FTA

FEDERAL TRANSIT ADMINISTRATION

FTA Annual Report on FY 2016 Public Transportation Innovation Research Projects

FEBRUARY 2017

FTA Report No. 0102
Federal Transit Administration

PREPARED BY
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Federal Transit Administration

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Federal Transit Administration
Office of Research, Demonstration and Innovation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC

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13. ABSTRACT

This report provides information on projects funded under Chapter 53 of Title 49 Section 5312 as amended by Federal public transportation law, Section 3008, and notes proposed allocation of appropriated funds for FY 2017. Consistent with FY 2015, FTA focused eligible projects in three strategic priority areas of mobility, asset management and asset innovation, and safety. Projects in these areas promoted public transportation innovation to improve operations, infrastructure, and the travelers' experience. For active projects in FY 2016, twenty-four percent ($36.8 million) were associated with safety; fifty-nine percent ($91.5 million) were associated with asset management and asset innovation; thirteen percent ($21.1 million) were associated with mobility; and four percent ($5.9 million) were for supportive services across all research areas. In 2016, FTA's Office of Research, Demonstration, and Innovation managed a total research portfolio of $155,413,775.

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**Federal Transit
Administration**

Dear Colleague:

I am pleased to provide you with the Federal Transit Administration's (FTA) Annual Report to Congress on Fiscal Year (FY) 2016 Public Transportation Innovation Research Projects. FTA invested over $155.4 million in FY 2016 and previous fiscal year appropriations as authorized in Federal public transportation law for ongoing or new projects. These investments are leading innovation and change in public transportation through many public/private partnerships, broad stakeholder engagements, and local public transit systems collaborations.

Active research projects in FY 2016 totaled $155,413,775. Consistent with FY 2015, FTA focused eligible projects in the three strategic priority areas of mobility, asset management and asset innovation, and safety. Projects in these areas promoted public transportation innovation to improve operations, infrastructure, and the travelers' experience. For active projects in FY 2016, twenty-four percent ($36.8 million) were associated with safety; fifty-nine percent ($91.5 million) were associated with asset management and asset innovation; thirteen percent ($21.1 million) were associated with mobility; and four percent ($5.9 million) were for supportive services across all research areas.

The report provides details of projects that received assistance or were approved for award in FY 2016, including their purpose, relevance to the industry, national significance, and timeframes for completion. This report also contains information on FTA's future direction for research, and the road ahead for public transportation innovation in the U.S.

I hope you will find this report useful and informative. Thank you for your continued support of public transportation innovation research.

Sincerely,

Carolyn Flowers
Acting Administrator

ABSTRACT

This report provides information on projects funded by the Federal Transit Administration's Section 5312 program (49 U.S.C. 5312) for 2016 and a proposed allocation of appropriated funds for FY 2017. Active research projects in FY 2016 totaled $155,413,775. Consistent with FY 2015, FTA focused eligible projects in three strategic priority areas of safety, asset management and asset innovation, and mobility. Projects in these areas promoted public transportation innovation to improve operations, infrastructure, and the travelers' experience. In FY 2016, twenty-four percent of project funds ($36.8 million) were associated with safety; fifty-nine percent of project funds ($91.5 million) were associated with asset management and asset innovation; thirteen percent of project funds ($21.1 million) were associated with mobility; and four percent of project funds ($5.9 million) were for supportive services across all research areas.

49 U.S.C. 5312 (Section 5312) focuses on three types of eligible projects: research; innovation and development; and demonstration, deployment, and evaluation. FTA continues to invest the most funding to test out promising approaches to public transportation innovation through demonstration programs – over seventy percent of active projects fall into this area. Below is the breakout of funding investment across the three types of eligible projects:

- Research – $13.8 million (nine percent) for public transportation research projects that provide more effective and efficient public transportation service.
- Innovation and Development – $17.8 million (eleven percent) for projects to improve public transportation systems nationwide to provide more efficient and effective delivery of public transportation services, including through technology and technological capacity improvements.
- Demonstration, and Deployment – $118 million (seventy-six percent) to promote the early deployment and demonstration of innovation in public transportation that has broad applicability.

An additional $5.9 million (four percent) was for services in support of an evaluation of projects. Included in the report are project descriptions and results for these activities in FY 2016, and a proposed plan for research expenditures in FY 2017.

EXECUTIVE SUMMARY

The mission of the Federal Transit Administration (FTA) is to improve public transportation for communities in the United States. Its vision is that America has a world-class public transportation system with access and mobility for all. FTA drives public transportation innovation research to advance FTA's strategic goals of:

1. *Safety* - Improve public health and safety by reducing transportation-related fatalities and injuries for all users, working toward no fatalities across all modes of travel;
2. *State of Good Repair* - Ensure the U.S. proactively maintains critical transportation infrastructure in a state of good repair;
3. *Economic Competitiveness* - Promote transportation policies and investments that create ladders of opportunity, support strong communities, and bring lasting and equitable economic benefits to the Nation and its citizens;
4. *Quality of Life in Communities* - Foster quality of life in communities by integrating transportation policies, plans, and investments with coordinated housing and economic development policies to increase transportation choices and access to transportation services for all;
5. *Environmental Sustainability* - Advance environmentally sustainable policies and investments that reduce carbon and other harmful emissions from transportation sources, reduce our nation's dependence on foreign oil, improve air quality, and promote public health.

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There is also $5.9 million in supportive services that cross all of these areas and evaluation which comprise the remainder of the $155,413,775 in active projects in FY 2016 – approximately four percent of the total.

The vision of FTA's Office of Research, Demonstration, and Innovation (TRI) is to expand rides to life that advance FTA's strategic goals. The mission of FTA's research is to advance public transportation innovation by leading multi-dimensional research, development, demonstration, deployment, evaluation, and supportive services projects for the transit industry that improves riders' experiences and enhances public transit's effectiveness, efficiency, quality, and safety. In 2016, FTA continued to focus eligible projects in the three strategic priority areas of safety; asset management and asset innovation; and mobility. In addition, FTA authorized evaluation and other projects that support these three priority research areas such as the Transportation Cooperative Research Program (TCRP) newly required by Federal public transportation law.

FTA leverages a broad group of stakeholders to carry out research, placing a significant emphasis on partnerships to achieve research goals. Per 49 U.S.C. 6503, in FY 2016 FTA developed a draft five year research and development strategic plan. Section 6503 requires a description of how the plan furthers the primary purposes of the transportation research and development program, which include:

1. Improving mobility of people and goods;
2. Reducing congestion;
3. Promoting safety;
4. Improving the durability and extending the life of transportation infrastructure;
5. Preserving the environment;
6. Preserving the existing transportation system.

