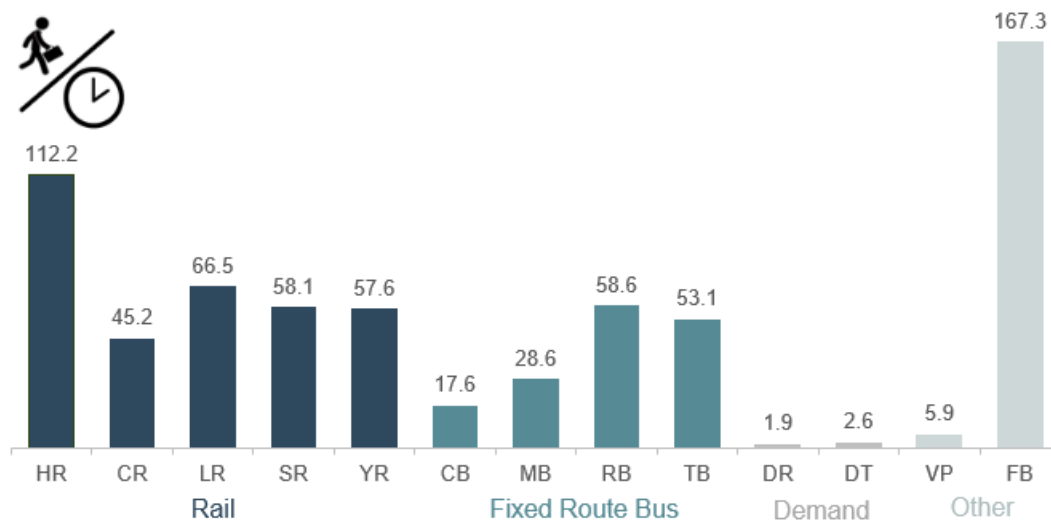


Figure 3. Unlinked Passenger Trips per Vehicle Revenue Hour⁴

Other than ferry boat, heavy rail carries the most passengers per VRH (112), while other rail and fixed route bus modes carry anywhere from 18 passengers (commuter bus) to 66 passengers (light rail). The average number of passengers carried in all forms of rail and fixed route bus is 55 passengers. Demand response modes carry a much smaller number of passengers – typically 1 to 3.

The data for cost per unlinked passenger trip and trips per VRH show the significant benefits of public transportation in a community both in terms of reduced congestion and reduced travel costs for travelers. At present, national data on the average cost per ride of transportation network companies (TNC's) like Uber and Lyft is not available, however, a recent study in Chicago showed that:

The average CTA fare is \$2.69, while Lyft and UberX rides averaged \$18.13 and \$17.90 respectively. Notably, riders who chose a carpool option for an on-demand ride spent a lot less when they rode UberPool than Lyft Line—those trips cost an average \$9.33 and \$14.04, respectively⁵.

Public transportation very safe and has many economic benefits that convey to the private sector and consumers. According to the American Public Transportation Association (APTA)⁶:

³ IBID., p. 8.

⁴ IBID, p. 16.

⁵ From a CityLab Report "The High Cost of Saving Travel Time." Retrieved 4-1-2019 from URL <https://www.citylab.com/transportation/2018/06/the-high-cost-of-saving-travel-time/563393/>

⁶ APTA Quick facts retrieved 3-28-2019 from URL: <https://www.apta.com/mediacenter/ptbenefits/Pages/FactSheet.aspx>.

- Every \$1 invested in public transportation generates \$4 in economic returns.
- Every \$1 billion invested in public transportation supports and creates more than 50,000 jobs.
- Every \$10 million in capital investment in public transportation yields \$30 million in increased business sales.
- Every \$10 million in operating investment yields \$32 million in increased business sales.
- 71% of public funding for public transportation flows to the private sector, creating and supporting hundreds of thousands of jobs. Home values performed 42% better than when located near high-frequency public transportation. A person can reduce his or her chance of being in an accident by more than 90% simply by taking public transportation as opposed to commuting by car.
- Traveling by public transportation is 10 times safer per mile than traveling by automobile.

As public transit agencies seek new revenue sources, an emerging area is congestion pricing. As an example, New York City is considering congestion pricing for the dual purpose of reducing cars and raising revenue. Outreach activities such as the FTA's and Federal Highways' research analysis partners noted the challenge emerging in 'curb space'. Cities are experiencing increased road congestion with both freight from retail trends to purchase online and with the expansion of TNC drop-off and pick-up. A bus on city streets causes far less congestion than a passenger vehicle. And dedicated lanes/subways for rail services do not increase road congestion. Given that public transportation modes such as buses and rail tend to move more people overall per vehicle than on demand rides of any kind – public and private – public transportation investment may help to mitigate road congestion.

The FTA's research programs seek to provide access to ideas and technologies for transit agencies to improve their efficiency, effectiveness, and quality of service. Federal research investments are meant to seed new ideas/technologies or act as a catalyst for innovative development and deployment. Key aspects of the Federal role in research include: leveraging both public and private assets while improving transit cost-effectiveness; ensuring effective as well as equitable mobility where everyone irrespective of age, disability, or income, can get a ride; driving a communities' economic growth; and providing a venue for exploring new mobility options and technologies. To support this mission, FTA has a research portfolio that is "grassroots" in nature, reserving the largest portion of research funds – usually about 70% - for demonstration programs at transit agencies to assess the realistic viability and sustainability of research solutions. Given the trends in ridership, VRH, cost per ride, private sector investments, and changing consumer preferences, FTA's research priorities continue to target areas where public transit agencies have the greatest need.

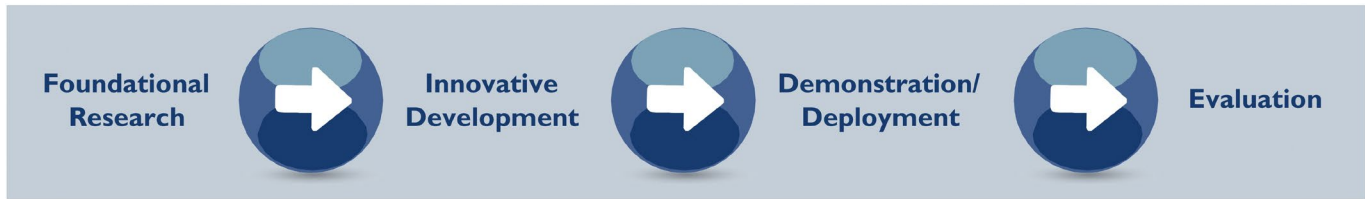
FTA Research Programs

Statutorily, there are four-phases of the FTA research pipeline process:

1. **Research** – developing and deploying new and innovative ideas, practices, and approaches.
2. **Innovative Development** – improving public transportation systems nationwide to provide more efficient and effective delivery of public transportation services including through technology and technological capacity improvements.
3. **Demonstration and Deployment** – enabling early deployment and demonstration of innovations in public transportation with broad applicability, including low or no emission vehicle deployment.

4. Evaluation and Implementation – analyzing project results and plans for broad-based implementation of research findings.

Figure 4. – Pipeline Phased Approach



The FTA’s continued focus on safety, infrastructure, and mobility innovation is based upon internal and external stakeholder feedback. The FTA’s research initiatives are part of a newly integrated approach across all USDOT’s research modes implemented by the Office of the Secretary for Research (OST-R). Over the last few years, a re-alignment of modal activities resulted from deeper cross-modal planning and topical research synergies. The FTA is leading one of these areas – the mobility innovation research group – and is an active participant in many other topical working groups especially those relating to safety, data, evaluation, and innovation. The FTA’s research priorities build upon the USDOT Secretary’s goals around safety, infrastructure, innovation, and accountability. The FTA also seeks input from the industry on its areas of research through TRAC. In these meetings, FTA discusses research results; new research ideas; and trends in the public transportation industry. Then the members of the committee provide their feedback and perspectives. These meetings provide vital input that helps FTA hone its research investments.

The FTA’s research programs directly support USDOT’s Strategic Plan goals in the following ways:

- **Safety** – research new products, ways to 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.
- **Infrastructure** – stimulate economic growth and evaluate methods, transit assets, service approaches, maintenance strategies, and practices that hold promise to improve lifecycle maintenance as well as systems operations and performance.
- **Mobility Innovation** – 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 public private partnerships, research, collaboration, and coordination.

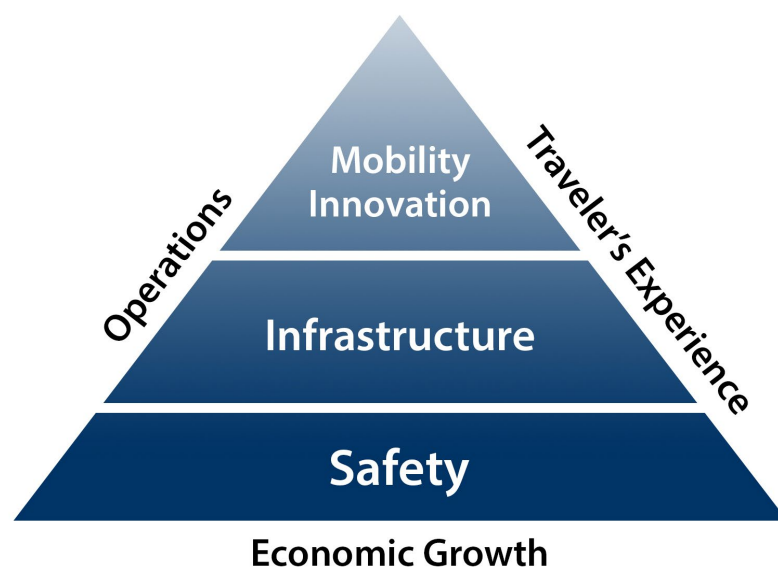


Figure 5. FTA Research Priorities and Goals

To ensure FTA meets the Secretary's strategic goal of accountability, FTA created the Technology Transfer and Performance Program. Key strategies for this initiative include increasing operational efficiency; strengthening technology transfer; facilitating the development of data-driven decision making; and improving program performance through a robust evaluation initiative. Additionally, an important, statutorily required extramural research program is the Transit Cooperative Research Program (TCRP). TCRP was established through Federal public transportation law (49 U.S.C. § 5312(i)). It is administered through the Transportation Research Board (TRB) of the NAS. TCRP oversees the

selection, development, and dissemination of research projects across a broad set of research topics based on the needs of the public transportation industry. TCRP provides applied research with near-term, practical results addressing key challenges identified by the public transportation industry. The FTA's research programs align with USDOT goals, as reflected in Table 1:

Table 1. FTA Research Program Alignment to DOT Strategic Plan Goals

DOT Goals	Safety	Infrastructure	Innovation	Accountability
FTA Research Programs				
Safety	✓			
Infrastructure		✓		
Mobility Innovation			✓	
TCRP		✓		
SBIR			✓	
Technology Transfer and Performance				✓

The FTA has critical research projects that support specific objectives within the USDOT goals. Often, a program with a major focus in one strategic goal may directly and significantly contribute to an objective in another strategic goal. As an example, maintaining a general state of good repair and enhancing asset conditions contribute to the priority for safety as well as infrastructure. In addition, all FTA research projects support the strategic goal of accountability and its two objectives: regulatory reform and mission efficiency. Mission efficiency is furthered through strategies to improve program performance and create small business development opportunities. Examples of USDOT objectives relating to specific FTA research programs are discussed in each program section in this document.

Collaboration Efforts

The FTA conducts its research activities through a collaborative process with internal and external partners. Over the last year, a major area of collaboration was the cross-modal exchanges facilitated by OST-R, especially through the topical research groups. The FTA's close modal partners include the Federal Highway Administration (FHWA), the Joint Program Office (JPO), the National Highway Traffic Safety Administration (NHTSA), and the Federal Motor Carrier Safety Administration (FMCSA). OST-R launched twelve cross-modal topical research working groups to bolster cross-modal coordination and collaboration and to facilitate project collaboration – this effort is particularly helpful for connecting the USDOT's surface transportation initiatives such as automation, mobility, intelligent transportation systems, safety, and accessibility. Each group is aligned with a research, development, and technology investment topic area and aligned with one of the four Departmental strategic goals of safety, infrastructure, innovation and accountability. This coordinated topical-driven approach enables FTA and USDOT to respond to new research needs that span one or more modes, and guards against duplication of research efforts. Table 2 provides a list of USDOT's working groups and as noted, FTA is an active participant in all of them.

Table 2. FTA Alignment with USDOT Strategic Objectives

USDOT Strategic Goal	Working Group	FTA Participation
Safety	Automation: Enable the safe integration of automated vehicles, vessels, and unmanned aircraft systems into the transportation system.	✓
	Systemic Safety Approach: Use systemic, performance-based approaches to ensuring transportation system safety.	✓
	Human Factors: Ensure the integration of human factors into the design of the transportation system.	✓
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.	✓
	Environmental Stewardship: Preserve the environment, ensure the safety and cost-effectiveness of alternative transportation energy sources, and ensure the safe transportation of hazardous materials.	✓
	Economic Competitiveness: Stimulate economic growth, productivity, and competitiveness through transportation infrastructure investments.	✓
Innovation	Emerging/Enabling Technologies: Advance the development of emerging/enabling practices and technologies.	✓
	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.	✓
	Cybersecurity: Develop approaches for maintaining the cybersecurity of the transportation system.	✓
Accountability	Technology Transfer/Deployment: Facilitate the deployment and adoption of DOT research products into the transportation system.	✓
	Evaluation/Performance Measurement: Monitor and evaluate the contribution of research, development and technology activities toward the achievement of DOT strategic goals and objectives.	✓
	Data: Ensure access to high-quality data to support data-driven technologies, operations, and decision making.	✓

The FTA chairs the Mobility Innovation working group. This group envisions a safe, carefree, reliable mobility ecosystem that supports the “complete trips for all⁷” concept, both in terms of personalized mobility and goods delivery. The group advances this vision by leveraging innovative technologies and facilitating public private partnerships to allow for user-centric mobility options for all travelers, including those with disabilities, from rural areas, and lower income populations.

⁷ The Complete Trip for All Concept derived from the Accessible Transportation Technology Research Initiative – ATTRI. A complete trip consists of all the steps an individual needs to do/navigate from origin to destination within the travel chain, including such links as trip planning, travel to station, station/stop use, vehicle boarding and unboarding, stops or transfers, and travel to destination after leaving the station/stop. If one link is inaccessible, then access to subsequent links is broken, and the trip cannot be completed – so the accessibility of all steps in the travel chain is a critical component of a complete trip.

The FTA's research regularly connects with a diverse range of external partners. For example, through the TCRP program, FTA is an active participant in the process that selects project ideas identified by the public transportation industry through a formal selection procedure. In another important area of FTA's work, private sector partnerships form the bedrock of research into new bus technologies including coordination with the Department of Energy's National Renewable Energy Laboratory (NREL). Additionally, as FTA works with public transit agency grantees to assess new service models, transportation network companies like VIA, Lyft and Uber are key partners. As noted earlier in this document, FTA also works closely with the National Academies (NAS) to gather input on its programs through the Transit Research Analysis Committee – in fact, in December of 2018, FHWA and FTA held the first ever joint meeting of their research industry groups. FTA interacts with small business through SBIR projects. And, industry exchanges are supported through FTA's work with the American Public Transportation Association (APTA) and the Community Transportation Association of America (CTAA). APTA is also a partner in the development of safety standards along with the Center for Urban Transportation Research (CUTR). Finally, the most important external partners for FTA's research are our customers – the public transit agencies and the people they serve. FTA's research investments are heavily skewed to ensure close connections with customers to better understand their needs, their challenges in providing transportation, the barriers they encounter when promoting mobility, and defining solutions that can extend service, cut costs, and help communities thrive.

Chapter 1. Introduction / Agency-Wide Research Approach

As noted in the Executive Summary, FTA's research directly supports FTA's mission to improve public transportation. Transit plays an important role in local communities by providing basic mobility services, as well as creating economic, environmental, and social benefits. Some of the benefits that transit creates accrue only to riders, some to private interests, some to public interests, and some to society. For example, in addition to the value of transit to riders, transit also creates economic value reflected in the premium buyers pay for homes near transit, the premium businesses pay for office space near transit, the amount drivers pay to park near transit, or the price companies pay to advertise in a transit station.

While transit construction costs and constraints on public funding for transit increase, decision makers in the US are increasingly looking to value capture strategies to recoup a greater share of the value transit creates and reinvest it into transit. Transit agencies are using value capture tools – such as air right and right-of-way leasing, and joint development, etc. – to generate revenue streams by participating in the lucrative business and development opportunities created by transit projects and systems. Local jurisdictions are using value capture tools – such as tax increment financing, special assessments, and impact fees, etc. – to tap into rising property values to finance local infrastructure improvements and encourage transit-oriented development (TOD).

Joint development occurs when a transit agency leases property it owns near a transit station to a developer to build office space or residential units, and raise revenue for transit. Another example is coordinated construction of an underground transit station and a private, mixed-use development in the air rights. Projects like these can be built using public-private partnerships (P3). Joint developments may utilize financial assistance from FTA, and since 2014, FTA has approved 16 joint development projects in eight states and the District of Columbia. FTA's original investment in these projects was \$52 million and transit agencies are using this as leverage to generate \$497 million in new revenue – a nearly 10-fold

return on FTA's investment. In addition, project sponsors estimate that these joint developments are stimulating \$1.6 billion in local, private funding for construction.⁸

Transit Increases Land Value. While transit's impact on land values varies widely based on local real estate market and transit system conditions, the value premium for land near transit is on average 30-40% compared to other properties. When and where conditions are optimal, the value premiums can be over 150%.⁹ For example, in 1975, the Washington Metropolitan Area Transit Authority (WMATA) acquired a property one block north of the Navy Yard Metro Station in southeast Washington, D.C. for \$116,500 with a federal grant covering two-thirds of the purchase price. The land currently houses a chiller plant serving the Navy Yard and Waterfront Metro stations.

In 2017, WMATA sold the property to a private real estate developer who is going to build a new, ten-story building with residences and ground floor retail space. The developer will also be obligated to, at its own cost, construct on-site, a new finished office space for WMATA staff, new housing for the chiller plant on the roof of the building, and parking and loading spaces. The developer will also store the existing chiller and provide a temporary chiller during construction. All told, the cash payment to WMATA and value of the transit improvements amount to \$11.7 million – a 151-fold return on FTA's investment. Additionally, the developer will spend \$56 million on construction.¹⁰

The FTA's research budget of \$36.5 million provides essential seed funding to help identify and test promising public transportation innovations to continue the support of public transportation. In the past, FTA's research efforts assisted the industry in adopting bus rapid transit, compressed natural gas buses, and smartcards. Today, FTA's research is well known for its work in safety standards development; testing safety technologies; facilitating emerging bus technologies in fuel cells and bus electrification; supporting research in transit bus automation, and driving new mobility models such as Mobility on Demand. Examples of expected future impacts of infrastructure and safety projects will include a better understanding of how new bus propulsion technologies perform in operational service and how bus cockpits can be redesigned to increase operator and pedestrian safety. Mobility innovations impacts will include the identification of the most promising transit bus automation solutions, as well as factors associated with success in deploying new mobility models and integrated payment systems. FTA's research seeks to give public transit agencies a path to the future. And, in FY2019, FTA's new investments in data analytics and research to practice will give FTA important information to track the adoption of models and technologies identified by FTA's research. Public transportation is a specialized industry affected by local and state governance systems and parallel issues in labor, land use and local economic development. As such, FTA's research complements the many relationships that public transit agencies maintain with their nearby academic institutions – not only do transit agencies help provide transportation to higher education, but those same institutions may reciprocate by assisting agencies with workforce, planning, technology, and operational research. FTA's research also complements private sector investments in advanced bus and transit bus automation product development, and, in FY2019, FTA began the Transit Vehicle Innovation Deployment Centers Projects with the Center for Transportation and the Environment (CTE) and CALSTART. These projects will be not only

⁸ Internal FTA-assisted joint development projects tracking database. Updated May 2019.

⁹ National Academies of Sciences, Engineering, and Medicine. 2004. Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. Washington, DC: The National Academies Press

¹⁰ Internal FTA-assisted joint development project application.

clearinghouses for information gleaned from bus testing activities, but will also enable episodic research projects to address new bus technology issues as they arise.

In FY2020, FTA will build upon past research investments in safety, infrastructure, and mobility innovation. New projects in each area are noted in the relevant program section. In FY2020 there are new projects within FTA's programs of safety, infrastructure, and mobility innovation. Additionally, FTA began a new data and technology transfer initiatives as part of its accountability program in FY2019, so FY2020 will be a critical year for seeing results from these investments in terms of our ability to articulate discrete performance outcomes and impacts. In FY2019, FTA hired a data scientist and began a robust data analytics initiative. The major focus for this new position, was during the course of FY2019, to do an inventory of available performance indicators and cross-reference this information with the types of indicators needed to measure the performance of not only the programs but also the entire research portfolio. By the end of FY2020, FTA will identify specific performance measures for all programs, research priorities, and the overall research portfolio.

The FTA research, development, and technology programs are fully represented in the USDOT Research Hub at <https://researchhub.bts.gov/search>, and the USDOT's National Transportation Library (NTL) Repository & Open Science Access Portal (ROSA P) at <https://rosap.ntl.bts.gov/>). The Research Hub is the database of USDOT-funded research projects hosting more than 10,000 records. FTA submits regular quarterly updates to the Research Hub with relevant reports and results. The information in the Research Hub includes project descriptions, performing organizations, periods of performance, funding amounts, links to final reports, datasets, and summary descriptions of research outputs, outcomes, and impacts.

The FTA also publishes final research reports on FTA's public website at <https://www.transit.dot.gov/research-innovation/fta-reports-and-publications>. To complement FTA's website and increase outreach to other stakeholders outside of public transportation, FTA is also in the process of developing a FTA special collection in ROSA-P. Finally, FTA is working with research grantees to ensure compliance with the USDOT Public Data Access Plan.

By hosting content in the Research Hub, ROSA P, and linking content to FTA webpages using persistent identifiers, FTA increases outreach; reduces duplication of storage spaces; and ensures ease of webpage URL maintenance. FTA has a liaison with USDOT's staff responsible for the Research Hub and NTL to ensure communication is accurate, consistent, and timely.

Acquisition/Assistance

The FTA's research program utilizes five primary acquisition methods – sole source grant or cooperative agreement; competitive contract; competitive grant; interagency agreement; and competitive cooperative agreement. The choice of acquisition methods is based upon statutory requirement and the availability of recipients for various types of projects. Demonstration programs are always competitive solicitations. When research projects are highly specialized, FTA will use a sole source method. Often, FTA's research requires a close collaborative relationship and a discovery planning research process. In these cases, a cooperative agreement is best because both FTA and the recipient need to work closely together as the project evolves. Additionally, when there are opportunities for cross-agency projects, FTA develops inter-agency agreements (IAA's) such as when working with the VOLPE Center. All competitive notices of

funding availability (NOFO's) are published in Grants.gov (<https://www.grants.gov/>). Most FTA research projects in are single-year acquisitions. Additionally, all demonstration grants require a minimum of 20% non-Federal match.

Technology Transfer (T2)

In FY2019, FTA created an expanded focus on technology transfer (T2) with the release of a NOFO for a Research to Practice Technical Assistance Center. The goals for this new center are to support FTA's promotion, dissemination, and tracking of the public transportation industry's adoption of FTA research findings. An essential part of FTA's national leadership role through T2 is to ensure that promising research findings and technologies benefit public transportation.

FTA's T2 vision is that research to practice and technology transfer activities employ eight key models: Knowledge transfer through training; Industry diffusion; Operational testing and demonstration; Partnerships; Standards development; Formal dissemination; Communities of practice; and Social network marketing. Research reviews identify which research findings rise to the level of adoption. As an example, FTA's mobility innovation projects benefit from a community of practice established to share information across not only FTA grantees but also other interested stakeholders. For dissemination of research reports, FTA sends out GovDelivery blasts to those who opted in the FTA's email lists. The FTA Office of Congressional and Public Affairs maintains roughly 60 GovDelivery subscriber lists with nearly 35,000 unique subscribers. The distribution list for "Research, Development, Demonstration, and Deployment," has 12,164 subscribers - more than one-third of FTA's overall subscribers. Additional outreach occurs when FTA and recipients make presentations at national industry conferences which creates a grassroots method for industry diffusion. Demonstration programs test out promising practices, then FTA's new Research to Practice Center will help develop promotion materials and track agency implementations. FTA maintains a close working relationship with CUTR for consistent report development and safety standards development. The National Transit Institute – the statutory training program for public transportation – supports knowledge transfer through training courses and special seminars. Figure 6 summarizes FTA's strategies for T2.



Figure 6. Eight Research to Practice Models

FTA maintains a close working relationship with CUTR for consistent report development and safety standards development. The National Transit Institute – the statutory training program for public transportation – supports knowledge transfer through training courses and special seminars. Figure 6 summarizes FTA's strategies for T2.

The FTA is increasing the uniformity of its activities to conduct and monitor research to practice activities across various programs. This includes the standardization of 'research to practice' language for Notices of Funding Opportunity; metrics for inclusion in Statements of Work; and regular reporting on research results.

Evaluation/Performance Measurement

Continued from the work started in FY 2018, FTA is implementing a multi-tiered, nested research evaluation framework – the FTA Nested Evaluation Research Framework (FTA-NERF). Data in this framework cascades upward from each level to the next (see *Figure 7. Nested Evaluation Research Framework*). There are four major tiers of research activities. Tier 4 relates to specific grantee activities within research projects and forms the basis for establishing results in Tier 3. Tier 3 encompasses demonstration programs that must be evaluated under federal public transportation law (49 U.S.C. § 5312(e)(4)). Tier 2 is associated with how well FTA’s research programs met efficiency, effectiveness, and quality goals. Finally, Tier 1 represents FTA’s overall research program impact – i.e. to what extent has FTA achieved the statutory mission of 49 U.S.C. § 5312 to improve public transportation through innovation. Under the FTA-NERF, the different tiers of research activity specifically build upon one another in the following way:

The Tier 3 demonstration program evaluations use Tier 4 data provided by individual demonstration project grantees to perform summative evaluations of overall program results. Evaluations assess demonstration program outcomes based upon demonstration project grantees’ pre-determined performance measures, document new questions or research needs generated by the discovery process, and harvest success stories for the 5312 Annual Report to Congress.

Tier 2 builds upon the results of the Tier 3 demonstration program evaluations and tracks longitudinal results of FTA’s three research priorities (Mobility Innovation, Infrastructure, and Safety). To provide uniformity, specific questions assess each of the three research priorities in terms of efficiency, effectiveness, and quality outcomes. These questions derive in part from the program goals, performance goals, and performance indicators defined by FTA’s three research programs. The role of FTA leadership in bringing about outcomes for each of the three research priorities is also tracked within Tier 2.

Lastly, Tier 1 builds upon the Tier 2 evaluations to articulate the impact of FTA’s research program in the form of compelling stories. Because Tier 1 applies to FTA’s entire research program, there is a strong focus on the importance of federal leadership responsibilities. In particular, inquiry relies on the concept of “research to practice” to assess the overall effectiveness of FTA’s research program in advancing public transportation innovation within the industry.

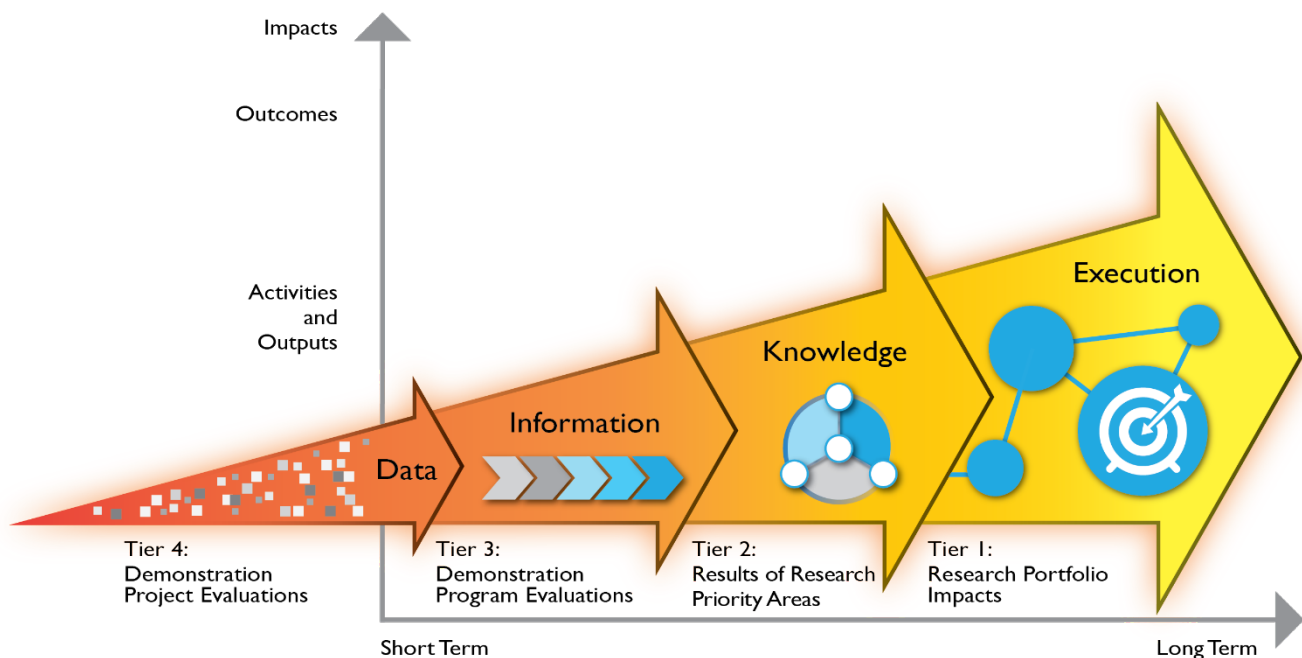
At the highest level, FTA’s research should advance public transportation innovation to solve issues facing the public transportation industry. Examples of some of these issues are declining bus ridership; rail safety; worker safety; challenges with accessible mobility; lack of public transportation infrastructure to meet the demand for services both geographically and hours of service; addressing first and last mile access to transit services; reducing the lifecycle costs of buses; taking advantage of new bus technologies; fulfilling rider expectations of real-time information for rides; public and private sector data integration; and finding ways to leverage private sector resources to reduce costs and expand public transportation. FTA is using FY 2017 research results to set key benchmarks for project performance measures. Once

fully implemented in FY2019, the FTA-NERF will enable FTA to go well beyond merely complying with federal requirements for the evaluation of demonstration programs – FTA will be able to report on research results at the program and portfolio level.

To facilitate a robust performance management environment, FTA is also developing in-house data-analytic capabilities. A recently hired data scientist will work with the multi-modal topical committee on data to learn best practices in setting up a world-class data analytic program with business intelligence tools. The goals are to utilize and standardize on the USDOT’s data analysis tools; import datasets such as the National Household Travel Survey; Census information; recipient public data resulting from FTA; the National Transit Database (NTD); TrAMS grantee information; and other useful datasets. FTA expects that through primary, secondary, and tertiary data analysis, important insights can be gleaned from research investments. This information, and the yearly measures FTA will adopt for research will then inform the FTA-NERF.

Thus, when combined with investments in data analytics and a research to practice center, this new FTA-NERF will enable FTA to demonstrate the utility of research activities, and track outcomes as well as impacts. Moreover, because the FTA-NERF is rooted in the principle of continuous improvement through rigorous problem-solving and effective leadership, it is a proactive framework that not only measures success, but contributes to it.

Figure 7. Nested Evaluation Research Framework



The FTA evaluated key terms and finalized measures and performance metrics to track research and T2 program performance. In FY2020, FTA intends to finalize performance measures and ensure that verifiable and reliable information is available for each.

Chapter 2. High Priority Project Descriptions

For the purpose of this Chapter, FTA is discussing five competitive demonstration sub-programs that, when awarded, will include a number of specific projects. The reason for this is that FTA must issue the notices of funding opportunity then award the specific projects in each sub-program. These activities and their resulting projects will further USDOT strategic goals, meet statutory requirements, and provide value to the public transportation industry. One sub-program is new, while others are an expansion of previous programs and projects: These five sub-programs are:

1. Transit Bus Automation
2. Safety Research Demonstrations
3. Real-Time Transit Infrastructure and Rolling Stock Condition Assessment Demonstrations
4. Bus Compartment Redesign (new initiative)
5. Performance Assessment.

Each sub-program has a description of why FTA is investing in the initiative; what other entities are researching the issues; what FTA has learned to date; objectives, activities, performance measures, the problem being addressed; how the activities align with USDOT Strategic goals; the expected total cost; anticipated funding for FY 2020; and any required non-Federal financial contribution.

Transit Bus Automation

Automation capabilities have grown rapidly in recent years and changed the dialogue around all aspects of the surface transportation system. Transit bus automation could deliver many potential benefits, but transit agencies need additional research and policy guidance to make informed deployment decisions. Although funding and policy constraints may play a role, there is also a reasonable unwillingness to risk public funding or to undertake new operational models without a full understanding of the approach or without Federal leadership and guidance. The goal of this sub-program is to address these transit industry issues, concerns, and needs. Research activities are organized around three complementary work areas – Enabling Research, Integrated Demonstrations, and Strategic partnerships. Collectively, the research results will address these industry challenges. In addition, stakeholder engagement and knowledge transfer activities are to occur during research implementation to ensure that the research meets stakeholder needs and that the industry can quickly build on results.

This research aligns with USDOT’s strategic goal of Innovation and the strategic objective of Deployment of Innovation. This research will ultimately result in safer transit service, increased mobility, increased transit productivity and efficiency, reduced transit agency costs from increases in safety and productivity/efficiency, improved bus operator satisfaction (e.g., less stress), and improved customer/passenger satisfaction from increases in mobility. The concepts and technical research outlined in the STAR Plan is innovative and the policy research will help to “modernize” Federal (and potentially state and local) rules, regulations, and statutes to safely support the deployment of automated vehicles

This research and demonstration effort will enable the transit industry to implement various levels of automation into transit operations and promote thoughtful adoption of the technology. Research results will address industry challenges in the areas of deployment, policy and compliance with Federal requirements. Continued stakeholder engagement and knowledge transfer activities will occur through this sub-program to ensure that the research meets industry needs and that results can be shared quickly.

Transit Bus Automation is designed to assist transit agencies with additional research and policy guidance to make informed deployment decisions. This research effort builds from the FTA developed five-year (FY 2018 – FY 2022) STAR Plan, accessible at <https://www.transit.dot.gov/research-innovation/strategic-transit-automation-research-plan-report-0116>, to advance the research, development, and deployment of transit bus automation. The total project cost and expected funding for FY 2020 is \$6,016,000.

Safety Research Demonstration (SRD) - Fixed Guideway Platform Edge Door Demonstration Sub-program

The SRD Sub-program is part of the priority to advance safety in public transportation at the US Department of Transportation (USDOT). SRD provides technical and financial support for transit agencies to pursue innovative approaches to eliminate or mitigate safety hazards through technology. The FY 2020 SRD sub-program will focus on passenger and worker protection with specific focus on the reduction and/or elimination of rail-related suicides and will be based upon findings from the FY 2019 Retrofitting Rain Transit Station Platform Doors: Cost Benefit Analysis & Pilot Program. The demonstration will explore barriers – determined by the earlier study to be cost-effective and financially feasible – to limit access to active rail transit rights-of-way to prevent pedestrian fatalities, trespassing and other illegal acts such as passengers being pushed in front of trains. Per the National Transit Database (NTD), suicides remain the most prevalent reason for transit-related fatalities.