FTA's research goals of the last several years mirror and support these goals. And, industry input to the strategic plan reinforced the utility of the current three research priorities with feedback suggesting FTA continue to focus on these priorities of safety; asset management and asset innovation; and mobility. Outreach to gather input occurred through two primary mechanisms – an online dialogue and an advisory committee led by the National Academies Transportation Research Board (TRB) called the Transit Research Analysis Committee (TRAC).

To support strategic planning, FTA conducted a research strategic plan Online Dialogue. The Online Dialogue is a social networking application that allowed 24/7 online input. Dialogue participants presented their ideas, commented on the ideas of others, and casted votes. The Online Dialogue drove transparent civic engagement. This resulted in extensive input, with more than 400 participants providing feedback to prioritize 131 research ideas through votes and comments. These ideas were distilled into six main themes of Mobility, Asset Management and Innovation, Safety, Transportation-Land Use Connection, Big Data and Data Sharing, and Workforce, which were further analyzed into 16 sub-themes. The

majority of the sub-themes mapped to FTA's current research priorities, which was positive reinforcement that FTA's research program is "on the right track." The Online Dialogue also provided critical information to inform the meeting of TRAC.

FTA, in cooperation with the National Academies of Sciences, restarted the TRAC, which met on September 23-24, 2016, for briefings and discussions on FTA's research priorities and to provide feedback on the current and future research efforts. FTA Executive Director Matthew Welbes; FTA Associate Administrator for Research, Demonstration, and Innovation Vincent Valdes; and FTA Deputy Associate Administrator Jamie Pfister led the discussion for FTA. TRAC consists of 13 members appointed by the National Academies for their wide-ranging expertise in public transportation. TRAC's interdisciplinary committee of experts from industry, academia, and the private and public sectors was charged with recommending actions that FTA can take to ensure that its research and innovation program is relevant, timely, and effective in meeting the diverse and changing needs of the public transportation community. A letter with those recommendations was submitted to FTA on November 11, 2016, and the recommendations indicated in the letter were taken into consideration when finalizing the Research Strategic Plan.

FTA awards cooperative agreements, contracts, and other eligible agreements across diverse geographic areas to ensure the highest level of industry impact once projects are completed and to ensure effective dissemination of results. Partnerships are an essential element of research. In addition to TRB, other key research partners include the Volpe Center, the Center for Urban Transportation Research at the University of South Florida, the National Transit Institute at Rutgers University, other Department of Transportation Modal Administrations, the American Public Transportation Association, and many other public and private entities with specialized expertise in public transportation.

FTA projects achieve public transportation innovation goals by using one or more of the following strategic directions:

- Enhancing equitable and accessible mobility for everyone.
- Encouraging public private partnerships.
- Ensuring public transportation efficiency, safety and reliability.
- Enabling seamless, effective integration across transportation modes and applications.
- Expanding customer satisfaction and value.

For FY 2016, FTA allocated dollars with a majority of funding going to asset innovation and asset management. The distribution of funds for projects across the FTA research priority areas were: twenty-four percent ($36.8 million) were associated with safety; fifty-nine percent ($91.5 million) were associated with asset management and asset innovation; thirteen percent ($21.1 million) were associated with mobility; and four percent ($5.9 million) were for supportive services across all research areas. For FY 2017, FTA requested $28 million in funding for Section 5312 projects.

Figure 1.

Distribution of Research Dollars by Priority Area

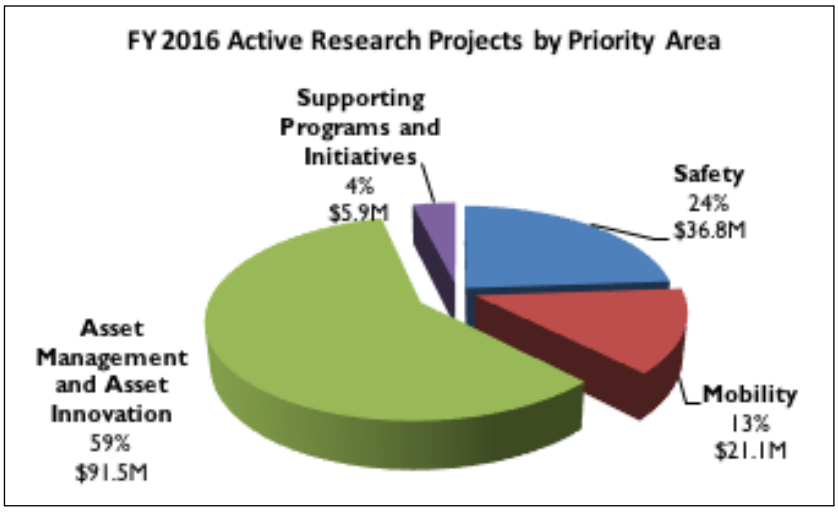


Table 1 shows how these investments track against both FTA's strategic goals and the Federal public transportation research strategic goals:

Table 1.
Crosswalk of FTA Goals, Federal Public Transportation Priorities, and FTA Research Program Areas

FTA Goals	Safety	State of Good Repair	Economic Competitiveness	Quality of Life in Communities	Environmental Sustainability
Federal Public Transportation Priorities	**Promote safety**	**Improve infrastructure durability, preserve existing transportation system**	**Improve mobility of people and goods**		**Preserve the environment, reduce congestion**
FTA Research Program Areas					
Safety	✓				
Asset Management/ Asset Innovation		✓			✓
Mobility			✓	✓	
TCRP*			✓	✓	

*TCRP is administered by the National Academy and provides research across all of these research areas and others as needed by the public transportation industry. TCRP is authorized under Section 5312(i) at $5 million per fiscal year (see 49 U.S.C. 5338(a)(2)(G)(ii).

It is a time of immense change in public transportation. Diverse and shifting demographic, technological, mobility, traffic, energy, and other trends are creating significant demand for more transportation choices. Indeed, the definition of "mobility" continues to evolve dramatically with the rise of new multimodal concepts, traveler needs, and emerging public and private transportation resources. FTA's research initiatives recognize and address challenges and opportunities emerging from the many trends affecting transportation in the 21st Century. Additionally, there are also cross-cutting issues such as data, technology, workforce development, standards, automation, and governance that affect the implementation of promising research findings. National trends across all of these areas, industry input, FTA office input, FTA's three research priorities, and cross-cutting issues all influence the selection of FTA research projects.

Requirements for this Report

Section 5312 requires an annual report that must be made available to the public on the website of the U.S. Department of Transportation and provides:

- a description of each project that received assistance under this section during the preceding fiscal year, and
- an evaluation of each project that received assistance in the preceding year including any evaluation conducted for demonstration and deployment projects.

This report reviews the required information by major FTA research priority area.

Background

For the last four years, the FTA Office of Research, Demonstration and Innovation (TRI), has relied on a "Research Business Plan" (Plan) developed in FY 2013. This Plan identified the three strategic priority areas for FTA investments and research efforts within the statutory framework of Federal public transportation law. These areas were safety; asset management and asset innovation; and mobility. For FY 2017 and subsequent years, FTA will use the new draft research and development strategic plan as a basis for research investment decisions. This strategic plan follows the statutory requirements of Federal public transportation law. The five year draft research and development strategic plan was developed through a highly collaborative process. This process relied heavily on broad stakeholder engagement, including a national online dialogue and a two-day meeting with the Transportation Research Board's (TRB) Transit Research Analysis Committee (TRAC). TRAC is an external advisory committee of the National Academies. The results of both of these stakeholder outreach initiatives reinforced FTA's current research priorities of mobility, asset management/ innovation, and safety. Since these priorities are directly related to Federal public transportation law research priorities, FTA continued with these areas of focus in FY 2016. FTA expects to do the same in FY 2017.

In April 12, 2016, FTA allocated $27.2 million for the Section 5312 program and projects (appropriated in FY 2015 and 2016). Some of the funds created new projects while other funds were added to existing programs from previous years. The tables in each of the sections of this report summarize all of the active projects in each respective research priority area.

Each summary table has two funding categories: ongoing or funding allocated in FY 2016; and approved in FY 2016 pending award. There are a number of reasons why a project could be approved in FY 2016 and pending award. FTA includes these projects in the annual report as having received assistance, because the project is active and in development. Such projects might be competitive demonstration grants where a request for proposal was released, grantees announced and selected, but the specific grantee awards are not yet made. Or, a project requires significantly more planning and creating the statement of work. Other projects might require partnership and industry outreach prior to obligation. Thus, FTA, in the spirit of full transparency, includes these projects in the annual report to Congress as they are receiving assistance in terms of staff time and are active projects.

Strategic Research Priorities Key Activities and Results Summary

Over $155 million in projects received some assistance in FY 2016. Projects included those funded from previous fiscal year appropriations as well as those funded from FY 2016 appropriations. Thus, projects were either ongoing or new projects. FTA leads a grassroots applied research portfolio so the predominance

of projects – over seventy percent – is field based cooperative agreement demonstration grants that are usually selected competitively.

In 2016, twenty-six active projects spanned the three priority research areas of inquiry: five for safety, six for mobility, twelve for asset management and asset innovation, and three for supporting activities. The large percentage of funding allocated to asset management and asset innovation – fifty-nine percent – reflects the history and requisite focus on capital and equipment for public transportation. The majority of federal formula grants in public transportation pay for major capital investments and infrastructure, so ensuring the effective management of these assets and supporting innovation to reduce emissions and improve fuel efficiency is a long-standing area of research and demonstration.

Asset management and asset innovation is a priority that directly addresses U.S. DOT's Environmental Sustainability strategy to promote the development and deployment of technologies to reduce the energy consumption and greenhouse gas (GHG) emissions of transit systems. This strategic priority includes activities supporting important goals and objectives for the state of good repair. FTA undertook research on zero emission vehicles, facilities, and technologies to identify innovative and sustainable uses of transit vehicles and services. FTA has a long history of foundational research in advanced bus technologies for environmental benefits as well as operational efficiencies. FTA also invested in projects that study how life-cycle costs impact asset investment decisions. Projects like these provide essential information for the public transportation industry and operators to think strategically about asset management and innovation.

FTA invested $91.5 million in asset management and asset innovation research activities. Table 2 provides a list of asset innovation and asset management programs funded by FTA in FY 2016.

Table 2. *Asset Innovation and Asset Management Programs Funded by FTA*

Asset Innovation and Asset Management Programs		
Type of Project	**Project Title**	**FTA Funding**
Research	Effects of Capital Cost Forecasting Study and Research	$200,000
Research	Best Practices and Research for Life-Cycle-Based Management	$200,000
Demonstration & Deployment	Track Asset Management Demonstration	$2,000,000
Demonstration & Deployment	Disadvantaged Business Enterprise (DBE) Demonstration and Study	$1,300,000
Innovation & Deployment	Zero Emission Bus Research	$2,750,000
Research	Zero-Emission Bus Evaluation and Support	$1,400,000
Research	Fuel Cell Bus Evaluation and Support	$1,125,000
Demonstration & Deployment	Low or No Emission Vehicle Deployment Program (LoNo) Program	$76,969,249
Demonstration & Deployment	Bus Efficiency Enhancements Research and Demonstrations (BEERD) Program	$3,000,000
Research	U.S.–China Zero Emissions Bus Collaboration	$500,000
Innovation & Development	Small Business Innovation Research (SBIR)	$1,090,000
Innovation & Development	Transit Conditions and Performance	$1,017,476
	Total	**$ 91,551,725**

Notable results of Asset Innovation and Asset Management projects include the following:

- The Zero Emission Bus Evaluation and Support Program enables transit agencies, vendors, and other industry stakeholders to make informed decisions regarding the costs and capabilities of new technology transit buses.
- New low and no emission buses are manufactured, and advanced technology bus lifecycle costs are lowered enough to make electric-drive buses the vehicle of choice for public transportation service.
- The Bus Efficiency Enhancements Research and Demonstrations (BEERD) Program supports demonstrations of four technologies that are expected to achieve substantial improvements in energy efficiency while supporting a pathway to greater electrification of transit and paratransit bus powertrains.
- The Transit Conditions and Performance project allows FTA to elevate relevance of topics to assist Congress in defining and setting capital funding polices for the National Transit Infrastructure.
- FTA's contributions to the Small Business Innovation Research (SBIR) Program permit small businesses to contribute to FTA's research needs, which benefit the department and the public; creates jobs; and opportunities for small businesses to thrive.

Safety is critical to public transportation and, as the second highest funded area of research at twenty-four percent, safety research seeks to address timely issues to make public transit safer for riders and workers. Within the U.S. DOT's Strategic Plan, Fiscal Years 2014-18, improving safety throughout the

transportation sector is one of FTA's highest priorities, with projects focused on reducing transit-related fatalities and injuries.

The type of research methods used in FTA's research program and corresponding outcomes will help agencies develop appropriate safety policies and procedures. These research activities identify effective safety practices and principles; determine whether transit agencies are implementing recommended practices; and evaluate the impact of those practices on transit safety. For safety risk management, FTA is researching emerging hazards and evaluating their associated risks to help agencies formulate controls to reduce or eliminate high risk hazards.