The focus of SRD in FY 2020 will be on validating/testing platform edge doors on heavy rail transit systems. Specifically, on the retrofit of existing stations. One of major safety hazards associated with heavy rail systems with very congested stations is the possibility of objects or people falling, tripping or being pushed on to the tracks. In addition, suicide is a major incident as well and platform edge doors would prevent such incidents. Potential impacts for successful SRD projects are increased safety and operational efficiency.

The performance measures for SRD will center around safety improvement, system effectiveness and return on investment. SRD for FY 2020 build on research from previous years. In FY 2016, SRD's focus was Wayside worker protection and collision avoidance technology; in FY 2018, it was rail safety, including suicide and trespasser mitigation and prevention; and in FY 2019 it was Retrofitting Rain Transit Station Platform Doors. SRD also builds upon the Safety Standards Program. The total project cost and expected funding for FY 2020 is \$5,208,000.

Real-Time Transit Infrastructure and Rolling Stock Condition Assessment Demonstration Sub-Program

The purpose of this research sub-program is to enable transit agencies to demonstrate and leverage state-of-the-art sensor technologies to improve the state of the good repair; effectively manage their assets; increase efficiency of their operations; and improve safety. The monitoring of transit infrastructure such as elevated track, bridges, tunnels, and dedicated rights-of-way and rolling stock is critical to the transit industry. Transit infrastructure inspection using state-of-the-art technologies, such as “smart sensors”, unmanned aerial vehicles, big data analytics and other technologies, can automatically measure, record, and report, in real-time, detailed information regarding the condition of the infrastructures. Thus, potentially, allowing transit agencies to detect defects earlier and proactively track and monitor deficiencies before they could impact transit revenue services, and potentially compromise system safety.

In FY 2020, this sub-program will evaluate ‘smart sensor’ technologies, including unmanned aerial vehicles, that can monitor transit infrastructure (elevated track, bridges, tunnels, transit right-of-way, etc.) and rolling stock. It will develop analytics and practices to process big data from the sensors and provide detailed real-time information to assess the condition of the infrastructures. Projects will demonstrate how condition assessment tools can detect and track defects and deficiencies before they negatively impact safety, and reduce infrastructure lifecycle costs. It will develop and implement technology transfer as one of the main components.

The industry is seeing rapid change and continuous innovation of technologies in the area of infrastructure monitoring and assessment but has not widely applied them. With FTA investments in this area, the transit industry will be able to restore transit assets to a state of good repair by monitoring infrastructure and rolling stock condition in real time; identifying the infrastructures that needs to be replaced or maintained; using resources efficiently; and reducing infrastructure lifecycle costs.

This sub-program supports two USDOT strategic goals and critical transportation topic areas of Promoting Safety and Improving Infrastructure. Demonstration projects in this area could potentially transform how public transit agencies monitor, assess and manage their fixed infrastructure and rolling stocks. Total project costs and expected funding for FY 2020 is \$2,736,000.

Bus Compartment Redesign

The purpose of this research activity is to work with the transit industry to manufacture and test a prototype design of a transit bus cockpit to improve transit bus safety for bus operators and pedestrians. The goals are to eliminate bus operator blind-spots around A-pillars of the bus to increase driver visibility and eliminate bus operator assaults by redesigning the space around the bus driver and create a physical barrier between the operator and passengers similar to a commercial airplane or heavy rail vehicle cockpit.

The intent of the project is to completely or greatly eliminate bus operator assaults and reduce the risk of pedestrian and motorized vehicle collisions due to increased operator visibility. The performance goals are reduction in operator assaults, transit agency liability and labor productivity, and increased pedestrian safety.

According to the Bureau of Labor Statistics and the National Institute for Occupational Safety and Health, there is an increased risk of workplace violence for workers who have direct contact with the public, have mobile workplaces or deliver services, work in community settings, deliver passengers, handle money, and work in small numbers. Transit bus operators fall into this large group. Therefore, a safe working environment coupled with personal comfort is critical for transit bus operators.

Between 2014 and 2107, bus operators at LA Metro experienced an annual average about 150 assaults. LA metro says, “If an assault occurs when a bus is in motion, or in service, this can pose a deadly threat to operators, passengers on board and the public.” LA Metro also notes that each bus driver assault cost the giant agency \$49,071 per workers compensation claim for legal expenses, disability payments and medical costs. In 2015, LA Metro spent more than \$6 million in public taxpayer dollars on compensation claims. LA Metro also said that sometimes operators did not return to the job after serious assaults. LA Metro is one of about 750 transit agencies nationwide that operates some type of local transit bus service that annually report data to FTA’s National Transit Database.

This project could potentially lead transit agencies and bus manufacturers to offer for sale a better bus that would eliminate driver assaults and collisions due to A-pillar and ‘moving blind-spot’, both add to high liability, reduced service reliability and efficiency for transit services. A complete redesign and rethinking of the bus compartment could potentially mitigate, if not eliminate, these two safety issues.

Performance Assessment Sub-program

The purpose of this sub-program is to facilitate the implementation of research and technology development, assess success, and advance the interests of public transportation. This effort will monitor, and report on research outcomes. It will also enhance the ability of transit agencies to deploy the results of research and technology investments, and assess any governance barriers identified in demonstration projects.

Over the last three years, FTA has invested over \$60M in projects that assess new ways of managing and providing public transportation. Innovative projects assessed new modes of providing safety; new types of capital; new mobility service models; new public/private partnerships; and the potential of automation. In addition to understanding how to identify and implement the most successful projects in these areas. The FTA also needs to understand how the local, state, and Federal regulatory framework affects success. This sub-program is designed to understand the current state of regulations across all three governance domains – local, state, Federal – and any recommendations for policy changes that will enhance FTA’s ability to fund improvements in public transportation. In addition, this sub-program is designed to monitor, report on, and improve outreach efforts for research to practice, or Technology Transfer (T2). OST-R defines (T2) as the process by which the transportation community receives and applies the results of research. FTA research terms T2 as research to practice. Another key aspect of this sub-program is supporting dissemination of research and ensuring that all publications are 508 Compliant.

The goals of this sub-program are to understand the current state of regulations across all three governance domains; facilitate the implementation of research and technology development; support research report finalization and 508 compliance; and to advance the interests of public transportation. These activities align with the Secretary’s strategic goal of accountability, and the strategic objective of Mission Efficiency and Support. They support USDOT’s mission requirements by efficiently and effectively planning for and managing sustainable operations and other mission support services. This project builds on the Information Dissemination and Evaluation Program. The total project cost and expected funding for FY 2020 is \$2,000,000.

Two Completed High Priority Sub-programs

Mobility on Demand (MOD)

The FTA’s mobility on demand (MOD) research was created to help the public transportation industry address and benefit from emerging mobility models and technologies. New mobility concepts, technologies, and solutions – from traveler planning and payment applications to demand-responsive bus services and ride sharing service start-ups – are providing travelers with new transportation options. These new models increased access to transportation for underserved communities in rural or suburban areas through first and last mile, and circulator services. MOD research was created to address Private sector feeder services are often critical for these communities to utilize public transportation resources. The FTA’s MOD project explores the emergence of these models; how they are being implemented; and how communities can take advantage of these new technologies and service models to expand travelers’ mobility and reduce operational costs.

The MOD Sandbox projects were competed via a NOFO posted on May 3, 2016. Eleven projects were selected from across the US, as noted in Table 3.

Table 3. MOD Sandbox Projects Receiving Assistance from FTA

Project Title	Project Recipient	City and State	FTA Award	Local Share
MOD Sandbox: Adaptive Mobility with Reliability and Efficiency	Regional Transportation Authority of Pima County	Tucson, AZ	\$669,158	\$175,986
MOD Sandbox: Mobility Platform	Valley Metro Rail, Inc.	Phoenix, AZ	\$1,001,000	\$399,000
MOD Sandbox: Bay Area Fair Value Commuting Demonstration	City of Palo Alto	Palo Alto, CA	\$1,085,000	\$271,251
MOD Sandbox: Los Angeles County and Puget Sound MOD Partnership	Los Angeles County Metropolitan Transportation Authority	Los Angeles, CA	\$1,350,000	\$400,000
MOD Sandbox: Integrated Carpool to Transit	San Francisco Bay Area Rapid Transit	San Francisco, CA	\$358,000	\$163,000
MOD Sandbox: Paratransit Mobility on Demand Demonstration	Pinellas Suncoast Transit Authority	St. Petersburg, FL	\$500,000	\$125,000
MOD Sandbox: Integrated Fare Systems – From Transit Fare to Bike Share	Chicago Transit Authority	Chicago, IL	\$400,000	\$100,000
MOD Sandbox: Open Trip Planner Share Use Mobility	Tri-County Metropolitan Transportation District	Portland, OR	\$678,000	\$324,000
MOD Sandbox: First and Last Mile Solution	Dallas Area Rapid Transit	Dallas, TX	\$1,204,000	\$301,000
MOD Sandbox: Flexible Trip Planner Project	Vermont Agency of Transportation	Montpelier, VT	\$480,000	\$120,000
MOD Sandbox: Limited Access Connections	Pierce County Public Transportation Benefit Area Corp.	Lakewood, WA	\$205,922	\$51,481
Total			\$7,931,080	\$2,430,718

The FTA coordinated the MOD project activities with other USDOT research offices including FHWA, the JPO, and the Department of Energy (DOE). The FTA also leveraged significant private sector and local funding through the MOD project-level demonstration effort, the MOD Sandbox. Many MOD solutions built upon DOT’s previous work in intelligent transportation systems (ITS); the mobility services for all Americans project; connected vehicle technologies; and some of the earlier breakthroughs in fare payment technologies. The current sandbox projects are educating FTA and the public transportation industry on how to approach MOD-related policies. These innovative projects are uncovering promising technologies, and business models through both formal and informal means. Formally, independent evaluations provide invaluable information on results, and informally, a growing community of practice promotes peer to peer information exchange. Specific impacts to date in MOD include:

- Expanding options for communities and transit agencies to provide MOD-based transportation solutions.
- Enhancing transit capacity and readiness to adopt MOD solutions.
- Greater understanding of innovative business models that deliver high-quality, seamless and equitable mobility.
- Enabling FTA to adopt FTA policies on shared mobility that improve transit agencies’ and communities’ ability to implement these new service models.

- Supporting the deployment of traveler-centric, effective transportation systems that share the MOD guiding principles of system integration, and partnership-driven solutions that are innovative and equitable.

The MOD Sandbox projects were completing their work in FY 2019. The outputs of the current Sandbox projects are already helping inform FTA and the industry on MOD-related policies, and what technologies and business models work best and resonate with every community. The MOD Sandbox is also linked to MOD efforts independent evaluations and established a community of practice around MOD to support industry dialogue and facilitate implementation of successful projects. The following are relevant and significant project results MOD Sandbox:

- Vermont Agency of Transportation (VTrans): introduced the GoVermont Flexible Trip Planner Project in February 2018. The trip planner, accessible to the public at <https://plan.vermont.org/>, is the first trip planner capable of presenting all public transportation services in Vermont, connecting users in multimodal journeys that offer viable transit solutions, even in rural regions without fixed-route networks. These new features include routing for Dial-a-Ride, Hail and Ride, and Deviated Fixed services, all especially common in the rural areas that other trip planner technologies have failed to serve effectively.
- San Francisco Bay Transit Authority (BART): demonstrated an integrated carpool to transit pilot project that matches carpool users traveling to BART stations and provides a way to reserve and pay for sought-after parking at the stations, improving access to transit stations. Information on this MOD project is accessible at <https://511.org/carpool-vanpool/carpool/bart>. The project has enabled enhancements to the Scoop app platform that improve the experience for BART commuters and has successfully expanded the demonstration to 17 stations. The project is exploring the feasibility and effectiveness of this innovative first/last mile solution to connect riders to transit at multiple locations within one system and is providing insights into how to implement successful MOD solutions more broadly.
- Valley Metro Rail of Phoenix: implemented a smart phone mobility platform called Pass2Go that integrates mobile ticketing and multimodal trip planning. The network included a range of mobility providers, including ride-hailing, allowing people at all levels of income, age, and disability to have access to an integrated, connected multimodal transportation system. Phase 1, which includes a basic trip planner and full-day fare mobile ticketing with visual validation, was launched in March 2018. The project will explore an approach to MOD solutions that integrates, through a transit agency's app, mobile ticketing, multi-modal trip planning and links to other app-based transportation options to make travel within Phoenix more seamless.
- Dallas Area Rapid Transit (DART): phased-in an upgraded GoPass regional mobile app that integrates microtransit, dynamic carpooling, and hailing services. It solved first/last mile issues, particularly in non-walkable areas not well served by transit. Phase 1, which integrated microtransit (GoLink) and dynamic carpooling (GoPool), was launched in May 2018. The project is exploring innovative approaches to linking multiple mobility options in an account-based system that enable travelers to choose. Travel modes that best serve their needs based on price, travel time and wait time.

Safety Standards Strategic Plan Development and Supporting Technical Documents

In the USDOT's *Strategic Plan Fiscal Years 2018–2022*, improving transportation safety continues to be the department's top priority, with a stated goal of focusing on those activities that will reduce transportation-related fatalities and injuries. Safety has consistently been USDOT's top strategic and

organizational goal. To improve transportation safety, the *Strategic Plan* establishes a desire to work effectively with state, local, Tribal, and private partners; address human behaviors to reduce safety risks; improve safety data analysis to guide decisions; continue to employ safety countermeasures; ensure that automation brings significant safety benefits; and pursue performance-based rather than prescriptive regulations. The structured objective toward this end is defined as a “systemic safety approach,” that includes strategies such as the identification of risks, collaboration with stakeholders, addressing safety risks in rural areas, a commitment to continually improve safety by fostering a positive safety culture across the transportation industry, the evaluation of the effectiveness of risk management strategies, and the promotion of performance-based standards and measures.

The results for this research were used by FTA in making decisions on developing new transit standards, guidance, and lessons learned, and assisting with closing National Transportation Safety Board findings. Results to assist FTA under this project were:

- Strategic Plan: A final FTA Safety Standards Strategic Plan (internal report) was developed, providing information to FTA about existing transit safety standards and gaps and proposed new standards for use by the transit industry. This strategic plan meets the goals of review of current transit safety standards for this project and conduct data analysis.
- Resource document: for the public transportation industry of transit safety standards and protocols, published in the Federal Register (81 FR 30605) in May 2016 and accessible on FTA’s website at <https://www.transit.dot.gov/regulations-and-guidance/safety/compendium-transit-safety-standards>. This document provides value to the industry and FTA by listing a comprehensive reference about existence and lack of standards in each transit safety area. This resource document meets the goals of review of current transit safety standards for this project and conduct data analysis.
- Report: A report titled Review and Evaluation of Public Transportation Safety Standards, published on FTA’s website in January 2017 and accessible at <https://www.transit.dot.gov/research-innovation/review-and-evaluation-public-transportation-safety-standards-fta-report-no-0103>. This document provides information about public transportation safety standards and protocols and their effectiveness in making transit safer. This report meets the goals of review of current transit safety standards for this project and conduct data analysis.

The above-mentioned documents also met FTA’s statutory requirements of the Federal public transportation law (49 U.S.C. § 3020 (a)). It requires the Secretary of Transportation to review public transportation safety standards and protocols to document existing standards and examine the efficacy of those standards and protocols.

Documents produced under this requirement assisted FTA in making the appropriate decisions regarding existing standards and protocols, meeting the goal of providing recommendations to FTA. The outputs of this project also highlighted the need for new minimum safety standards to ensure public transportation is safe. FTA provided \$1,500,000 in funding for this project, with CUTR providing a local match of \$375,000.

The following are the relevant results and impacts of the program:

- The FTA could direct its standard focus to high risk areas in transit safety based on the findings and recommendations from this project.
- The project provided information to the industry where gaps exist in safety standards and if there was a need to develop or update new standards.

- Transit stakeholders have been sharing information more openly on new safety technologies and the best practices they have implemented through the stakeholder working group.
- The FTA could address and provide technical research to support standards development and closure of (National Transportation Safety Board) NTSB recommendations in the following areas:
 - Event Data Recorders for transit buses and rail vehicles.
 - Crash energy management for transit buses and various rail modes.
 - Emergency lighting and signage for rail transit.
 - Rail tunnel design and maintenance.
 - Track Standards for Inspection and Maintenance.
 - Crashworthiness of “Less than 30 Feet.”
 - Fatigue Management/Fitness for Duty.
 - Bus/Rail Accident Investigations manual/Guidance Document.
 - Closed six NTSB Recommendations to FTA (5 of 6 are included in the Strategic Plan Report).

As the project evolved from background research to data analysis to completion of final reports, it was clear that the success depended on how the industry got involved. Stakeholders were actively participating, sharing information and providing comments in each phase and on each report completed by the project. A big lesson learned is that FTA needs to work with the industry as much as possible whether it is in research, testing or evaluation.

The FTA’s Office of Research, Demonstration and Innovation (TRI) coordinated the Safety Standards Strategic Plan project activities with Office of Safety and Oversight (TSO). The project actively involved TSO staff for all major project activities, including monthly meetings, report reviews, and final decisions. TRI also leveraged stakeholder involvement through the CUTR Working Group, which provided the CUTR research team with significant inputs and comments on safety risks, focus areas of research, result validations and recommendations. The 20-member working group consisted of subject matter experts from Community Transportation Association of America (CTAA), APTA, Amalgamated Transit Union (ATU) and many big and medium transit agencies. The research project has provided TRI, TSO and the transit industry with information on minimum performance measures and the need for standard-related policies.

An outgrowth of Safety Standards Research is the Safety Standards Development Program, which is a technical assistance activity. The technical assistance effort covers a variety of public transportation topics with current focus on safety standards. The FTA is working with public transportation industry organizations in the development of voluntary safety standards, best practices documents, and guidance documents. The technical assistance program tasks include background research on safety focus areas, and modification and enhancement of existing standards and development of new voluntary standards by working with the Standard Development Organizations (SDOs).