FTA's safety research in 2016 also supported FTA's regulatory role and its responsibility to develop a safety oversight framework. $24 million was spent for Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations (SRER) projects. In addition, a bicycle/pedestrian research effort to develop a guidebook addresses issues due to the rise of walking, biking, increased transit use, and more transit vehicles operating in mixed traffic. This project, when complete, will enhance pedestrian and bicyclists safety. As shown in Table 3, FTA allocated $36.8 million in Section 5312 funds to support public transportation safety initiatives.

Table 3.

Safety Programs Funded by FTA

Safety Programs		
Type of Project	**Project Title**	**FTA Funding**
Demonstration & Deployment	Safety Research and Demonstration Program (SRD)	$7,000,000
Research	Safety Standards Strategic Plan Development and Data Collection Strategy	$1,500,000
Innovation & Development	FTA Employee Safety Reporting and Confidential Close Call Reporting Pilot Program	$3,000,000
Demonstration & Deployment	Vehicle Assist and Automation (VAA) Demonstration*	$1,300,000
Demonstration & Deployment	Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations (SRER)	$24,000,000
	Total	**$36,800,000**

Safety research programs sought to preserve and expand public transit's vital safety role, and resulted in the following accomplishments in FY 2016:

- The Employee Safety Reporting Pilot Program is improving the safety culture at transit agencies, supporting stakeholder coordination and outreach, and working to develop transit safety standards, protocols, and best practices.

- The Safety Standards Strategic Plan Development and Data Collection Strategy project is assisting FTA to make appropriate decisions that ensure public transit is safer. The project is creating a compendium of transit safety standards and protocols with a comprehensive set of safety recommendations and actions for the Secretary.
- The Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations (SRER) program is gathering data on the effectiveness of various approaches to enhancing safety, resiliency, and emergency response designed to reduce the number of collisions, fatalities, and mitigate the severity of transit-related injuries.
- The Vehicle Assist and Automation (VAA) Demonstration Program demonstrates the technical feasibility of partial automation (steering) of a 60-ft articulated bus in a narrow, winding BRT transitway. The independent evaluation assesses VAA operations via objective and subjective performance metrics in the categories of efficiency/productivity, technical performance, maintenance, safety, bus operator satisfaction, and customer satisfaction.

Mobility models that leverage public and private assets to extend the reach of public transportation services to travelers are a growing area of research. Approximately $21 million of Section 5312 funds were invested in mobility research projects in FY 2016. FTA's mobility projects focused on accessibility, shared public and private services, and leveraging technology such as smart phones and web applications to expand traveler information and on-demand services. To experiment and gather information about these changing traveler and provider transportation resources, FTA launched a major initiative called Mobility on Demand (MOD).

MOD builds upon many years of findings from the Mobility Services for All Americans' projects managed by U.S. DOT's Intelligent Transportation Systems Joint Program Office. MOD projects such as the Mobility on Demand Sandbox are encouraging the development of complementary and supplemental public and private mobility options. New and expanded partnerships with private sector services, such as those run by transportation network services companies (TNCs) like Uber and Lyft, are growing. Many transit agencies are able to address first and last mile access, expand geographic coverage, and hours of services for their communities through these partnerships, but research is needed to identify successful models and any barriers or issues that may arise.

Overall, mobility research projects are improving 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. New technologies resulting from projects like the Accessible Transportation Technology Research Initiative (ATTRI) are enabling greater levels of accessibility for people living with disabilities of all ages. Table 4 lists the over $21 million in mobility research programs.

Table 4.

Mobility Programs funded by FTA

Mobility Programs		
Type of Project	**Project Title**	**FTA Funding**
Research	Transit Automation User Case Analysis	$400,000
Innovation & Development	Mobility on Demand (MOD) Program	$9,141,080
Research	Accessible Transportation Technologies Research Initiative (ATTRI)	$2,500,000
Research	Rides to Wellness	$5,927,518
Demonstration & Deployment	Veterans Transportation and Community Living Initiative (VTCLI)	$2,357,907
Innovation & Development	Mobility Services for All Americans (MSAA)	$795,545
	Total	**$ 21,122,050**

Mobility research projects have provided numerous benefits to the transit industry and to the public. Some of these benefits include the following:

- Through the Rides to Wellness Program nineteen demonstration grants are showing how access to transportation can improve health outcomes for individuals who are unable to provide their own transportation as a result of a disability, an age-related condition, or an income constraint. The program fosters local partnerships among health, transportation, home and community-based services, and other sectors to collaboratively develop and support solutions that increase healthcare access.
- MOD projects, when completed, will make transportation systems more efficient and accessible, particularly for people who lack access to a car. MOD promotes agile, responsive, accessible, and seamless multimodal service inclusive of transit through enabling technologies and innovative partnerships.
- ATTRI is reducing barriers to mobility for people with disabilities (including veterans with disabilities) and older adults. ATTRI solutions leverage technological advancements to increase independence and the ability to more easily navigate transportation networks for people who use mobility or assistive devices.
- The Veterans Transportation and Community Living Initiative (VTCLI) leverages one click one call centers to increase access to transportation resources for veterans and members of the military community, while also increasing overall community mobility. Additionally, the partnerships established through the program have resulted in improved local coordinated planning of services to meet specialized goals.
- The Mobility Services for All Americans (MSAA) Program works to improve the travel experience for all Americans and especially seeks to assist people living with disabilities, older adults, and persons of limited income. Through MSAA, some transportation agencies have already implemented a coordinated system to easily book rides and transfers for customers across

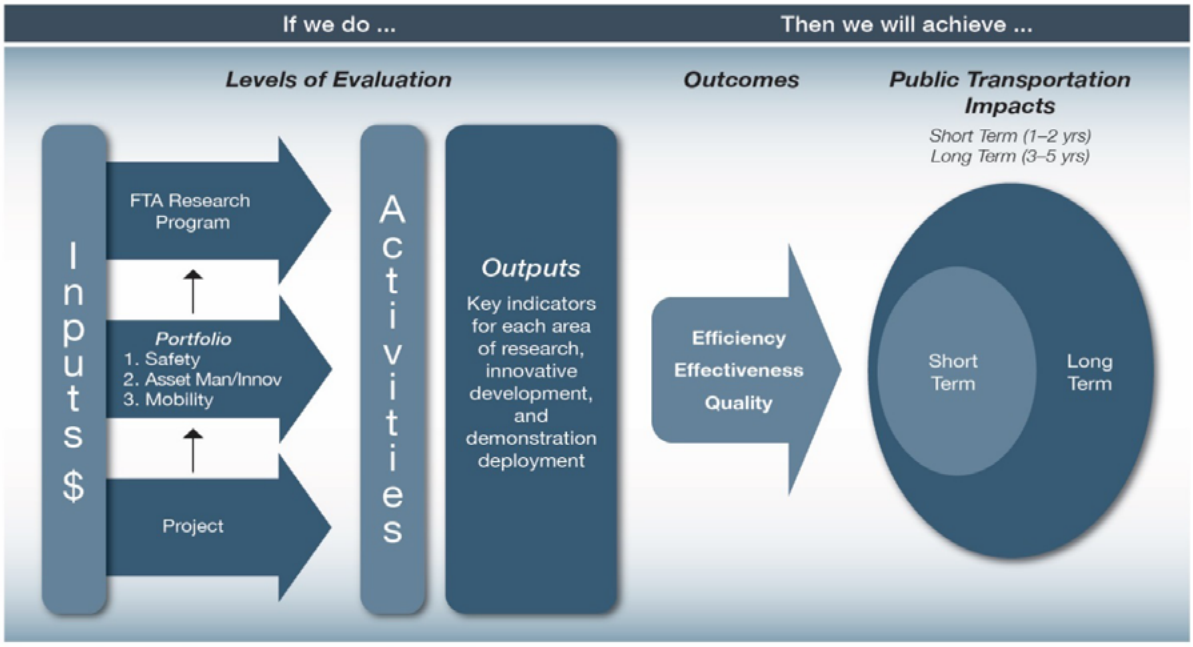
service areas; thus, improving the customer experience and minimizing duplication.

FTA's mobility research is identifying promising practices in shared services that not only increase access but also address operational efficiencies and effectiveness. Research is also examining data collection, data access, payment systems, and data management issues rising from the need to share public, private, and personal information. There is a significant return on investment for these new paradigms – both for riders and providers. But, there are also some extremely challenging technology issues that have to be overcome.

Supporting services for these projects across the three priority areas, enhance research to practice, and expands independent research activities. Major demonstration projects are evaluated to assess their effectiveness, and provide a venue to effectively disseminate the most efficacious results. The TCRP complements FTA's research program with additional activities as requested by an independent governing board of industry experts and leaders. Research to practice methods, such as social networking, peer to peer exchange, webinars, and marketing outreach materials, get useful information to the public transportation industry. An important component of dissemination for the future is to establish and support communities of practice and more peer-to-peer exchanges.

Research project efficacy for demonstration programs is reviewed through comprehensive evaluations. These independent studies assess program outcomes and impacts to see if the projects are meeting their research goals. By providing feedback on both program design and execution, evaluation can also play a key role in program management by honing future projects based upon evaluation findings. In FY 2016, to complement and build upon the formal statutory evaluation requirements, TRI created a three tiered evaluation concept. After the frameworks are completed, TRI will have a consistent methodology that cascades findings and results upward and reviews strategic accomplishments at the project, portfolio, and program levels. The structural foundation for the tiered evaluation concept is illustrated in Figure 2.

Figure 2. *TRI Evaluation Program Conceptual Model**



**Structure adapted from a Centers for Disease Control (CDC) conceptual evaluation logic model*

The project-level evaluations will assess results (outputs and outcomes) of the demonstration grant projects in accordance with goals and pre-determined measures; note additional questions or research needs generated by the discovery process; and harvest success stories for this annual report. Evaluations at the portfolio level will be based on strategic plan goals, and build upon the outcomes of the demonstration project evaluations. These will be longitudinal evaluations that compare year over year impacts to assess how well priorities are met and how well they further innovation in public transportation. Finally, the program-level evaluations will assess the research program results against FTA's Research Strategic Plan, FTA's Agency plan, and integrate the program with departmental and other modal plans. Table 5 provides a list of projects funded by FTA that support the three research priority areas.

Table 5.

Supporting Programs and Initiatives Funded by FTA

Supporting Programs and Initiatives		
Type of Project	**Project Title**	**FTA Funding**
Innovation & Deployment	Information Dissemination and Evaluation Program	$700,000
Research	Workforce Development Program Evaluation and Dissemination	$250,000
Research	Transit Cooperative Research Program (TCRP)	$5,000,000
	Total	$5,950,000

Impacts of the supporting programs funded by FTA include the following:

- FTA's Information Dissemination and Evaluation Program provides timely information on research results for the diverse and changing needs of the public transportation community. It assists agencies to implement promising practices and acquire products/technologies that increase the efficiency, effectiveness, and quality of public transportation in the U.S. The program is also assisting FTA in creating a framework for evaluating its research demonstration programs.
- The Workforce Development Program Evaluation and Dissemination contract with Axiom is evaluating the results of two rounds of workforce development grants. This will result in the identification of proven promising practices for expanding employment career ladder opportunities; recruiting the transit workforce; and retaining key public transportation staff.
- TCRP conducts research that solves the transit industry's business problems and supports research activities that directly support emerging challenges in the public transportation industry. TCRP is a continuing program of practical, operator-oriented, problem-solving applied research that examines short-term, high priority topics of common interest to the transit industry.

Project Descriptions

Following are detailed descriptions of programs and projects funded by FTA under Section 5312. They are categorized by priority area—Safety, Asset Management and Asset Innovation, and Mobility—and end with the supporting programs and initiatives. Projects were either approved in FY 2016 but unable to be obligated until 2017 due to the shift in grants management systems; funded and begun in FY 2016; or were ongoing in FY 2016 from previous year funding. Each priority area review notes the overall objective and provides a detailed description and list of projects, outputs, and outcomes/impacts, followed by a list of each associated project. Then individual project descriptions provides details with a project title; grantee(s); purpose; national relevance of the research; relevance to the transit industry and to the community; expected final products and delivery dates; performance indicators (outputs); performance goals (outcomes); project/program impacts; and FTA funding.

Improving Safety

Objective:

The Safety Research program's objectives are to improve public transportation safety by reducing transit-related injuries, fatalities, safety events, and system reliability (state of good repair).

Description:

Recent changes to Federal public transportation law expanded national transit safety research priorities and platforms. The heightened focus on new regulatory authorities for FTA, along with high-profile transit safety events, led to specific new and renewed research initiatives. To develop and implement the safety research area, FTA identified key areas of exploration and data collection needs. FTA also uses research funds to address bus fleet safety associated with alternative fuels; study safety-enhancing practices, technologies, and programs; and assess and promote traveler, pedestrian, and bicycle safety practices and policies. Research is ongoing in areas such as increasing safety culture with transit workers, rail track monitoring through new technologies, advanced technologies to reduce vehicle collision, improving safety through vehicle design of the human/machine interface, and ways to support the development of safety management systems.

Outputs:

- Identify emerging transit safety issues working in concert with the Office of Safety and Oversight and continue to finalize the safety research strategic plan.
- Study safety-enhancing practices, technologies, and programs and address bus fleet safety issues associated with alternative fuels (e.g., hydrogen, natural gas, propane, and electric, etc.).