Chapter 3 – FY 2020 Program Descriptions

FY 2020 RD&T Program Funding Details

RD&T Program Name	FY 2020 Enacted (\$000)	FY 2020 Basic (\$000)	FY 2020 Applied (\$000)	FY 2020 Development (\$000)	FY 2020 Technology (\$000)
Mobility Innovation	\$15,916		\$1,416	\$6,000	\$8,500
Infrastructure	\$7,736		\$3,736	\$4,000	
Safety	\$5,208		\$208	\$500	\$4,500
Transit Cooperative Research Project (TCRP)	\$5,000		\$5,000		
Small Business Innovation Research (SBIR) Program	\$640		\$640		
Accountability	\$2,000		\$2,000		
Totals	\$36,500		\$13,000	\$10,500	\$13,000

FY 2020 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2020 Enacted (\$000)	SAFETY (\$000)	INFRA- STRUCTURE (\$000)	INNOVATION (\$000)	ACCOUNTA- BILITY (\$000)
Mobility Innovation	\$15,916			\$15,916	
Infrastructure	\$7,736		\$7,736		
Safety	\$5,208	\$5,208			
TCRP	\$5,000		\$5,000		
SBIR	\$640			\$640	
Accountability	\$2,000				\$2,000
Totals	\$36,500	\$5,208	\$12,736	\$16,556	\$2,000

Mobility Innovation \$15,916,000

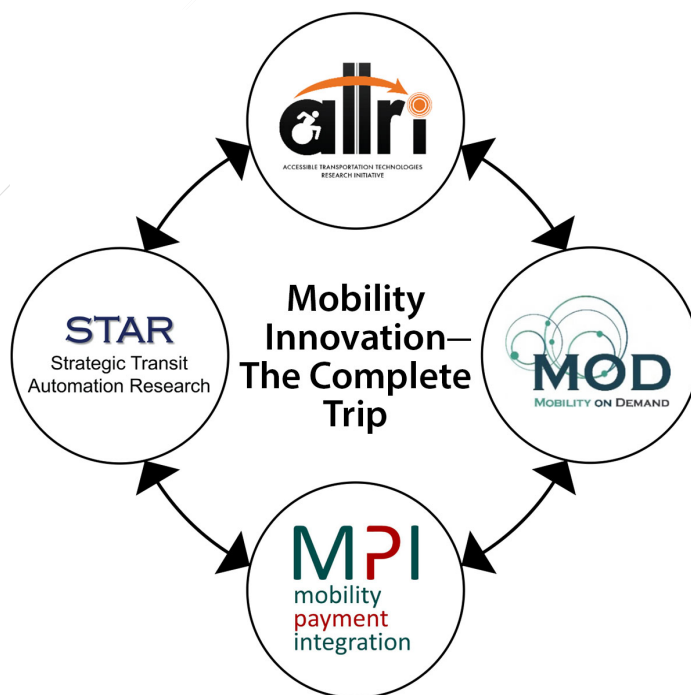
Program Description

In alignment with USDOT's Strategic Goal of Innovation, FTA's Mobility Innovation - Complete Trips for All research seeks to strengthen the capacity of transit agencies and communities to navigate the dynamic, evolving landscape of personal mobility. Access and accessibility of a transportation system can be described in terms of the ability of individuals to go from home to a destination without breaks or in terms of a travel chain with various links such as trip planning, travel to station, station/stop use, boarding vehicles, using vehicles, leaving vehicles, using the stop or transferring, and travel to destination after leaving the station or stop. If one link is not accessible, then access to a subsequent link is unattainable and the trip cannot be completed. Thus, the travel chain defines the scope of potential research and development in accessible transportation and user centric mobility.

The inability to get to and from destinations – from home to a transit station and from the station to a destination (the first mile/last mile problem – and distance traveled are persistent problems in the travel chain. An accessible travel chain allows individuals with disabilities, especially those with severe disabilities, to have independent access to work sites, educational programs, health facilities, and social and recreational activities.

The FTA's Mobility Innovation – Complete Trips for All Program envisions a safe, carefree, reliable mobility ecosystem that supports Complete Trips for All. This vision is advanced by leveraging emerging and innovative technologies and facilitating 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 & services.

The Mobility Innovation – Complete Trips for All Program research includes several areas of research, coordinated across USDOT modes: Mobility on Demand (MOD), Strategic Transit Automation Research (STAR), Accessible Transportation Technologies Research Initiative (ATTRI), and Mobility Payment Integration (MPI). Building upon these foundational efforts, FTA is conducting its research using an agile and needs-driven approach to advance the vision of Complete Trips for All, where all users can independently plan and execute all parts of a seamless trip, and all goods are transported from production to consumption most efficiently. The proposed research represents the logical and strategic continuation of past and current FTA research. Each project contributes not only to the development of the vision but has enabled the implementation of practices, adoption of policies, and deployment of technologies. These projects include the following:



**Current and Past Projects Applicable to
Complete Trips for All Proposed Research**

Current/Past	Description
Integrated Mobility Innovation (IMI) Demonstration	<p>IMI Demonstration is designed to facilitate collaboration by bringing together multiple areas of mobility research to showcase collective impacts of mobility innovations. IMI Demonstration projects will encompass three distinct areas of inquiry: MOD Sandbox demonstrations, STAR, and MPI. These areas are integrated in one Notice of Funding Opportunity (NOFO) to allow and encourage demonstrations to comprehensively leverage multiple areas of mobility research as appropriate. In addition, it is FTA’s intent to integrate phase 2 ATTRI prototype projects into IMI awards.</p> <p>Key IMI Demonstration lessons learned and enabling technologies are: This demonstration program follows FTA’s vision of complete trips for all – promoting safe, carefree and reliable transportation for everyone. IMI will integrate the technologies and practices from past research and demonstration efforts.</p>
Mobility on Demand (MOD)	<p>MOD is one of the two predecessors for Mobility Innovation – Complete Trips for All program. MOD developed the vision for an integrated multi-modal network of safe, carefree, affordable, and reliable transportation options that are available to all. MOD vision promotes choice in personal mobility, leverages emerging and existing technologies and big data capabilities, encourages multimodal connectivity and system interoperability, and promotes new business models that enhance traveler experiences.</p> <p>Key MOD lessons learned and enabling technologies are: 1. Shifting the paradigm to a mobility service oriented approach for transit and traffic management; 3. Continue the approach to support mobility, accessibility, economy by providing user centric services; 2. Land use context matters - the variety of urbanization patterns pose several opportunities for MOD deployment; 3. There is a need to explore the economic impacts of MOD such as industry benchmark, key economic indicators, and macro and micro-level impacts; 4. Immediate response and point-to-point service are proving to be attractive versus low frequency fixed-route service; and 5. Data needs to be protected, and standardized to facilitate safe sharing and interoperability when necessary between public and private partners.</p>
Accessible Transportation Technologies Research Initiative	<p>ATTRI is another immediate predecessor to the Mobility Innovation – Complete Trips for All program. ATTRI leads efforts to develop and implement transformative applications to improve mobility options for all travelers, particularly those with disabilities and older adults. ATTRI research focuses on removing barriers to transportation for people with visual, hearing, cognitive, and mobility disabilities. ATTRI developed the Complete Trip concept based on the understanding that a person’s travel comprises a chain of steps beginning with an often-spontaneous decision to make a trip, through to planning an itinerary, traversing the built environment and its transportation networks (with or without a vehicle); navigating streets, intersections, facilities, stations, and stops to their destination—safely, efficiently, and carefree.</p>

**Current and Past Projects Applicable to
Complete Trips for All Proposed Research**

Current/Past	Description
	<p>Key ATTRI lessons learned and enabling technologies are: 1. Universal design principles are the foundation for a complete trip; 2. Must consider all users – old and young, and all disability types during the development and implementation of solutions; 3. Data needs are more complex; 4. Private sector support for services, assistive technologies, standards, data, and training are critically important for all users and 5. The Complete Trip approach has been well received by the community at large.</p>
<p>Mobility Services for All Americans (MSAA)</p>	<p>MSAA enhances accessibility and mobility for people who are transportation disadvantaged and the public by applying technological solutions to advance human service transportation, overcome technical and institutional barriers to coordination, and showcase promising technologies and practices that enhance mobility. People demand more responsive transportation services and at the same time demand for paratransit services, including as mandated by the ADA, is growing. Yet, such specialized transportation services are often difficult to use, and inefficient to operate; this wastes money and reduces the quality of life for travelers. MSAA has laid the groundwork for the development of Travel Management Coordination Centers (TMCCs) that help coordinate these important mobility assets while connecting those more easily with riders.</p> <p>Key MSAA lessons learned and enabling technologies: Emerging and innovative technologies and services allow the TMCC model to expand to serve the holistic mobility innovation vision. Specifically, TMCC functions include fleet scheduling, dispatching, routing; integrated fare payment and processing; better trip planning; and advanced demand-response systems.</p>
<p>Integrated Corridor Management (ICM)</p>	<p>ICM is the coordinated operations of individual network operations between adjacent facilities and significant improvements in the efficient movement of people and goods through the integrated, proactive management of existing infrastructure along major corridors. Through an ICM approach, transportation professionals manage the transportation networks and services as a multimodal system.</p> <p>Key ICM lessons learned and enabling technologies are: 1. A fundamental understanding that a coordinated and collaborative approach to operations is necessary to support a shift to a user centric approach to mobility management; 2. Influencing traveler behavior to induce time of day and mode shift is necessary to improve performance; 3. Complexity of an integrated system requires improved data integration; and 4. Must eliminate barriers to mode shift, including integration of payment, and providing first mile/last mile options.</p>

Program Activities

1. *Mobility on Demand (MOD)* – Year three, builds upon the outcomes and lessons learned from earlier MOD project. FY2020 research investments in MOD will focus on the continued development, testing, and evaluation of implementation and operational practices, enabling technologies, and supporting policies; and validating and accelerating adoption of proven solutions to provide travelers with enhanced mobility options. New MOD projects will aim to explore and assess incremental enhancements concerning innovative operational and service models in transit agencies such as solutions for the first/last mile; more effective leveraging of existing investments; and improving service quality. This year three of MOD demonstrations will layer into the lessons learned to date the Complete Trip for All concepts. FTA is working with MOD stakeholders to promote the transit industry's preparedness for MOD, accelerate technology transfer and adoption of proven MOD solutions, and to uncover governance issues and challenges to widespread implementation. The research will continue to invest in innovation and knowledge transfer for successful deployments of integrated MOD solutions in communities. This research is also exploring how rural and suburban residents can benefit from these new service models.
2. *Transit Bus Automation Research* – This is an integrated demonstration project focusing on level 4 automation in transit maintenance yard settings. Specific use cases may include 1) precision movement for fueling, maintenance, and bus wash, and 2) automated remote parking and recall of buses. This demonstration will include an independent evaluation to assess and measure impacts. This project will showcase more efficient, timely, and safe operations of bus movement activities within a bus yard, which may reduce bus yard property (reduce bus yard footprint) and operating costs, and increase safety. The performance goals for this project will be proof-of-concept and impacts testing results (e.g., functionality of automation technology, assessment of costs, reduction in bus yard operations time and costs, reduction in bus yard operations incidents resulting in property damage and personnel injuries).
3. *Accessible Transportation Technologies Research Initiative (ATTRI) – The Complete Trip* – ATTRI projects will leverage the advances in accessible technology development for vehicles, mobile devices, and infrastructure; as well as accessible data, computing, robotics, artificial intelligence, object detection, and navigation. The ATTRI program developed the Complete Trip concept and developed the framework to evaluate the effectiveness, societal benefit, system costs, and policy impact of technologies for accessibility. These technologies, along with services and policies, represent the touch points for every user long their trip chain and are fundamental to the complete trip. FY2020 projects will include industry forums and stakeholder engagements activities to identify detailed user needs, scan the industry, identify gaps, and make investment decisions to position; demonstrations of integrated accessible technologies, practices and policies, support the development in industry-driven standards to enable the realization of the complete trip concept, and implementation of the recommendations for necessary approaches, methodologies, guidance, and tools for comprehensive analysis for public sector and industry decision makers to justify investments in technologies, practices, or policy changes
4. *Mobility Payment Integration (MPI)* – MPI reflects FTA's recognition of the emergence and rapid evolution of the mobility payment marketplace, its importance in managing and integrating mobility, and ultimately, its overall influence on mobility outcomes. This research area is promoting the quick adoption of integrated payment options for transit agencies and other mobility providers at the regional and interregional levels. Such payment systems facilitate and increase seamless traveler experiences and data availability, thus improving overall system wide mobility

efficiency and performance. FTA is maintaining a 5-year MPI Program Plan and continues to engage a broad group of public and private stakeholders in this area. FY20 projects include enabling research for policy analysis of barriers to partnerships/collaborations and technology implementation, and regulatory restrictions, workforce impact assessment, and economic benefits and impacts assessment.

5. *Accelerating Innovative Mobility (AIM)* – This new initiative is designed to foster innovative transit technologies, practices and solutions to incentivize travelers to choose transit, promote economic development in communities, and enhance public/private partnerships. AIM will accelerate the development, implementation and adoption of innovative technologies, practices, and service models to improve mobility and enhance the traveler experience, with a focus on innovative service delivery models, creative financing, novel partnerships, and integrated payment solutions.

Program Objectives

The primary objectives of FTA’s Mobility Innovation Research are to:

1. Improve transit operations and reduce costs by leveraging public and private assets and technologies.
2. Improve personal mobility by identifying and promoting innovative practices and technologies – public and private - for enhanced mobility of all travelers.

Mobility Innovation – Complete Trips for All research is identifying promising practices in shared services that not only increase access but also address operational efficiencies and effectiveness. The research is doing this by examining important operational details such as data collection, data access, and data management issues rising from the need to share and integrate public, private and personal information in the new mobility paradigm. The research looks at advanced payment systems, communications and system navigation techniques that form the basis of a future integrated mobility environment. There are some extremely challenging technology issues that must be overcome but with potentially high payoff for travelers.

Overall, Mobility Innovation –Complete Trips for All Program research projects improve the efficiency, effectiveness, and quality of public transportation services through adaptation to new mobility options by public transportation providers. Transformative and, at times, disruptive, technologies are driving massive changes in the way customers access and use public transportation and transportation information.

Statutory Requirements

The FTA’s Mobility Innovation Program is not mandated by statute but its discretionary activities eligible under Public Transportation Law at 49 U.S.C. § 5312.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Mobility Innovation	Improving Mobility

The Mobility Innovation – Complete Trips for All Program closely aligns with the USDOT strategic goal to lead in the Development and Deployment of Innovative Practices and Technologies that Improve Safety and Performance of the nation’s transportation system. Specifically, Mobility Innovation – Complete Trips for All projects are developing innovations by providing seed funding so communities can experiment with new approaches then report back to FTA so those findings can inform other public transit agencies’ activities. Development of innovation is also supporting the objectives of expanding partnerships and coordination between the public and private sector. Deployment of innovation is furthered by the growth of communities of practice; widespread stakeholder collaboration activities; and broad outreach to support technology integration and technology transfer.

Mobility Innovation – Complete Trips for All projects further support the USDOT strategic goal of innovation by funding projects that explore automation in the public transportation industry. As an example, the FTA STAR plan will be a useful tool for planning and executing USDOT-sponsored transit automation development and demonstration projects and integrated, multi-modal service solutions. Thus, transit agencies will be able to significantly accelerate deployment of automation or partial automation in their operations.

The Mobility Innovation – Complete Trips for All Program provides a venue through which integrated concepts and solutions – supported through local partnerships – are demonstrated in real-world settings in both urban and rural areas. One example of a rural setting is in the Vermont MOD Sandbox Project - Flexible Trip Planner. In this project, FTA is partnering with the Vermont Agency of Transportation to create a statewide transit trip planner that enables flex-route, hail-a-ride, and other non-fixed-route services to be incorporated in mobility apps. The online trip planner for both fixed and flexible transit services particularly benefits non-traditional rural transit system users, allowing universal access to transit information, including for people with disabilities. The project advances an innovative business model and fosters a marketplace for future business opportunities. Through its role in leading the USDOT Mobility Innovation Research Working Group, FTA sets a strategic priority to identify and facilitate cross-modal mobility research collaboration opportunities. An evidence of such priority was the IMI Demonstration program.

USDOT Research Priorities

The FTA’s Mobility Innovation research investigates the technical and institutional feasibility of various business models and partnerships, such as microtransit. FTA recognizes microtransit as a service model that sits between traditional fixed-route transit and the new tech-enabled TNC models. It is a demand-responsive service using ad-hoc pickup and drop-off points within a few minutes’ walk of multiple customers, generally within limited service zones. In general, microtransit uses vehicles smaller than traditional 30-ft or 40-ft transit buses but larger than the passenger vehicles commonly used by TNCs. Prices are higher than for standard transit service, but lower than a TNC ride over the same route. The hallmark of microtransit is the ability to flexibly create routes and stops in response to customer demand. In practice, the services tend to converge on a limited number of routes between dense areas of high demand, and most operate only at weekday peak hours.

Transit agencies may collaborate with microtransit providers to address service gaps in their mobility networks. In addition, FTA also incorporates microtransit as a tool in the Mobility on Demand toolbox. Microtransit contributes to an integrated and connected multi-modal network of safe, affordable, and reliable transportation options available to all. The FTA is examining specific challenges facing public transportation agencies as they seek to leverage microtransit opportunities:

- Need for Capital Investment and Subsidy: to date, “microtransit” relies on a business model that involves leasing (generally larger, wheelchair accessible) vehicles and paying drivers as employees – a different business model than the TNC model.
- Equity of Service: there are challenges around the usability of microtransit services by all travelers for travelers without smart phones or credit cards.
- Marketing: The design of a service, and how it is promoted are key to its success.
- Workforce: impacts to the existing transit workforce may vary with the nature of the employment model and contractual arrangement.

Facing rapidly evolving technologies and innovations, FTA mobility research is also gathering data to understand the economic opportunities supported by the new mobility paradigm. In FY 2019 and FY 2020, FTA is also evaluating existing public transportation policies and regulations to see how they affect the adoption of new service models and economic growth.

The FTA is developing a set of performance indicators that reflect the dynamic and multimodal nature of mobility to facilitate innovation and modernize regulation. In FY 2019, FTA will define performance indicators and units of measurement to reflect the economic impact of regulatory reform at three geographic scales: by the local jurisdictions, at the regional level, and at the national level. It is primarily at the second (regional) and the third (national) levels where economic impacts such as productivity and jobs are found. In FY 2020, FTA plans to test the validity and usefulness of these performance indicators in various settings, such as the MOD Sandbox projects. As an integral part of FTA’s Mobility Innovation research, regulatory relief requires FTA to work with partners and stakeholders in government, industry, and the public for input. It is also essential to examine the potential impact and possible unintended consequences of regulatory changes on safety, efficiency, innovation and economy.

The FTA’s Mobility Innovation – Complete Trips for All research considers cybersecurity issues in the areas of automation, fare payment, and personalized mobility services. Safety issues are critical for public transit providers, and automation systems introduce new types of risks, ranging from technology limitations, hardware failures, and cybersecurity breaches. The FTA is considering the potential for assaults and criminal activity to become more prevalent in driverless vehicles. Currently, the presence of a driver or other public transit employee such as law enforcement can act as a deterrent to criminal behavior. The security of personally identifiable information, Health Insurance Portability and Accountability Act, and personal banking/credit access must be addressed and assured.

When conducting mobility innovation research, development and demonstration in Fiscal Years 2019 and 2020, FTA will continue to emphasize the requirement for sufficient cybersecurity and fail-safe measures. In the meantime, FTA will continue to actively participate in all Departmental cybersecurity initiatives where transit representation and subject matter expertise are needed.

Lastly, Mobility Innovation – Complete Trips for All research is grounded in universal design and the need to support communities, access and accessibility for all communities, especially for people with disabilities, older adults, lower income, and rural communities. Land use context is critical to the provision of demand responsive and share use mobility; payment integration is the technical foundation for equitable access to mobility services; and accessible technologies, including automation, provide independence for all users.

Research Collaboration Partners

The FTA builds Mobility Innovation – Complete Trips all Research is guided by four principles.

1. **User-centric** – promotes choice in personal mobility and utilizes universal design principles to satisfy the needs of all users.
2. **Mode-agnostic** – supports connectivity and interoperability where all modes of transportation work together to achieve the complete trip vision and efficient delivery of goods and services
3. **Technology-enabled** – leverages emerging and innovative use of technologies to enable and incentivize smart decision making by all users and operators in the mobility ecosystem.
4. **Partnership driven** – encourages partnerships, both public and private, to accelerate innovation and deployment of proven mobility solutions to benefit all.

As such, all research activities are inherently multi-modal. The USDOT program partners include various offices within the Office of the Secretary (OST-P, -R -X), the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), and the Intelligent Transportation System (ITS) Joint Program Office (JPO). The FTA Mobility Innovation – Complete Trips for All Program also regularly interacts with other Federal partners outside of USDOT on common research interests, knowledge exchanges, and the active sharing of resources. These partners include the Department of Energy Vehicle Technology Office and the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR).

Technical assistance partners like the Shared Use Mobility Center provide critical information on how new mobility models are being used and are increasing across the United States – FTA is using this map to track the some of the results of the program – the adoption rates for new mobility models. The model can be found at: <http://maps.sharedusemobilitycenter.org/sumc/>. Other partners are supporting dissemination activities and convening peer to peer communities of practice. As the STAR work develops, FTA expects to engage external partners in supporting the expansion of automated public transit systems and disseminate promising results.

The FTA engages in strategic partnerships that leverage research initiatives and investments led by other entities, both public and private. In many instances, FTA funding and technical assistance supplements the work of partners in the development, deployment and evaluation of specific innovative activities. Current external partners include APTA, TransitCenter, CTAA, Booz Allen Hamilton, the Shared Use Mobility Center, as well as Valley Metro in Phoenix, AZ.

Safety
\$5,208,000

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 new safety 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 Activity

1. *Safety Research and Demonstration - Fixed Guideway Platform Edge Door Demonstration Program* – The SRD Program is part of the priority on safety at the US Department of Transportation (USDOT). SRD provides technical and financial support for transit agencies to pursue innovative approaches to eliminate or mitigate safety hazards. The SRD program focuses on demonstration and deployment of technologies and safer designs to improve safety. The FY 2020 SRD program will focus on passenger and worker protection with specific focus on the reduction and/or elimination of rail-related suicides and will be based upon findings from the FY 2019 Retrofitting Rail Transit Station Platform Doors: Cost Benefit Analysis & Pilot Program. The demonstration will explore barriers – determined by the earlier study to be cost-effective and financially feasible – to limit access to active rail transit rights-of-way to prevent pedestrian fatalities, trespassing and other illegal acts such as passengers being pushed in front of trains. Per the National Transit Database (NTD), suicides remain the most prevalent reason for transit-related fatalities.

The focus of SRD in FY 2020 will be on validating/testing of platform edge doors on heavy rail transit systems. Specifically, on the retrofit of existing stations. One of major safety hazard associated with heavy rail system with very congested stations where exist the possibility of objects or people falling, tripping or pushed on to the tracks. In addition, suicide is a major incident as well and platform edge doors would be able to prevent such incidents. Potential impacts are on safety and operational efficiency. The performance measures will center around safety improvement, system effectiveness and return on investment.

Program Objectives

The objectives of FTA's Safety research program are to improve public transportation safety, support the Agency's regulatory role, and, to support the development of a comprehensive safety oversight framework. The program is focused on improving public safety by reducing transit-related injuries, fatalities, safety events, and enhancing system reliability. Though public transportation is a very safe system overall, accidents do happen. When accidents happen, FTA must learn from these events and develop safety improvements as well as proactive safety measures. FTA's safety responsibilities have increased over the last ten years, and there are new requirements for rail safety that must be considered given FTA's responsibility with the State Safety Oversight (SSO) and rail transit systems. Thus, the main goal for FTA's safety research improve public safety by reducing transit-related injuries, fatalities, safety events, and system reliability by testing promising new safety technologies, designs and practices; and assessing ways to promote better public transportation safety cultures through the adoption of promising voluntary safety standards and best-practices documents.

The primary objectives of FTA's Safety Research are to:

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

Whenever possible, the FTA Safety research program uses a methodical and data-driven approach to research. The program uses the statutory pipeline phased approach (Foundational research, innovation/development, demonstration/deployment and evaluation) with the aim of improving the safety of the nation's public transportation system. The use of performance-based regulations to promote safety and reduce risk in high-hazard industries is at the core of FTA's Safety program research. The broad definition of "performance-based" refers to: (a) standards that mandate outcomes and provide flexibility in meeting them; or (b) requirements for using management systems consisting of internal plans and practices to promote safety and reduce risk.

FY 2020 research and demonstration will build upon continued collaboration with internal and external stakeholders. External safety committees run by the industry will play invaluable roles to educate FTA on important perspectives. Committee such as TRAC, TRACS and Standards Working Group. Safety research evaluation program and evaluators will remain a significant partner as the FY 2018 SRD program is expected to yield results, as number of projects are estimated to be completed starting FY 2020.

Statutory Requirements

FTA's Safety Program is not mandated by statute but its discretionary activities eligible under Public Transportation Law at 49 U.S.C. § 5312.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Safety	Promoting Safety

USDOT's Safety goal seeks to reduce transportation-related fatalities and serious injuries across the transportation system, and FTA's research addresses this goal in public transit systems. FTA continues to work within a systematic safety framework that builds upon prior research and demonstration programs to mitigate risks and encourage the adoption of infrastructure and behavior changes that improve safety. FTA is using a data-driven systemic safety approach to identify these risks, enhance voluntary standards program, and evaluate effectiveness of safety research programs. FTA's Safety research and demonstration program can potentially transform how urban and rural public transit systems monitor, assess, and manage their systems to address safety. The mission of FTA's safety research program is 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. In FY 2020, FTA's Safety research program will continue to focus on demonstrating and deploying transformative technologies and innovative operational practices through partnership with transit agencies, technology suppliers, and other private sector entities. In FY 2020, FTA's investment in safety research will pursue both development as well as real-world technology deployments pilot projects.

USDOT Research Priorities

Regulatory reform is directed at making sure that regulations remain fully responsive to changes in the economic, social and technological conditions surrounding them. FTA's safety research program is working with an independent evaluator to document and evaluate each project on performance metrics such as safety improvements, system effectiveness, and return on investment. This information can be used to assess the economic and the potential impact of regulatory reform on overall transit safety. FTA's safety program does not address or track the potential economic impact of permitting reform as it is not an area that falls within the domain of safety research and demonstration. FTA's *Safety Research Strategic Plan* and FTA's *Standards Strategic Plan* do not identify asset recycling as an area of focus for future research and demonstration. The FTA Standards Development program is designed with a data-driven approaches and leverage consensus based, voluntary standards to improve the overall safety of transit industry. This approach allows FTA the flexibility to promote safety practices and seek consensus and partnerships, when appropriate. It also allows for the implementation of performance-based regulations, guidelines, or voluntary standards when the data suggest the need or there is in a positive return on investment based on the data collected from the safety research programs.

Research Collaboration Partners

At every step, FTA utilizes input from a variety of working groups and sources such as the Transit Research Analysis Committee (TRAC), the Transit Advisory Committee for Safety (TRACS), the safety standards working group, webinars, Transportation Research Board publications, academic research, collaboration with FTA's safety office, and industry engagement to inform research and demonstration decisions. Frequent and constant collaboration is expected with internal and external stakeholders. Some partners include the Office of the Secretary, FHWA, National Highway Traffic Safety Administration (NHTSA), Federal Motor Carrier Safety Administration (FMCSA), Federal Railroad Administration (FRA), and the Intelligent Transportation System (ITS) Joint Program Office (JPO). FTA's safety research program also regularly communicates with others outside of the USDOT for common research interests and knowledge exchange and sharing of resources such as transit agencies, APTA and other trade associations, academia, and private consulting firms.

Infrastructure **\$7,736,000**

Program Description/Activities

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. FTA's infrastructure research and demonstration focus continues to ensure that transformative innovations, technologies, and practices meet the public demand for safe, resilient, cost efficient, and create private-sector economic benefits. FTA applied this thinking to all research activities within the infrastructure research program to include near-zero and zero emissions vehicles, and related infrastructure. Through infrastructure research activities, FTA assesses the development and deployment of zero emission transit buses, facilities, and related charging and maintenance technologies as well as ways to ensure effective management of all related capital assets.

Program Activities

1. *Real-Time Transit Infrastructure and Rolling Stock Condition Assessment Demonstration Program* – The monitoring of transit infrastructure such as elevated track, bridges, tunnels, and dedicated rights-of-way and rolling stock is critical to the transit industry. Transit infrastructure inspection using state-of-the-art technologies, such as “smart sensors”, unmanned aerial vehicles, big data analytics and other technologies, can automatically measure, record, and report, in real-time, detailed information regarding the condition of the infrastructures. Thus, potentially, allowing transit agencies to detect defects earlier and proactively track and monitor deficiencies before they could impact transit revenue services, and potentially compromise system safety.
2. *Low and No (LoNo) Emissions Component Assessment Program (LoNo-CAP)* – This program provides unbiased assessments of LoNo components used in transit buses, publishing the assessments online, and summarizing them in a required annual report to Congress. For LoNo-CAP, the term “low or no emission component” means an item that is separately installed in and removable from a low or no emission transit bus. LoNo is a voluntary program for LoNo component manufacturers. When components are tested under LoNo-CAP, it will significantly support low or zero emissions transit bus operation. This program is statutorily required LoNo-CAP is authorized in Federal public transportation law (49 U.S.C. § 5312(h)).

The Real-Time Transit Infrastructure and Rolling Stock Condition Assessment Demonstration Program will assist transit agencies restore critical infrastructure and rolling stock to a state of good repair, over time, through asset management planning and innovative maintenance strategies. The rapidly-changing and continuous innovation of new technologies have made it challenging for the transit industry to keep pace. It is essential to keep the transit infrastructure abreast of new technologies for monitoring the condition of fixed assets and rolling stock. This program will also assist the transit industry to identify the infrastructure that needs to be replaced or maintained and thereby allows transit agencies to assign and use resources efficiently. This research will be continuation of Real-Time Transit Infrastructure and Rolling Stock Condition Assessment Demonstration Program that is funded under the FY18 research program.

Program Objectives

Public transportation infrastructure assets need significant investments to maintain state of good repair, and funding constraints for maintaining and improving infrastructure typically require Federal assistance. In 2020, FTA estimates that transit assets continue to be listed in marginal or poor condition, with a

backlog of well over \$100 billion in deferred maintenance and replacement. Additionally, growing pressures on operational costs require public transit agencies to find ways to reduce the lifecycle costs of capital such as energy and maintenance. Thus, the main goal of infrastructure research is to improve deteriorating public transportation infrastructure, bring assets up to a state of good repair, and improve lifecycle maintenance by evaluating methods, products, materials, approaches, and practices to develop products or service more efficiently, deploy cutting edge “infrastructure health monitoring” technologies, and create American jobs. The program also seeks to collaborate with internal and external stakeholders to share information and to identify, collect, and analyze data.

The primary objectives of FTA’s Infrastructure Research are to:

1. Improve lifecycle maintenance by evaluating methods, products, approaches, and practice to develop products or service more efficiently.
2. Enhance the environment by providing mechanisms for mainstreaming and determining performance specifications for low and no emission transit bus components through university-based laboratory testing.
3. Improve the build and project approval process.
4. Stimulate economic growth.

Statutory Requirements

FTA’s Infrastructure Program is not mandated by statute but its discretionary activities are eligible under Public Transportation Law at 49 U.S.C. § 5312.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure

USDOT’s Strategic goal of Infrastructure looks to invest in infrastructure to ensure mobility and accessibility and to stimulate economic growth, productivity, and competitiveness for American workers and businesses. USDOT seeks to facilitate expanded infrastructure development, modernization, and construction in both rural and urban communities by fostering more efficient and collaborative planning and construction techniques, accelerating project approval, leveraging all sources of funding, and promoting innovative financing while maintaining environmental stewardship.

USDOT Research Priorities

While the infrastructure research and demonstration program has not identified any unnecessary regulatory barriers, it is aware of FTA’s efforts to streamline the environmental process for project delivery and is in full support of this USDOT priority and will proactively seek input from internal and external stakeholders regarding any regulatory burdens and barriers. Even though the current portfolio of FTA infrastructure research and demonstration projects does not involve infrastructure projects that require environmental review through the NEPA process, the Infrastructure program supports the development of tools, processes, and reform that will reduce delays and accelerate the delivery of public transportation infrastructure projects.

Another potential impact is the lengthy delays in the permitting process. The delays in the permitting process costs billions, or perhaps trillions, of dollars for both the public and private sectors. Direct costs increase for materials, supplies, and labor during permitting delays. There is also a real public cost to delaying needed infrastructure improvements with older facilities and systems such as aging heavy rail systems and bridges in rural areas. This also greatly reduces the safety of these facilities and systems. Other economic issues with permitting delays include the adverse effects of prolonging inefficiencies and unnecessary pollution from existing and outdated infrastructure. Any effort to rebuild America's public transit systems, roads, bridges, tunnels, energy and manufacturing sectors without substantive permitting reform may increase long-term costs to taxpayers.

Many countries, including the United States, use forms of performance-based regulation to promote resiliency and reduce risk in high-hazard situations across their transportation systems. The term "performance-based" is often used to refer to (a) standards that mandate outcomes and give flexibility in how to meet them, or (b) requirements for use management systems consisting of internal plans and practices for promoting resiliency and reducing risk. Whenever possible and prudent, through coordination with FTA's Standards Program, the advantages and disadvantages of prescriptive- and performance-based forms of infrastructure regulation, standards, and best practices will be identified for possible opportunities for, and constraints on, their recommended use. For example, transit agencies might consider establishing a rating system and standard procedures for evaluation, and a prioritization of aging fixed guideway tunnels. Such a rating system and condition assessment procedure can provide numerical justification for repairs or rehabilitation of tunnel infrastructure, and make it safer and more resilient. Such a comprehensive prioritization method may consider the following items: effectiveness, a risk-based analysis, capital funding and staffing programs to accomplish tunnel preservation goals and serves as a training tool for new personnel.

The potential impacts of asset recycling, coupled with the use of Federal government infrastructure incentive payments (up to 15%) to states or local governments, could expand and improve public transportation infrastructure and operations/maintenance over both the long and short-term. Current publicly-owned infrastructure and assets includes existing leasable and sellable (privatization) assets that could fund new or expand existing public transit systems. For example, these publicly-owned assets could be waste and water treatment plants, highways/roads (tolling), vacant land or buildings underutilized parking lots and parks, and other similar resources. The recycling of these assets could be applied to new light, heavy, or commuter rail systems, expanded transit bus operations such as Bus Rapid Transit Systems, or to repair aging public infrastructure such as bridges, tunnels, or rail tracks. Asset recycling provides a reliable and steady revenue stream to expand build new public transportation infrastructure. It has become increasingly clear that the presence of public transportation infrastructure (stations, right of way, Bus Rapid Transit) has the potential to increase connected property values and result in valuable development opportunities including value capture. Coupled with constrained transit funding for both operations and capital improvements such as new and expanded fixed guideway transit systems, the infrastructure research program is increasingly interested in researching the value that transit confers to surrounding properties to fund transit infrastructure or related improvements.

As a modal administration, FTA's mission is improving the movement of people and not improving the movement of freight. Thus, FTA's infrastructure program does not address the issue of improving the mobility of freight. The FTA's infrastructure program does not address the feasibility of Micro-Transit. The feasibility of micro-transit is addressed by FTA's Mobility Innovation Program. This research program will have a direct impact on rural communities in the form of improved public transportation infrastructure, and the overall condition of assets. For example, the infrastructure program will improve transit-related infrastructure to include the use of nano-technology to reinforce concrete to extend its

useful life for elevated rails transit structures, bridges, and transit bus stop pads. Developing promising practices for lifecycle maintenance and asset management can help all sizes of transit systems with proven processes to improve operations. New technology buses can help reduce energy costs which, again, supports all sizes of systems. Specific research associated with rural communities' infrastructure issues may be an area for future research consideration.