- Support collision reduction and avoidance through technology applications, such as telemetry-based driver reporting systems and collision avoidance warning systems and associated technologies; and training and procedural improvements.
- Improve transit operator safety (including bus operator assaults) and transit operator health and wellness.
- Study traveler, pedestrian, and bicycle safety practices and policies.

Outcome/Impact:

- Identify specific promising practices and operational activities that will reduce traffic injuries and fatalities and identify effective safety practices and principles, determining whether transit agencies are implementing recommended practices and evaluating the impact of those practices on transit safety.

List of Projects: (5)

1. Safety Research and Demonstration Program (SRD)
2. Safety Standards Strategic Plan Development and Data Collection Strategy
3. FTA Employee Safety Reporting and Confidential Close Call Reporting Pilot Program
4. Vehicle Assist and Automation (VAA) Demonstration
5. Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations (SRER)

Title: *Safety Research and Demonstration (SRD) Program*

Grantee: Local governments, transit authorities, educational institutions, and private firms

Project Purpose:

The Safety Research and Demonstration (SRD) Program is part of a larger safety research effort of the U.S. Department of Transportation that provides technical and financial support for transit agencies to pursue innovative approaches to eliminate or mitigate safety hazards. The SRD Program focuses on demonstration of technologies and safer designs. SRD objectives include:

- Explore advanced technologies to prevent transit vehicle collisions.
- Enhance safety of transit services by incorporating safer design elements.
- Evaluate cost-effectiveness and practicability of potential solutions.

The FY 2016 SRD Program targets collision avoidance and mitigation and transit worker safety protection. The program provides financial and technical

assistance for transit agencies to pursue cutting-edge technologies and innovative approaches to safety. The funding is intended to assess the practicality and effectiveness of potential solutions to improve safety as well as influence transit industry guidance and standards.

National Relevance of the Research:

The results of these projects will be widely applicable nationwide and will support FTA's efforts to promote safe public transportation systems.

Relevance to the Transit Industry and Community:

Projects will develop and demonstrate new or substantially-improved safety technologies and designs that will increase the operational safety of public transportation services and reduce the risk of transit-related injuries and fatalities.

Expected Final Products and Delivery Dates:

- Demonstration projects will yield data on the effectiveness of various approaches to enhancing safety.
- Final reports are expected about 3-4 years after cooperative agreements are awarded (Fall 2020–Fall 2021).
- Each project sponsor will submit a required final report evaluating the effectiveness of the proposed technology or design.

Performance Indicators (Outputs):

Each project under the SRD Program will submit a final report at the end of the project that details specific outputs for each respective grantee.

Performance Goals (Outcomes):

- Advance the development of technologies and safer designs to reduce the number of collisions and fatalities, and mitigate the severity of transit-related injuries.

Project/Program Impacts:

- Improve the safety culture at transit agencies, support stakeholder coordination and outreach for collision avoidance and mitigation, and support transit worker safety protection.

FTA Funding: $7,000,000

Title: *Safety Standards Strategic Plan Development and Data Collection Strategy*

Grantee: University of South Florida, Center for Urban Transportation Research (CUTR)

Project Purpose:

The purpose of this research is to review transit safety standards, conduct data analysis, and provide recommendations to assist FTA's Office of Safety and Oversight (TSO) with its effort to develop transit safety standards, guidance, or advisories. The final research deliverable will inform TSO about existing transit safety standards and potential gaps in those standards and will propose new standards, when applicable, for use by the transit industry. This research effort will not develop new transit safety standards but will provide necessary information to support TSO as it develops its plan for the rollout of transit safety standards.

National Relevance of the Research:

This research meets Federal public transportation law requirements for safety standards review, evaluation, and public report by FTA. The research work also provides background information and strategic direction for FTA/TSO to implement the rulemaking authority on minimum safety performance standards.

Relevance to the Transit Industry and Community:

Projects will identify and recommend minimum safety standards to help FTA roll out a plan for safety standards implementation. This will enable the transit industry nationwide to implement minimum safety standards to help make transit safe.

Published and Anticipated Final Products:

- Compendium of transit safety standards and protocols published in the *Federal Register* (81 FR 30605)
- Safety Standards Review and Evaluation or Federal public transportation law report to be made available on a publicly-accessible website
- FTA Safety Standards Strategic Plan

Performance Indicators (Outputs):

- Federal public transportation law report with comprehensive set of safety recommendations and actions for the Secretary

Performance Goals (Outcomes):

- Identify minimum safety standards to make public transit safer.

Project/Program Impacts:

- The safety standards assist TSO and FTA in making the appropriate decisions to ensure public transit is safer.

FTA Funding: $1,500,000 (FY 2015)

Title: *FTA Employee Safety Reporting Pilot Program*

Grantee: Volpe National Transportation Systems Center and Transit Authorities

Project Purpose:

The objective of the FTA Employee Safety Reporting Pilot Program is to launch several Employee Safety Reporting systems in a variety of transit agencies with different modes and service conditions. FTA aims to demonstrate the effectiveness of employee reporting systems in a variety of transit operations that are representative of the transit industry. In addition, FTA aims to produce a guidance document for the industry to use when agencies are setting up their own Employee Safety Reporting systems.

National Relevance of the Research:

The results of this pilot program will provide guidance to transit agencies nationwide to improve effectiveness in safety reporting with a how-to guide for setting up an Employee Safety Reporting system.

Relevance to the Transit Industry and Community:

Employee Safety Reporting systems are essential to monitoring and improving safety.

Expected Final Products and Delivery Dates:

- Grantee will gather information from pilot programs and collect data on effectiveness of various Employee Safety Reporting systems. An evaluation report will be delivered approximately three years after the start of the pilot.
- Delivery of the guidance documents is expected two years after the start of the pilot (FY 2018).

Performance Indicators (Outputs):

- How-to guidance document in setting up an Employee Safety Reporting system.
- Evaluation of the program and effectiveness of each pilot site.

Performance Goals (Outcomes):

- Improve the safety culture at transit agencies, support stakeholder coordination and outreach.

Project/Program Impact:

- Support development of transit safety standards, protocols, and best practices.