The infrastructure research program, like the Safety Research Program, will work more closely with industry partners on cyber security issues on transit assets to include hardened infrastructure and rolling stock. The FTA's research office will incorporate cybersecurity reviews on infrastructure pilot projects that will deploy equipment with networking and communication capabilities.

Research Collaboration Partners

Frequent and constant collaboration is conducted with internal and external stakeholders including the Office of the Secretary, Federal Highway Administration (FHWA), National Highway Traffic Safety Administration (NHTSA), Federal Motor Carrier Safety Administration (FMCSA), Federal Railroad Administration (FRA), and to a lesser extent the Intelligent Transportation System (ITS) Joint Program Office (JPO). Other federal partners include the Department of Energy and Department of Homeland Security.

The FTA's infrastructure research program also regularly communicates with others outside of the USDOT for common research interests, knowledge exchange, and sharing of resources. In certain instances, private industry has partnered with FTA and transit agencies to provide technical expertise in the form of in-kind labor as well as hardware/software products used in the program-level technology, testing, and/or demonstrations. Important partners also include the testing centers and organizations like CALSTART, the Center for Transportation and the Environment, and the Center for Urban Transportation are a key part of external collaboration activities in infrastructure.

Transit Cooperative Research Program (TCRP)

\$5,000,000

Program Description

The Transit Cooperative Research Program (TCRP) is authorized in Federal public transportation law (49 U.S.C. § 5312(i)) and operated through the Transportation Research Board of the National Academies of Science, Engineering, and Medicine. 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. TCRP is a critical partner in shaping and sharing information about FTA's public transportation innovation projects, and is a key driver for moving research to practice. TCRP plays a unique role as a national resource for the public transportation industry, where such pooled research can be delivered more cost-effectively. The TCRP Oversight and Project Selection (TOPS) Committee-selected projects are monitored and supported through a panel of expert practitioners from the industry and managed by TRB staff. The engagement inherent in TCRP studies brings together the transit industry, interested stakeholders, and the public. TCRP's mission is to promote, select, and conduct research and disseminate research findings to improve the practice and performance of public transportation.

Program Activities

1. *Research Project Selection:* TCRP issues requests for a variety of research problem statements throughout the year in the sub-program areas of Research Reports; Ideas Deserving Exploratory Analysis; Legal Studies; and Syntheses. The TOPS Committee and project panels meet annually to discuss, identify, prioritize research needs, and select approximately 25 projects for funding. The TOPS Committee sets the funding level for the sub-programs and selects problem statements for the sub-program of Research Reports.
2. *Research Project Panel and Solicitation:* Selected statements and project panels are developed by TRB staff, the TCRP project panel reviews solicitation and bids, and FTA liaisons participate in the process to assist TCRP with the release to solicit bids to carry out the research.
3. *Conduct Research:* Proposal submissions are evaluated, a winning proposal is selected, and the TCRP project team oversees the applied research product to offer insights, guidance, and feedback.
4. *Dissemination:* TRB publishes final reports and related tools through the National Academies Press. Results are also shared on the TRCP website and through webinars hosted by TRB and the National Transit Institute. APTA, through their J-1 program for TCRP, leads outreach to promote the results of TCRP project findings.

Program Objectives

The stated objectives of the Transit Cooperative Research Program remain:

- To identify transit problems in need of research and development (R&D) investigation; and to establish a priority ranking for them.

- To 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.
- To improve communications, technical information transfer, and dissemination.
- To provide a means of addressing a variety of near-term transit problems in cooperation and in coordination with Federal public transportation research.

The existence of TCRP is related to a market need. There are more than 3,000 organizations across the country that receive FTA funds to provide public transportation. Often, these organizations are lean, and cannot afford to put their limited funding into research unlike private sector transportation organizations who have a profit-based structure.

Despite differences in geography, markets, and organizational capacity, transit providers share many areas of common interest and concern. Building on the National Academies' commitment to objectivity and independence, TCRP meets an important market niche for public transportation research that is directly driven by the public transportation industry.

Statutory Requirements

This program is statutorily mandated in Federal public transportation law (49 U.S.C. § 5312(i)) for FTA to make grants to the National Academy of Sciences carry out activities for public transportation research, development, and technology transfer activities.

The TCRP concentrates on applied research projects. The program is directed at problems of an immediate, near-term nature that can be undertaken with moderate research funds. TCRP project funding levels are typically around \$250,000 per project.

Program Alignment with Strategic Goals

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure

The TCRP supports DOT's Strategic Goal of infrastructure, though the program is cross-cutting and often addresses all of DOT's strategic goals. However, because of the strong focus of TCRP to field practical research that aids public transit agencies' operations, this relates to the infrastructure strategic goal and helps to drive economic vitality for America's communities.

The TCRP advises proposers that TCRP project ideas are selected based on being "consistent with, and supportive of, USDOT strategic goals and TCRP strategic priorities." The online solicitation for new ideas goes on to present USDOT strategic goals as outlined in the USDOT Strategic Plan.

The TCRP develops research products across several sub-programs: Research Reports, Ideas Deserving Exploratory Analysis, Legal Studies, and Syntheses. Research Reports are further categorized to address emerging practice in: Operations, Service Configuration, Engineering of Vehicles and Equipment, Engineering of Fixed Facilities, Maintenance, Human Resources, Administration, Policy and Planning, and Special Projects.

USDOT Research Priorities

In addition to explicitly linking TCRP selection criteria to USDOT strategic goals, TCRP products address a variety of topics that resonate with DOT's research priorities. The [National Academies Press website](#) is the authoritative repository for all TCRP publications.

- Economic Impact of Regulatory Reform:
 - TCRP has not addressed the economic impact of regulatory reform at Federal, State, or local levels. However, TCRP has produced related to streamlining and better integrating transit services, such as: *Improving Transit Integration Among Multiple Providers*.
- Economic Impact of Permitting Reform:
 - TCRP has not addressed the economic impact of permitting reform at Federal, State, or local levels. However, it does address the issue of permitting reform more generally in a *Practices for Utility Coordination in Transit Projects*; and *Livable Transit Corridors: Methods, Metrics, and Strategies*.
- Performance Based Regulations and Safety:
 - TCRP has produced many publications in the area of performance measurement. Those specifically related to safety, include: *Manual to Improve Rail Transit Safety at Platform/Vehicle and Platform/Guideway Interfaces*; *Improving Safety Culture in Public Transportation*; *Elevator and Escalator Maintenance and Safety Practices*; and *Improving Safety-Related Rules Compliance in the Public Transportation Industry*.
- Potential Impact of Asset Recycling:
 - Those specifically related to asset management, include: *The Relationship Between Transit Asset Condition and Service Quality*; *Guidance for Developing a Transit Asset Management Plan*; *State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Capital Assets and Evaluating the Implications for Transit*; *Transit Asset Condition Reporting*; and *Funding for Infrastructure Maintenance: Achieving and Sustaining a State of Good Repair*.
- Potential Impact of Value Capture:
 - TCRP has produced a number of publications in the area of innovative financing tools for public transportation, including: *Public Transportation Guidebook for Small- and Medium-Sized Public-Private Partnerships*; the *Guide to Value Capture Financing for Public Transportation Projects*; and *Transit-Oriented and Joint Development: Case Studies and Legal Issues*.
- Improving the Mobility of Freight:
 - As a public transportation-focused program, TCRP focused on passenger transportation and does not explicitly address freight or goods movement.
- Feasibility of Micro-Transit:
 - The topic of Mobility Innovation and new mobility options has been an incredibly hot topic for TCRP in recent years. The program has issued several publications and for the first time in TRB history, webinar registrations hit the system maximum for a session on *Shared Mobility and the Transformation of Public Transit*.
- Improving Mobility for Underserved Communities:

- TCRP has a positive impact on underserved communities. TCRP has produced an array of resources dedicated to improving mobility for underserved communities, particularly related to increasing access to healthcare, such as: the *Handbook for Examining the Effects of Non-Emergency Medical Transportation Brokerages on Transportation Coordination*. Other related work includes: *Developing Partnerships between Transportation Agencies and the Disability and Underrepresented Communities* and *Coordinated Approaches to Expanding Access to Public Transportation*. For rural communities, TCRP is a unique resource that pools expertise from many providers to create useful tools and materials. Rural transit providers tend to be more limited in resources and technical capacity to conduct their own independent research, though rural formula grants do allow states to allocate funding to research projects. With the TOPS Committee and sub-program panel selection processes, issues of significant importance to rural communities can be selected, though there is not a provision for a specific amount of funding for research focused on the unique aspects of rural communities. Membership of TCRP's governing board (the TOPS Committee) reflects the diversity of the public transportation community, and includes members from rural and rural-serving organizations to inform the project selection process. While many general research reports are applicable to rural contexts (asset management, safety, human resources, etc.) TCRP has published reports with a specific focus on rural operators, some examples include *Methods for Forecasting Demand and Quantifying Need for Rural Passenger Transportation* accessible at <https://www.nap.edu/catalog/22619/methods-for-forecasting-demand-and-quantifying-need-for-rural-passenger-transportation-final-workbook> and *Toolkit for Estimating Demand for Rural Intercity Bus Services* accessible at <https://www.nap.edu/catalog/22857/toolkit-for-estimating-demand-for-rural-intercity-bus-services>.
- Cybersecurity:
 - TCRP has produced several research reports that include considerations of cybersecurity, such as *Protection of Transportation Infrastructure from Cyber Attacks: A Primer*; *Uses of Social Media in Public Transportation*; and, *Reconciling Security, Disclosure, and Record-Retention Requirements in Transit Procurements*.

Research Collaboration Partners

The TCRP is a cooperative undertaking characterized by continuous opportunities for public and stakeholder partnership. It is a research program for the public transportation community, guided by the public transportation community, and produces reports of maximum benefit to the public transportation community. The processes described earlier demonstrate the broad reach of the program's partnerships. Each project is managed by industry subject matter experts; projects are selected by a diverse industry committee.

Yearly, TCRP issues a series of public solicitations requesting proposals for research ideas, vets the ideas, then uses full and open competition to source contractors for selected research projects. Contractor selection is based on: (1) understanding of the problem, (2) research approach, (3) experience of the research team, (4) application of results and implementation plan, (5) plan for participation by

disadvantaged business enterprises, and (6) facilities and equipment. Staff and panel members evaluate all proposals based on these criteria. Each research product is guided by a panel of expert practitioners who represent public transportation and related organizations. Solicitations to (self-)nominate to serve on a research panel are public. Determinations are made through TRB to ensure adequate diversity of perspectives. TCRP governing board publicly conducts an annual process to solicit and select new members. TCRP tracks the number and types of proposals received as well as qualitative panel input throughout the development of the research product. TCRP periodically surveys those serving on panels to gauge levels of satisfaction with the experience.

Key Internal USDOT partners include:

- The FTA Research Office (lead), FTA Program offices, FTA Regional offices, FTA Office of the Administrator and FTA Office of Communications.
- The FTA's Research office informally shares information about TCRP with other modes as appropriate, particularly with peer program managers working with the other cooperative research programs.

Key External non-USDOT partners include:

- National Academy of Sciences, Engineering, and Medicine / Transportation Research Board (NASEM / TRB) – serves as the formal host of TCRP to conduct solicitations for research, build expert practitioner panels, manage the production of research deliverables and overall dissemination. As the premier platform for transportation research globally, TRB brings extensive resources to the TCRP.
- American Public Transportation Association (APTA) –APTA administers the Transit Development Corporation (TDC), which is a formal partner and signatory of an MOA with TRB and FTA on carrying out the program. The TDC manages the governance board, the TCRP Oversight and Project Selection (TOPS) Committee. APTA also holds the contract to carry out dissemination activities for TCRP. Given that APTA's membership represents most transit providers, APTA plays a key role in connecting TCRP deliverables with the primary intended audience.
- Conference of Minority Transportation Officials (COMTO) – COMTO has a formal agreement with APTA to carry out a TCRP Ambassadors program, whereby industry professionals are competitively selected to represent TCRP at conferences and meetings to educate the community about TCRP results.
- National Transit Institute (NTI) – NTI supports TCRP dissemination primarily through webinars. There are also instances where NTI course curricula is updated to reflect new ideas and the latest thinking on a given issue, as reflected in TCRP publications.

Evaluation / Performance Measurement

The TCRP and the FTA collaborated extensively over the last year to develop a new set of performance measures, adopted by the TOPS Committee in June 2018. Currently, TCRP is utilizing the following measures to track performance:

CORE PERFORMANCE METRICS <i>(Annual and trends)</i>	
<u>EFFICIENCY</u>	
Percent of new panels formed within 6 months of project selection	
Percent of new projects under contract within 12 months of selection	
Percent of research projects completed on schedule	
<u>EFFECTIVENESS</u>	
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	
Percent of increase in number of webinar participants: NTI and TRB	
Percent increase in the number of social media posts	
Presentations on TCRP deliverables at conferences and meetings with estimate of attendees	
<u>DIVERSITY</u>	
Panel diversity and inclusiveness: by gender and race	
Contractor diversity: by gender and race	
<u>QUALITY</u>	
Panel satisfaction with participation in TCRP (Follow-up e-survey)	
<u>IMPACT</u>	
User/customer satisfaction with TCRP deliverables (Follow-up survey to download)	

The TCRP tracks many variables, and has begun to conduct a systematic year over year tracking of performance across a series of formalized indicators. TCRP also issues periodic surveys to capture information about the program's longer-term impacts and benefits.

FY 2018 TCRP Scorecard

Objective	Target	Actuals	Trend	On Target	Notes
TCRP: Scorecard					
EFFICIENCY					
Percent of new panels formed within 6 months of project selection	100%	89%	↓	●	8 of 9 projects were started within 6 months of project selection. One project (B-46) was jointly funded with NCHRP.
Percent of new projects under contract within 12 months of selection	90%	50%	↓	●	
Percent of research projects completed on schedule	75%	35%	↓	●	
EFFECTIVENESS					
Percent of Problem statements rated 3.5 or higher by the Screening Panel and TOPS	25%	38.20%	↑	●	
Percent of Increase in total downloads and by TCRP product type since 2017	Top 20% of NAP Publications under category of Transportation and Infrastructure	4.80%	↑	●	2017: 57,294; 2018: 60,059
Percent of Increase in number of webinar participants: NTI and TRB	5% increase in participation	18.50%	↑	●	2018:4,415; 2017: 3,727
Percent satisfactory score (only TRB)	80% customer engagement and experience score	91.60%	↑	●	
Percent Increase in the number of social media posts (TRB and APTA)	10% increase in # of posts	86%	↑	●	2018:134; 2017:72
Presentations on TCRP deliverables at conferences and meetings with estimate of attendees	10% increase in #of presentations made annually	42.9%%	↑	●	This may change before the end of the year as there may be additional opportunities to present at conferences
DIVERSITY					
Panel diversity and inclusiveness: by gender and race					
Women	25% women	36.80%	↑	●	
Minorities	25% minorities	20.50%	↓	●	
Percent from public transportation agencies	40%	26.70%	↓	●	More outreach is needed.
QUALITY					
Panel satisfaction with participation in TCRP (Follow-up e-survey)	Satisfaction rate 4.0 out of 5.0	4.5	↑	●	
IMPACT					
User/customer satisfaction with TCRP deliverables (Follow-up survey to download)					User Customer Satisfaction survey in FY 2019

TCRP Performance Goals for FY 2019 and FY 2020

The TCRP uses feedback from each year to improve on the deliverables for the following years. FTA and TCRP draft a cooperative agreement, which serves as a roadmap for that year. At the end of a quarter, principals meet to discuss what worked well and where to seek improvement. An example of recent progress, TCRP partners worked cooperatively to develop program performances measures, outlined above.

As noted earlier, TCRP research is broad and can align with each USDOT goal. However, since TCRP is primarily an applied research program designed to address near-term issues facing the public transportation industry – the program is most closely aligned with USDOT’s strategic goal of Infrastructure. Many TCRP reports provide invaluable information on asset delivery, planning, funding

and finance as well as ways to improve lifecycle/preventive maintenance, and systems operations and performance. The TCRP research has even examined workforce issues. The TCRP governance committee meets twice annually to discuss, identify, and prioritize research needs relevant to the transit industry. The TCRP selects research projects as recommended by an independent governing board of public transportation stakeholders. The TCRP plays a critical role in suggesting public transportation research, development, and technology transfer activities that further the effectiveness, efficiency, and quality of public transportation. The TCRP also communicates FTA's strategic research goals to its audiences, helping to further extend FTA's reach.

Small Business Innovation Research Program (SBIR)

\$640,000

Program Description

The Small Business Innovation Research (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. Federal Law mandates that FTA allocate 3.2 percent of R&D budget to the SBIR program. 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. FTA's SBIR program helps invest in promising early-stage innovations that may otherwise be too high of a risk for private investors.

Program Activities

The SBIR program is administered by each individual agency with guidelines established by Federal Law. FTA designates research and development (R&D) topics for annual solicitations and accepts proposals from small businesses through a competitive review process. The FTA 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.

The FTA SBIR program is currently funding one Phase I project and two Phase 2 projects in the areas of safety and mobility. FTA's Phase I research on using virtual and augmented reality to aid transit use by all travelers with a focus on travelers with disabilities ends in FY 2019. FTA is inviting the small business to submit proposal for Phase II that will continue through FY 2020 and 2021. FTA's Phase II research on Pedestrian and Cyclist Detection Devices for buses will continue into FY 2020 with the expectation that the small business will develop a commercially viable product. FTA's Phase II research on passenger counting and reidentification technology to maximize transit capacity and improve delay time ends in FY 2019 with the expectation that the small business has developed a solid foundation for a commercially viable product.