FTA Funding: $3,000,000 (FY 2015)

Title: *Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations (SRER)*

Grantee: Local Governments, Transit Authorities, Educational Institutions, and Private Firms

Project Purpose:

A key strategic goal of the U.S. DOT and FTA is to improve and maintain America's public transportation systems to ensure safety and state of good repair to meet performance objectives. The proposals selected for innovative research and demonstrations are intended to develop and showcase promising technologies, methods, practices, and techniques that improve public transportation systems. To this end, FTA is funding 13 projects in 9 states that engage in the demonstration of innovative technologies, methods, practices, and techniques in 3 areas: (1) operational safety, (2) infrastructure or equipment resiliency, and (3) all-hazards emergency response and recovery methods. Under operational safety, SRER will develop and demonstrate new or substantially-improved technologies, methods, practices, and techniques that will increase the operational safety of public transportation services and reduce the risk of transit-related injuries and fatalities. Under resilience, the project will identify, develop, and demonstrate technologies, methods, practices, and techniques for increasing the resiliency of public transportation systems to natural disasters and other emergencies that result from an external cause. Under all-hazards emergency response and recovery, SRER will investigate technologies, methods, practices, and techniques that can improve communication with emergency responders in the event of emergencies, disruptions, and catastrophic failures and conduct demonstrations of the most promising methods and/or technologies in an operational environment to restore transit services. Table 6 provides a list of projects approved by FTA.

National Relevance of the Research:

The results of these projects will be widely applicable nationwide and support FTA's efforts to promote safe public transportation and preserving the national

investment in transit infrastructure through enhanced resiliency to natural disasters and other emergencies.

Relevance to the Transit Industry and Community:

Projects will develop and demonstrate new or substantially-improved technologies, methods, practices and techniques that will increase the operational safety of public transportation services and reduce the risk of transit-related injuries and fatalities. The results of these projects will enable transit agencies to incorporate lessons learned from the demonstration projects into their own efforts to improve safety, resiliency to natural disasters, and emergency response.

Expected Final Products and Delivery Dates:

- Demonstration projects will yield data on the effectiveness of various approaches to enhancing safety, resiliency, and emergency response.
- Delivery of final reports is expected about 2-3 years after award of cooperative agreements (Fall 2017–Fall 2018).
- Each project sponsor will submit a required independent evaluation.

Performance Indicators (Outputs):

- Final report and an independent evaluation report at the end of the project for each area.

Performance Goals (Outcomes):

- Advance the development of materials, technologies, and safer designs to reduce the number of collisions, fatalities and mitigate the severity of transit-related injuries.

Project/Program Impacts:

- Improve the safety culture at transit agencies, as well as support stakeholder coordination and outreach (for the areas of operational safety, resiliency and all-hazard emergency management).

FTA Funding: $24,000,000

Table 6. *SRER Programs Funded by FTA*

Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations (SRER)			
Project Title	**Project Recipient**	**City, State**	**FTA Award**
Demonstration and Commercialization of an LRV Bumper for Enhanced Safety in Shared Right-of-Way Street Environments	Applied Research Associates	Albuquerque, NM	$1,323,414
TrackSafe Phase II Demonstration Project	Metropolitan Atlanta Rapid Transit Authority	Atlanta, GA	$4,233,865
Development of a Bus Exportable Power System for Emergency Response	Center for Transportation and the Environment	Atlanta, GA	$995,098
Coordinated Transit Response Planning and Operations Support Tools for Mitigating Impacts of All-Hazard Emergency Events	University of Chicago	Chicago, IL	$2,890,600
Evacuation and Return: Increasing Safety and Reducing Risk	City of New Orleans	New Orleans, LA	$500,329
Driver Assist System (DAS) Technology to Support Robust, Flexible Bus-on-Shoulder (BOS) and Narrow-Lane Operations for Robust Transit Service	Minnesota Valley Transit Authority	Burnsville, MN	$1,790,014
New Jersey Transit Critical Infrastructure Storm Surge Warning System (NJT CISSWS)	New Jersey Transit Corporation	Newark, NJ	$843,750
Connected Vehicle Infrastructure: Urban Bus Operational Safety Platform	Battelle Memorial Institute	Columbus, OH	$2,741,617
Smart, Shared, and Social: Enhancing All-Hazards Recovery Plans with Demand Management Technologies	Portland State University	Portland, OR	$943,984
Innovative Platform Track Intrusion Detection System (PTIDS) Technology: A Demonstration on Los Angeles Metro Rail System	Los Angeles County Metropolitan Transportation Authority	Los Angeles, CA	$1,722,400
Resilient Concrete Crosstie and Fastening System Designs for Light Rail, Heavy Rail, and Commuter Rail Transit Infrastructure	University of Illinois	Urbana, IL	$2,396,981
Integrated Wheel/Rail Characterization and Safety through Advanced Monitoring and Analytics	New York Metropolitan Transportation Authority	New York, NY	$3,617,948
		Total	**$24,000,000**

A major objective of the TrackSafe Pilot Deployment project led by the Metropolitan Atlanta Rapid Transit Authority (MARTA) under the SRER Program is to mitigate risks of one of the most hazardous roles in rail transportation—inspecting and maintaining track and wayside infrastructure. The hazards associated with working in the right-of-way (ROW) are an everyday issue for Maintenance of Way staff. MARTA is partnering with Bombardier to deploy six miles of TrackSafe technology on MARTA's rail system to improve track worker safety and reduce hazards associated with track inspection, maintenance, and repair. The technology solution proposed by Bombardier is essentially a secondary wayside worker warning device that captures the locations of track workers and trains and uses this information to provide alerts as trains are approaching the location of mobile or fixed work crews. The technology will be installed between Medical Center and North Springs stations on MARTA's Red Line and will alert track workers to the presence of an approaching train, and train operators and control center staff to the specific location of MOW workers. More information on this project is available at https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0046.pdf.

Ongoing Projects in 2016

The following projects were active in 2016 but funded in previous years.

Title: *Vehicle Assist and Automation (VAA) Demonstration*

Grantee: California State DOT (Caltrans), Division of Mass Transit

Project Purpose:

The purpose of this project is to demonstrate the technical merits and feasibility of VAA technology applications in bus revenue service and assess its costs and benefits. Caltrans, partnering with Lane Transit District, demonstrated the VAA applications of bus lateral control in a transitway and precision docking at bus stops using magnetic marker sensing technology. The project was independently evaluated by the National Bus Rapid Transit Institute at CUTR.

National Relevance of the Research:

Initial research has shown that VAA technologies have significant promise to provide benefits to transit agencies in terms of more efficient operations. In most cases, full technical feasibility and the benefits have not been quantified yet. The technical merits and benefits of these technologies could be fully quantified in a demonstration involving revenue service.

Relevance to the Transit Industry and Community:

Based on initial research, FTA is interested in demonstrating two viable VAA applications, precision docking and lateral guidance/control. Anticipated VAA benefits include fewer collisions, reduced maintenance costs (e.g., reduced bus wear and tear), improved productivity and efficiency, improved travel time and reliability, reduced fuel consumption, improved bus driver satisfaction (e.g., reduced stress), and improved customer satisfaction (e.g., easier boarding, smoother ride). VAA has the potential to reduce ROW requirements and could provide a cost-effective bus alternative to traditional light or heavy rail systems in selected corridors. This project provided systems engineering documentation and benefits information of the two targeted VAA applications to the transit industry and community. It is anticipated that this information will help transit agencies deploy VAA systems sooner and on a wider basis.

Expected Final Products and Delivery Dates:

- Final evaluation report completed in May 2016 and posted on FTA's website at https://www.transit.dot.gov/research-innovation/vehicle-assist-and-automation-vaa-demonstration-evaluation-report-report-no-0093. Final project report will be completed by end of 2016 and expected to be posted in March 2017.

Performance Indicators (Outputs):

- Revenue service proof-of-concept demonstration of lateral control and precision docking VAA applications using magnetic marker sensing technology, evaluation report, project report, and webinars.

Performance Goals (Outcomes):

- Project demonstrates the technical feasibility of partial automation (steering) of a 60-ft articulated bus in a narrow, winding BRT transitway. The independent evaluation assesses VAA operations via objective and subjective performance metrics in the categories of efficiency/productivity, technical performance, maintenance, safety, bus operator satisfaction, and customer satisfaction.

Project/Program Impact:

- Project helps expedite application and deployment of transit automation through technical and institutional lessons learned and knowledge transfer.

FTA Funding: $1,300,000

The VAA Demonstration Project demonstrated and evaluated a proof-of-concept VAA system in revenue service operations, which included lateral control and precision docking capabilities on a segment of Lane Transit District's Emerald Express BRT system. The 1.5-mile demonstration involved the use of magnetic sensors for precision docking at three stations and lane guidance between the stations. The VAA system was evaluated in six broad areas: bus driver satisfaction, customer satisfaction, efficiency/productivity, technical performance, maintenance, and safety. Data were collected from a variety of sources, including customer surveys, driver surveys and focus groups, accident reports, maintenance reports, and lane position data from the VAA on-board computer system. Key findings indicated that the VAA system kept the bus better centered in the busway while it was in motion, and it consistently docked the bus closer to the station platform. The VAA was widely praised by the bus operators and passengers for its precision docking at the station platforms. This photo shows the consistency of the gap between the VAA-equipped 60-ft articulated New Flyer bus and a station platform on Lane Transit District's Emerald Express (EmX) BRT route.

Enhancing Mobility

Objective:

The objectives of this program are to support research and innovation to encourage the development of complementary and supplemental mobility options, improve the overall experience for public transportation travelers, adapt to new mobility options by public and private transportation providers, and strengthen transit agency and community capacity as they navigate the dynamic, evolving landscape of personal mobility.

Description:

Demonstrations under the mobility area will explore innovative business models, use cases and partnerships with enhanced mobility options, improve travel decision tools, and enable convenient and seamless travel and fare payment. Throughout this area are areas of research need, and FTA's mobility program's 2016 Sandbox project will identify many of these issues and pave the way for future innovative research and demonstration.

The definition of "mobility" is changing dramatically with the rise of new multimodal options. These fundamental changes in the way transportation services are offered also influence the form of our communities. Options such as mobile way-finding, bicycling (including bikesharing), on-demand ridesharing, and

even a future that includes autonomous vehicles mean that mobility options—particularly in urban areas—will alter the nature of public transit. The traditional transportation split between public transit and the personal automobile will give way to a traveler-centric mobility portfolio that will offer seamless service through peer auto-sharing schemes, on-demand taxi trips, demand-responsive paratransit, and other innovative transportation methods.

Outputs:

- Identify, understand, and promote technical and operational choices in personal mobility, including technologies, techniques, applications, operations, and institutional arrangements that demonstrate potential and warrant further consideration.
- Investigate and document innovative ways to dynamically optimize existing infrastructure operations and mobility resources to prioritize for shared-use, personal mobility.
- Develop and promote a seamless transportation system that engages all modes for enhanced mobility for all travelers.
- Address accessibility issues through application of innovative technologies and practices.
- Improve the quality of the traveler experience and the transit product.
- Identify new mobility-enhancing practices and technologies.

Outcome/Impact:

Enhance traveler experiences by improving the efficiency and effectiveness of community transportation options leveraging both public and private assets to increase the quality and accessibility of transportation options for everyone.

List of Projects: (6)

1. Transit Automation User Case Analysis
2. Rides to Wellness
3. Mobility on Demand (MOD) Program
4. Accessible Transportation Technologies Research Initiative (ATTRI)
5. Veterans Transportation and Community Living Initiative (VTCLI)
6. Mobility Services for All Americans (MSAA)

Title: *Transit Automation User Case Analysis*

Grantee: Volpe National Transportation Systems Center

Project Purpose:

This project will identify, analyze, and prioritize use case scenarios for automating transit operations, such as first-mile/last-mile operations for line-haul operations.

For each scenario, the study will discuss appropriate automation technologies and methods, identify benefits and costs, and present a plan for future transit automation development and demonstration projects sponsored by the U.S. DOT. The project also will engage transit stakeholders (e.g., transit agencies) to obtain their input and feedback. Stakeholder engagement, along with benefit and cost information, will help the U.S. DOT prioritize any future transit automation development and demonstration projects.

National Relevance of the Research:

Many transit agencies have expressed interest in automating some aspect of its transit service and operations. In 2005, Noblis assessed automation of various transit operating scenarios, such as maintenance operations, urban and suburban circulators, designated arterial lanes, etc. Rapid advances in technology and mobility models, such as mobility on demand, have occurred since Noblis reviewed these various automation opportunity areas. This project will identify, analyze, and prioritize areas identified above as well as others that hold promise for public transit innovation through automation.

Relevance to the Transit Industry and Community:

This project will allow FTA to study MOD and other transit operations aspects that could and should be automated. It also will allow FTA to prioritize any future VAA demonstrations and deployments for transit. Without this study, these FTA research programs may not be logically planned and executed to include automation. Also, without FTA research, transit agencies may decide to significantly delay or forgo automation for certain aspects of transit operations, which would be a disadvantage to the transit community and the U.S. transportation system.

Expected Final Products and Delivery Dates:

- Transit Automation Research Program Plan, September 2017
- Project Report, September 2017

Performance Indicators (Outputs):

- Major deliverables will be a project report with transit automation benefit and costs information that will be disseminated to the transit industry, and a transit automation research program plan to direct and guide future FTA research on transit automation.

Performance Goals (Outcomes):

- The project will provide informed input for planning and executing U.S. DOT-sponsored transit automation development and demonstration projects and FTA research programs that may include elements of automation.

Project/Program