Each year, FTA surveys internal and external stakeholders on important research areas of need in transit. FTA is currently accepting proposals for Phase I research through a competitive solicitation topic titled "Cost Allocation Technology for Non-Emergency Medical Transportation" open February 19, 2019 to April 22, 2019. FTA is seeking innovative solutions for a cost allocation method/technology that accounts for divergent federal requirements and funding sources by trip that will result in improved coordination across multiple Federal Agency programs that provide funding to access human services transportation. Selected Phase I proposals are expected to be awarded at the end of FY 2019 and ending in FY 2020. FTA will invite awarded Phase I small businesses to apply for Phase II funding after Phase I activities in FY 2020 are completed.

Program Objectives

The SBIR program is a Federally Mandated program and each agency administers its own individual program within the guidelines established by Federal law. FTA's SBIR program objectives must align with the overall SBIR program objectives. The programs objectives are four-fold:

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.

The FTA holds an annual solicitation where requests for proposals are sent to small businesses to address priority research areas in transit. The call for proposals are sent out to small business across the nation fostering and encouraging participations in innovation and entrepreneurship especially among women and socially or economically disadvantage groups. The call for proposals creates a process where the most innovative proposals compete against one another and in return helps stimulates technological innovation. Investment in these technological innovations helps FTA meet Federal research and development needs with the goal of creating commercially viable products and solutions derived from Federal research and development.

Statutory Requirements

FTA's Small Business Innovation Research (SBIR) program was established 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 Fiscal Year 2017 (Pub. Law 114-328, § 1834).

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Innovation	Development of Innovation

The SBIR program closely aligns with USDOT's Strategic Goal of Innovation. The goal of USDOT 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 SBIR program meets USDOT's Strategic goal of Innovation by stimulating technological innovation through coordination across modes, stakeholders, and institutions and through partnerships with the private sector and research organizations. The goal of SBIR is to also foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantage persons and increase private-sector commercialization of innovations derived from Federal research and developmental funding.

USDOT Research Priorities

SBIR research investments align and are prioritized by USDOT's Strategic goals. This allows FTA's SBIR program to have a proactive and forward-looking approach as it relates research priorities of with immediate need. For example, SBIR research aligns with research exploring the feasibility of Microtransit. This is articulated through the current research around accessible transportation technologies and how they operate in the context of public transportation and shared-ride services like Uber and Lyft. SBIR research is aligned with Improving Mobility for Underserved Communities. For example, SBIR is conducting research around augmented and virtual reality to aid transit use by all travelers, whether they have disabilities or other barriers to using transportation. The goal of the research is to assess the transportation needs of end-users and developing suitable technologies to meet those needs.

The FTA's SBIR program has not identified any unnecessary regulatory barriers, but is aligned with FTA's efforts and in support of this USDOT priority and will continue to keep lines of communication open for small businesses and partners that express any regulatory burdens and barriers as it relates to SBIR research. Though current FTA SBIR research does not involve infrastructure projects that require NEPA review, the SBIR program fully supports the development of tools, processes, and reform that will reduce delays and accelerate the delivery of transportation projects.

The FTA's SBIR program research supports the use of scientific methods and data-driven processes as it relates to guiding safety programs and innovative technological solutions. For example, FTA's SBIR research on pedestrian and cyclist detection was motivated by data collected on nationwide transit bus collisions (i.e. injury and fatal) and the collision prediction and threat assessments are based off scientific probabilistic models by combining fused data and information from sensor system.

Research Collaboration Partners

The SBIR program partners with both Internal USDOT stakeholders and External stakeholders. The DOT partners include the Office of the Secretary, The Volpe Center, and Federal Highway Administration (FHWA), and the Intelligent Transportation System (ITS) Joint Program Office (JPO). The benefits of these partnerships ensure that FTA research priorities are aligned with USDOT-wide strategic goals and allows FTA to collaborate on multi-modal initiatives. This collaboration encourages input for future research topics and potential cross-modal efforts. The SBIR program also partners with a diverse group of small businesses as well. The purpose of the SBIR program is to stimulate technological innovation by helping small businesses grow through funding product development research in strategic areas important to transit.

Technology Transfer and Performance

\$2,000,000

The purpose of this program is to facilitate the implementation of research and technology development and to advance the interests of public transportation. Termed within USDOT as ‘technology transfer’ this project will monitor, report on, and improve outreach efforts for research to practice. It will also enhance the ability of transit agencies to deploy the results of research and technology investments, and assess any governance barriers identified in demonstration programs. Over the last three years, FTA has invested over \$60M in projects that assess new ways of managing and providing public transportation. Innovative projects assessed new modes of providing safety; new types of capital; new mobility service models; new public/private partnerships; and the potential of automation. In addition to understanding how to identify and implement the most successful projects in these areas, FTA also needs to understand how the local, state, and Federal regulatory framework affects success. This program is designed to understand the current state of regulations across all three governance domains – local, state, Federal – and any recommendations for policy changes that will enhance FTA’s ability to fund improvements in public transportation.

Program Activity

Activities for this program include:

1. *Technology Transfer (T2), Governance, and Assessment Program* – The goals of this program are to understand the current state of regulations across all three governance domains; facilitate the implementation of research and technology development; support research report finalization and 508 compliance; and advance the interests of public transportation. The outputs of this program are the number of research reports published; and number of performance indicators tracked in one year. The outcomes are improvement of program dissemination of research to practice results. The impact of this program is that public transit agencies will directly benefit with either improved operations; enhanced traveler experiences; and communities will have improved economic vitality.

A portion of this project builds on the Information Dissemination and Outreach Program with the Center for Urban Transportation Research (CUTR). The governance studies and assessment as well as research to practice tools, are new.

Program Objectives

1. Analyze the current state of local, state, and Federal regulations.
2. Produce high-quality research products that are useful for the public transportation industry and actively promote the results of FTA’s research.
3. Working with the results of research projects to ensure public transit agencies have the information necessary to deploy and implement promising research findings – i.e. facilitate research to practice.

The FTA’s research program relies on major investments in demonstration programs that support testing viable research solutions at public transit agencies. It is essential that agencies have the tools to understand and implement promising research results. Thus, ensuring funding for research to practice is an important part of FTA’s research projects.

Statutory Requirements

The FTA's Accountability Program is not mandated by statute but it is a discretionary project within the eligibilities authorized by 49 U.S.C. § 5312.

Program Alignment with Strategic Goals

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Accountability	Mission Efficiency and Support

This program closely aligns with DOT' Strategic Goal of Accountability. This program supports mission efficiency by ensuring quality results and effective evaluation methods. It supports USDOT's mission requirements by efficiently and effectively planning for and managing sustainable operations and other mission support services.

USDOT Research Priorities

This new research activity will support FTA's program areas of Mobility Innovation, Safety, and Infrastructure. This program will assist those programs in tracking any economic impact of regulatory reform; economic impact of permitting reform; performance based regulations and safety; potential impact of asset recycling; potential impact of value capture; improving the mobility of freight; feasibility of micro-transit; improving mobility for underserved communities; and cybersecurity when applicable. This program will feed from the results of other FTA research activities and it will ensure FTA research meets FTA's and USDOT's strategic goals and objectives.

Research Collaboration Partners

Many of FTA's partners such as the American Public Transportation Association, the Transportation Research Board, the Shared Use Mobility Center, and many others, provide opportunities for FTA's research grantees to share successes. However, no entity has the responsibility for ensuring effective research to practice for federally funded activities – this is a federal role. This program is the result of the cooperative efforts between FTA, OST-R, NTL, and other FTA offices.

Chapter 4 – FY 2021 Program Descriptions

Mobility Innovation

Program Description

The FY 2021 mobility innovation program will build upon the findings of prior years. By FY 2021, the FY 2016 MOD sandbox projects should be completed, and the first set of transit automation grants should be obligated and in process. FTA will have several years of data on the new performance measures using the FY 2017 baseline. The program will remain tightly aligned with USDOT's Strategic Goal of Innovation. FTA's Mobility Innovation research will continue to strengthen the capacity of transit agencies and communities to navigate the dynamic, evolving landscape of personal mobility. Data should be available on how well the new innovative business models, partnerships, and private-sector solutions have seamlessly improved mobility options for all travelers. FTA will also be able to assess if there were commensurate reductions in costs for public transit agency operations – though the lag time for significant changes would suggest that one year would not be expected to yield significant results.

Program Activities – goals for these activities remain consistent with FY 2020

1. *Mobility on Demand (MOD)* – this series of projects are exploring ways to provide travelers with enhanced mobility options; improving travel decision tools; and increasing convenient and seamless travel. MOD projects are testing innovative new operational models in transit agencies such as solutions for the first/last mile; more effective leveraging of existing investments; and improving service quality. FTA is working with MOD stakeholders to promote the transit industry's awareness and support preparedness for MOD, and to understand impediments to implementation. The research will also increase awareness and buy-in from local stakeholders and transportation companies/vendors needed for successful deployments of integrated MOD solutions in communities.
2. *Transit Automation Research* – demonstration programs should be underway, and FTA will be working with grantees to develop detailed statements of work and automation plans. Research may have begun to gather data on use cases. FTA hopes to have a good understanding as well regarding any regulatory or programmatic barriers that need to be addressed.
3. *Accessible Transportation Technologies Research Initiative (ATTRI)* – data should begin to be available for how well new technologies such as accessible data, mobile computing, robotics, artificial intelligence, and object detection, are enhancing independent trip planning and navigation for people with disabilities.
4. *Multi-modal Integrated Universal Payment Systems* – expected level of progress for this area is uncertain for FY 2021. It will be essential that MOD and transit automation research can leverage research into integrated payment options for transit agencies and other mobility providers at the regional and interregional levels.

Program Objectives

The primary objectives of FTA's Mobility Research for FY 2021 will remain to:

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 engages all modes – public and private - for enhanced mobility of all travelers.

In FY 2021, FTA will be able to assess how well Mobility Innovation research projects improved the efficiency, effectiveness, and quality of public transportation services through adaptation to new mobility options by public transportation providers. FTA will apply the new FTA research evaluation framework that uses public transportation efficiency and effectiveness as measures to track Mobility Innovation program performance. FTA will see if mobility projects improved transit operational efficiency and reduced costs by leveraging public and private assets as well as the development and deployment of innovative technologies. FTA will measure the percent change in the type of service options used by transit agencies that expand service using alternative shared mobility solutions and public private partnerships. The measure is being baselined in FY 2018 through data in the National Transit Database (NTD), and will be tracked annually with a goal to have a longitudinal trend assessed over 5 years. FTA will also record the percent change in the number of public transit agencies that expand service coverage (geographic or temporal) through alternative shared mobility solutions and public private partnerships. The measure will be tracked annually with a baseline established from FY 2017 data from the SUMC map with a goal to have a longitudinal trend tracked over 5 years.

The FTA's Mobility Innovation research will continue to identify promising practices in shared services and help transit agencies make the shift to being providers of mobility. New public data access plans should be in place for all grantees which would give FTA access to new data sources. There are some extremely challenging technology issues that must be overcome but with potentially high payoff for travelers – FTA should have a greater understanding of the return on investment and cost benefit for some of these new mobility paradigms. FTA will continue to partner across USDOT and with key industry partners such as APTA, CTAA, SUMC, TCRP, ITS America and TransitCenter – many of whom will field their own areas of inquiry into new mobility paradigms in public transportation.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Mobility Innovation	Improving Mobility

The MOD program will continue to closely align with the USDOT strategic goal to lead in the Development and Deployment of Innovative Practices and Technologies that Improve the Safety and Performance of the Nation's Transportation System. Specifically, MOD projects are developing innovations by providing seed funding so communities can experiment with new approaches then report back to FTA so those findings can inform other public transit agencies' activities. Development of innovation is also supporting the objectives of expanding partnerships and coordination between the public and private sector. Deployment of innovation is furthered by the growth of communities of practice; widespread stakeholder collaboration activities; and broad outreach to support technology integration and technology transfer.

Safety

Program Description

In FY 2021, 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. FTA will continue to support research on new safety 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 Activity

1. *Safety Research and Demonstration (SRD) Program* – SRD builds on a portfolio of demonstration projects that provides technical and financial support for transit agencies to pursue innovative approaches to eliminate or mitigate safety hazards. This program focuses on implementing innovative technological solutions to improve safety of transit systems. The SRD program uses a methodical and data driven approach to focus the research on specific areas that have been identified as a safety risk for transit agencies and the public. Every year, FTA selects a topic(s) based on safety data analysis, data from prior demonstration projects, input from the industry and stakeholders such as TRAC, TRACS, NTSB recommendations, FTA Standards Working group and others. As well as, input from FTA's Safety Office based on their interaction with the SSO's, the safety directives issued, and safety oversight of the transit agencies. The program uses the statutory pipeline phased approach (Foundational research, innovation/development, demonstration/deployment and evaluation) with the aim of improving the safety of the nation's public transportation system. As an example; for FY16 SRD program, FTA focused the program on developing technological solutions for transit worker protection and bus collision avoidance and mitigations. In FY18 SRD program, FTA is focusing on rail safety and trespassing & suicide prevention issues. FY19 and FY20 SRD program, FTA plans to focus the SRD research program on street running rail collisions and implementing pilot projects on Platform Edge Doors solutions for existing heavy rail agencies. FTA will decide on the topic for FY21 SRD program, in a near future, based on the inputs and process described above.

Program Objectives

The objectives of FTA's safety research program will remain unchanged for FY2021 to maintain the integrity of the evaluation and data gathering efforts. The safety research program will continue to improve public transportation safety and support FTA's overall regulatory role. The program is focused on improving public safety by reducing transit-related injuries, fatalities, and related safety events to reduce excessive property damage.

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

Without FTA assistance to continue to fund innovations and identify the most promising technologies with real-world assessment of implementation processes, new technologies might not be available or useable. The limited application of these types of safety technologies to a unique public-sector system makes private sector investment in these areas lag other transportation safety initiatives such as with cars, so that public sector investment is critical to seeding private sector investments.

Like in FY 2020, extensive partnerships will continue to be critical to maintain technology and multi-modal approaches. FY 2021 research and demonstration will build upon continued collaboration with internal and external stakeholders. External safety committees run by the industry will play invaluable roles to educate FTA on important perspectives. An academic institution will remain a significant partner as the safety program evaluator and with staff who support FTA as safety subject matter experts.

In FY 2021, FTA will continue to collect data to assess the safety efficiency and effectiveness measures to track the program's performance. At present, a robust set of project results do not exist that can form the basis for future research and demonstration projects. FTA measures safety effectiveness as operating transit systems in a safer manner through application of advanced technologies and innovative practices, as well as, improved safety culture development and human factors. FTA rates the change in public transportation agency deployment rate of advanced safety technologies and voluntary safety standards to track results. The measure will be assessed annually with a baseline established from FY 2017 data with a goal to have a longitudinal trend tracked over 5 years. Improving transit capital and operational efficiency while supporting improved transit system safety is the efficiency measure which will utilize NTD data. To assess overall industry impact, FTA seeks to reduce injuries and fatalities by using innovative technologies that improve worker and rider safety. There is a major lag time between demonstration research and having results in the field through the implementation of evidence-based safety technologies.

Key safety outcomes serving as proxies to the longer-term result of lower injuries and fatalities, such as the increase in the demonstration and deployment of innovative practices or technologies at transit agencies; increases in the adoption of a safety management systems plans; the adoption rate of employee safety reporting systems across the US; and the use of data to improve transit agency safety policies and practices.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Safety	Promoting Safety

The FTA's research will continue to align with USDOT's Safety goal to reduce transportation-related fatalities and serious injuries connected to public transit systems. FTA's strategic safety approach will be to mitigate risks and encourage the adoption of useful infrastructure and behavior changes that directly address safety for both urban and rural communities. Specifically, FTA will leverage funding to improve the safety of both urban and rural passengers, employees, emergency responders, and anyone who encounter public transits systems across America. FTA's Safety research program will continue to focus on demonstrating and deploying transformative technologies and operational practices through partnership with transit agencies, technology suppliers, and other private sector entities to address increased safety.

By allocating Federal research resources aimed at targeted specific safety hazards identified via FTA's *Safety Research Strategic Plan* and FTA's *Standards Development Strategic Plan*, public transit agencies will be able to deliver significant and scalable safety improvements to the traveling public. Additionally, promotion at the Federal level of a public-transit-agency-safety culture by emphasizing safety performance and innovation as key components is critical to making public transportation an even safer mode of travel.

At present, FTA and FRA have some research areas that overlaps both in term of technology demonstration (wayside worker protection, track inspection technologies, trespassing mitigation, etc.) and standards development (crash energy management, event recorders, emergency evacuation signs, etc.). FTA research office had arranged multiple meetings with our counterparts at FRA to share our research programs in the past to exchange ideas and results. Nevertheless, the focus for FRA and FTA are not exactly aligned since FTA research is focused on public transportation while FRA research is focused on freight and intercity passenger rail.

To date, FTA has expended considerable resources in support of public transportation safety research through demonstrations and the development of safety-related standards and best practices documents. FTA has learned that, while very safe, public transportation in America has a serious safety issue with infrastructure and state-of-good repair, and there is a need to increase safety culture within the public transportation industry.

The proposed FY 2021 activities, like prior fiscal years, have a projected time of completion from three to six years before producing a tangible outcome. For example, a tangible outcome would be the installation of platform edge doors (PED) to address the issue of trespassing and suicides by transit agencies. Given all competing interests, the installation PEDs at even a small subset of passenger rail transit agencies might take up to 10 years beyond the completion of a successful safety demonstration project(s) focused on PEDs.

Infrastructure

Program Description

In FY 2021, FTA should be finalizing phase I projects on the Bus Compartment Redesign Program. FTA and the program evaluators would select one or 2 most promising designs and proceed with phase II as part of the infrastructure activity.

The FTA will have data from advances in technology and new information on the market growth of new buses which will provide important information on the economic impact of FTA's infrastructure research. New projects will build upon FY 2018, FY 2019 and FY 2020 results, and in FY 2021 may be a year when FTA should re-assess research infrastructure investment areas – perhaps embarking on new research based upon what was learned from over \$200 million in grants invested in low and no research concludes.

Program Activities

1. *Bus Compartment Redesign Program Phase II* – After the conclusion of the Phase I. FTA, working with the evaluators, will select the most promising designs and fund Phase II, which is to build a prototype bus with the new design and test the prototype bus at Altoona or other alternate facility. The main goals of the program are to eliminate or minimize bus operator blind-spots to increase driver visibility; eliminate or minimize bus operator assaults; and maintain or improve boarding, payment, accessibility process.
2. *Low and No (LoNo) Emissions Component Assessment Program (LoNo-CAP)* – This program provides unbiased assessments of LoNo components used in transit buses, publishing the assessments online, and summarizing them in a required annual report to Congress. For LoNo-CAP, the term “low or no emission component” means an item that is separately installed in and removable from a low or no emission transit bus. LoNo is a voluntary program for LoNo component manufacturers. When components are tested under LoNo-CAP, it will significantly support low or zero emissions transit bus operation. This program is statutorily required LoNo-CAP is authorized in Federal public transportation law (49 U.S.C. § 5312(h)).

Program Objectives

The main goal of infrastructure research remains the same in FY2021. The goal of the program is to improve deteriorating public transportation infrastructure, bring assets up to a state of good repair, and improve lifecycle maintenance by evaluating methods, products, approaches, materials, and practices to develop products or service more efficiently, deploy cutting edge “infrastructure health monitoring” technologies, and create American jobs.

In FY 2021, FTA will leverage the extensive partnerships and collaboration with both public and private sector stakeholders. It is expected that transit vehicle manufacturers and important partners like CALSTART and the Center for Transportation and the Environment will expand in their roles working with FTA. By FY2021, FTA expects to overhaul the bus testing program and create a national network of Centers of Excellence in advanced propulsion – this set of Centers will add significant value to the public transportation industry.

The FTA's infrastructure research activities with FHWA, NHTSA, FRA, FMCSA, and other Federal partners including the Department of Energy, as well as outcomes from TCRP studies and the National Renewable Energy Labs will help refine infrastructure research and demonstration projects. With so many

significant investments in infrastructure research ending by FY 2020, a major area of focus for FTA will be research-to-practice and technology transfer to ensure that the public transportation industry benefits from these investments.

Results from NREL evaluations and technology validations team of fuel cell electric buses (FCEBs) will provide comprehensive, unbiased results of fuel cell bus development and performance compared to conventional baseline vehicles to aid public transit agency acquisition decisions. The new FTA research evaluation framework will be applied to assess infrastructure research efficiency and economic competitiveness. For infrastructure efficiency, FTA hopes to report on whether there was an improvement in lifecycle maintenance practice approaches that promote more efficient asset management, and preservation of federally procured capital. FTA will verify whether there was a percent change in lifecycle maintenance costs for maintaining rolling stock and FTA will continue to monitor the growth of the low and no emissions bus industry.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure

The FTA's program remains aligned to USDOT's Strategic goal for Infrastructure which is to Invest in Infrastructure to Ensure Mobility and Accessibility and to Stimulate Economic Growth, Productivity and Competitiveness for American Workers and Businesses.

The Infrastructure strategic goal combines the previous State of Good Repair and Economic Competitiveness goals. Improving the nation's infrastructure encompasses improving both system conditions and system performance in support of the Nation's economy, as well as speeding up project delivery. FTA will improve how it measures system condition with more thorough data and clearer metrics.

The FTA's FY 2021 Infrastructure Research Program will continue to support DOT's strategic infrastructure goals by:

1. Improving lifecycle maintenance by evaluating methods, products, approaches, and practice to develop products or service more efficiently.
2. Enhancing the environment by providing mechanisms for mainstreaming and determining performance specifications for low and no emission transit bus components through university-based laboratory testing.
3. Improving the build and project approval process.
4. Stimulating economic growth.

The backlog of transit assets that are not in a State of Good Repair needs continuous improvement. By improving Life Cycle and Preventive Maintenance practices, FTA will keep the Nation's transportation infrastructure secure and in a state of good repair by maintaining and upgrading existing systems in rural and urban communities. FTA will determine what analytical tools and processes can significantly aid in extending the life of transit assets.

Research in life cycle and preventative maintenance will support DOT's goal to reverse the trend of transit infrastructure assets in worsening conditions. System operations and performance will improve with further analysis and evaluation of LoNo vehicles and will aid in the deployment of innovative technologies that enhance the safety and performance of the Nation's transportation system.

Industry partnerships and collaboration with both public and private sector stakeholders continue to play a vital role in technology and infrastructure research. Several DOT agencies are advancing research with a goal of improving conditions of America's transportation-related infrastructure including Office of the Secretary, Federal Highway Administration, National Highway Traffic Safety Administration, Federal Motor Carrier Safety Administration, Federal Railroad Administration and other federal partners including Department of Energy and Department of Homeland Security.

The FTA continuously supports investments in infrastructure research that promote transportation innovations, expands deployment of new technologies and practices and measures that reduce the State of Good Repair backlog. Results of previous examinations have identified state of the art practices, assisted transit agencies and the industry with technical guidance in addition to providing data that will enhance service efficiency. As projects are completed, FTA has identified gaps in its research that warrant further investigation.

Industry adoption of completed research and sustained departmental support both factor into completing projects with practical results. As an example, infrastructure research activities have had a significant impact in reducing the cost of on-going maintenance of transit assets. Other completed activities have established monitoring technologies and/or Standards that have yielded results on the economic impact to the state of good repair backlog.

Transit Cooperative Research Program (TCRP)

Program Description – this statutory program will remain unchanged in FY 2021 except there will be new problem statements and research agreements finalized

The Transit Cooperative Research Program (TCRP), operated through the Transportation Research Board of the National Academy of Sciences, is an applied contract research program manages near-term, practical research that addresses key challenges facing transit agencies. An independent board comprised of key public transportation industry stakeholders selects projects to ensure that research projects responds to the most pressing needs of the industry – the TCRP Oversight and Project Selection (TOPS) committee.

Recently published research reports addressed critical issues such as public private partnerships, value-capture financing, shared use mobility, rail transit safety, emergency response, and multiagency electronic fare payment systems. TCRP is a critical partner in shaping and sharing information about FTA's public transportation innovation projects, and is a key driver for moving research to practice. TCRP plays a unique role as a national resource for public transportation agencies whose operations are usually so lean as to make individualized research activities cost prohibitive. TOPS selected projects are monitored and supported through a panel of expert practitioners from the industry.

The engagement inherent in TCRP studies brings together the transit industry, interested stakeholders, and the public. TCRP is a trusted and enduring forum for the transit community to share ideas and best practices to improve public transportation in communities across the country. TCRP's mission is to promote, select, and conduct research and disseminate research findings to improve the practice and performance of public transportation. TCRP disseminates research findings in cooperation with its TCRP J-1, Dissemination and Implementation of TCRP Research Findings, panel. J-1 uses various dissemination means including the National Academies Press database for publications; Transportation Research Board platforms; and through formal partnerships with the APTA, the Conference of Minority Transportation Officials (COMPTO), and the National Transit Institute (NTI). As an example, APTA's main website has links for TCRP projects, and NTI regularly does webinars on TCRP research findings.

Program Activities

1. *Research Project Selection:* Twice yearly, TCRP issues requests for research problem and synthesis statements. The TOPS Committee then meets twice annually to discuss, identify, prioritize research needs, and select approximately 15 problem statements for funding.
2. *Research Project Panel and Solicitation:* Selected statements and project panels are developed by TRB staff, the TCRP project panel reviews solicitation and bids, and FTA liaisons participate in the process to assist TCRP with the release to solicit bids to carry out the research.
3. *Conduct Research:* Proposal submissions are evaluated, a winning proposal is selected, and the TCRP project team oversees the applied research product to offer insights, guidance, and feedback.
4. *Dissemination:* Results are published on the TRCP website, and the American Public Transportation Association, through their J-1 program for TCRP, leads the outreach to promote the results of TCRP project findings.

Program Objectives

The objectives of the Transit Cooperative Research Program are:

1. To identify transit problems in need of research and development (R&D) investigation; and to establish a priority ranking for them.
2. To 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. To improve communications, technical information transfer, and dissemination.
4. To provide a means of addressing a variety of near-term transit problems in cooperation and in coordination with Federal public transportation research.

The TCRP is a cooperative undertaking characterized by continuous opportunities for public and stakeholder partnership. It is a research program for the public transportation community, guided by the public transportation community, and produces reports of maximum benefit to the public transportation community. The processes described earlier demonstrate the broad reach of the program's partnerships. Each project is managed by industry subject matter experts; projects are selected by a diverse industry committee; and research to practice is driven by a cooperative agreement with an industry association – APTA.

Key Internal USDOT partners include:

- FTA Research Office (lead), FTA Program offices, FTA Regional offices, FTA Office of the Administrator and FTA Office of Communications.
- FTA's Research office informally shares information about TCRP with other modes as appropriate, particularly with peer program managers working with the other cooperative research programs.

Key External non-USDOT partners include:

- National Academy of Sciences / Transportation Research Board (NAS / TRB) – serves as the formal host of TCRP to conduct solicitations for research, build expert practitioner panels, manage the production of research deliverables and overall dissemination. As the premier platform for transportation research globally, TRB brings extensive resources to the TCRP.
- American Public Transportation Association (APTA) – Formal partner, signatory of an MOA with TRB and FTA on carrying out the program. APTA administers the Transit Development Corporation, which manages the governance board, the TCRP Oversight and Project Selection (TOPS) Committee. APTA also holds the contract to carry out dissemination activities for TCRP. Given that APTA's membership represents most transit providers, APTA plays a key role in connecting TCRP deliverables with the primary intended audience.
- Conference of Minority Transportation Officials (COMTO) – COMTO has a formal agreement with APTA to carry out a TCRP Ambassadors program, whereby industry professionals are competitively selected to represent TCRP at conferences and meetings to educate the community about TCRP results.

- National Transit Institute (NTI) – NTI supports TCRP dissemination primarily through webinars. There are also instances where NTI course curricula is updated to reflected new ideas and the latest thinking on a given issue, as reflected in TCRP publications.

In FY 2021, TCRP will have one year utilizing a new performance scorecard verified by the TOPS committee in June of 2018. This scorecard expects to track the below measures; however, slight modifications may occur between the time this FTA AMRP is completed and the final measures are adopted.

Measure: Program Span and Outreach Effectiveness

- Description: Through conferences, webinars, and project panels, maintain industry and stakeholder engagement. Maintain a high level of public transportation industry and stakeholder participation and involvement in the TCRP Program.
- Calculation methodology: Total number of stakeholders engaged in various TCRP activities involving formulation of research topics to improve the state of public transportation.

Measure: TCRP Project Selection Effectiveness

- Description: Select timely and high priority research projects through the TOPS Committee process to ensure that the most immediate needs of the public transportation industry are selected for research.
- Calculation methodology: Total number of specific projects selected and funding allocation to support those projects through TOPS committee meetings.

Measure: TCRP Program Innovation

- Description: Identify the most significant public transportation needs and determine appropriate applied research through the generation of submitted research problem statements from the public transportation industry and stakeholders.
- Calculation methodology: The annual total number of problem statements submitted to TCRP due to outreach activities and generation of interest.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Infrastructure	Improving Infrastructure

The TCRP supports USDOT's Strategic Goal of infrastructure, though the program is cross-cutting and often addresses all USDOT's strategic goals. However, because of the strong focus of TCRP to field practical research that aids public transit agencies' operations, this relates to the infrastructure strategic goal and helps to drive economic vitality for America's communities.

The TCRP develops research products across several sub-programs: Research Reports, Ideas Deserving Exploratory Analysis, Legal Studies, and Syntheses. Research Reports are further categorized to address emerging practice in: Operations, Service Configuration, Engineering of Vehicles and Equipment, Engineering of Fixed Facilities, Maintenance, Human Resources, Administration, Policy and Planning, and Special Projects.

Small Business Innovation Research Program (SBIR)

Program Description

The Small Business Innovation Research (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. Federal Law mandates that FTA allocate 3.2 percent of R&D budget to the SBIR program. 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. FTA's SBIR program helps invest in promising early-stage innovations that may otherwise be too high of a risk for private investors.

In FY 2021, the SBIR research program will also have its annual solicitation where FTA 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.

Program Activities

The SBIR program is administered by each individual agency with guidelines established by Federal Law. FTA designates research and development (R&D) topics for annual solicitations and accepts proposals from small businesses through a competitive review process. The FTA 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.

The SBIR program partners with both Internal USDOT stakeholders and External stakeholders. The DOT partners include the Office of the Secretary, The Volpe Center, and Federal Highway Administration (FHWA), and the Intelligent Transportation System (ITS) Joint Program Office (JPO). The benefits of these partnerships ensure that FTA research priorities are aligned with USDOT-wide strategic goals and allows FTA to collaborate on multi-modal initiatives. This collaboration encourages input for future research topics and potential cross-modal efforts.

Program Objectives

The SBIR program is a Federally Mandated program and each agency administers its own individual program within the guidelines established by Federal law. FTA's SBIR program objectives must align with the overall SBIR program objectives.

The program's objectives are:

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.

FTA holds an annual solicitation where requests for proposals are sent to small businesses to address priority research areas in transit. The call for proposals are sent out to small business across the nation fostering and encouraging participations in innovation and entrepreneurship especially among women and socially or economically disadvantage groups. The call for proposals creates a process where the most innovative proposals compete against one another and in return helps stimulates technological innovation. Investment in these technological innovations helps FTA meet Federal research and development needs with the goal of creating commercially viable products and solutions derived from Federal research and development.

Program Alignment with Strategic Goals

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Innovation	Development of Innovation

The SBIR program closely aligns with USDOT' Strategic Goal of Innovation. The goal of USDOT 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 SBIR program meets DOT's Strategic goal of Innovation by stimulating technological innovation through coordination across modes, stakeholders, and institutions and through partnerships with the private sector and research organizations. The goal of SBIR is to also foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantage persons and increase private-sector commercialization of innovations derived from Federal research and developmental funding. FTA invest in small business research not only because it is mandated by Federal Law, but FTA's SBIR program helps invest in promising early-stage innovations that may otherwise be too high of a risk for private investors.

Technology Transfer and Performance

Program Description

This program will build from results and lesson learned in FY 2020. For FY 2021, the program will continue facilitate the implementation of research and technology development and to advance the interests of public transportation. It will also continue to enhance the ability of transit agencies to deploy the results of research and technology investments, and assess any governance barriers identified in demonstration programs. This program will continue to understand the current state of regulations across all three governance domains – local, state, Federal – and any recommendations for policy changes that will enhance FTA’s ability to fund improvements in public transportation.

Program Activity

1. *Technology Transfer (T2), Governance, and Assessment Program* – The goals of this program in FY 2021 will continue to aim to understand the current state of regulations across all three governance domains; facilitate the implementation of research and technology development; support research report finalization and 508 compliance; and advance the interests of public transportation. The outputs of this program are the number of research reports published; and number of performance indicators tracked in one year. The outcomes are improvement of program dissemination of research to practice results. The impact is of this program is that public transit agencies will directly benefit with either improved operations; enhanced traveler experiences; and communities will have improved economic vitality.

Program Objectives

1. Analyze the current state of local, state, and Federal regulations.
2. Produce high-quality research products that are useful for the public transportation industry and actively promote the results of FTA’s research.
3. Working with the results of research projects to ensure public transit agencies have the information necessary to deploy and implement promising research findings – i.e. facilitate research to practice.

The FTA’s research program relies on major investments in demonstration programs that support testing viable research solutions at public transit agencies. It is essential that agencies have the tools to understand and implement promising research results. Thus, ensuring funding for research to practice is an important part of FTA’s research projects.

Program Alignment with Strategic Goals:

USDOT Strategic Goal	USDOT RD&T Critical Transportation Topic
Accountability	Mission Efficiency and Support

This program closely aligns with DOT’ Strategic Goal of Accountability. This program supports mission efficiency by ensuring quality results and effective evaluation methods. It supports USDOT’s mission

requirements by efficiently and effectively planning for and managing sustainable operations and other mission support services.

[END]

For FTA Discussion Only

Nearly 7,000 Organizations* are Stakeholders in FTA's Programs

U.S. Department of Transportation

FHWA

FTA Funding
Beneficiaries:
6680

Rail Systems
Under
Construction: 7

Other Planning &
Building
Organizations: 13

State Safety
Oversight
Agencies: 31

Metropolitan
Planning
Organizations: 409

State, Territorial,
& District Depts of
Transportation: 56

Transit Agencies with FTA Funding and Oversight

Ferryboat
Operators: 35

Commuter
Rail, Alaska
Rail, and
FRA-
regulated
YR: 29

FTA
Oversight
Rail
Agencies: 55

Commuter
Bus
Operators: 189

Vanpool
Operators: 102
(7 "Enterprise"
and vltide
operators)

5310-Only
Subrecipients
Local Gov't
Entities: 700

Bus &
Paratransit
Agencies: 1
996

Tribes
Providing
Transit: 131

Tribes
not
Providing
Transit: 78

Intercity Bus
Operators: 76

5310-Only
Subrecipients
Private, Non-
Profit: 3,800

FMCSA

NHTSA

USCG

*Providers with multiple modes of service are represented in all relevant categories. To prevent double-counting, agencies are included only once in the total number of Agency Service Providers.

Sources: National Transit Database 2017 Annual Reports; FTA Fiscal Year 2015 Grant Obligations; FTA Office of Planning & Environment; Seekins, Tom, et al., University of Montana. "Allocation and Use of 5310 Funds in Urban and Rural America." Journal of Public Transportation, 2007.

FTA
FEDERAL TRANSIT ADMINISTRATION

1

Locations of Rail Transit Systems by Federal Regulator

U.S. Rail Transit Systems by Federal Regulator

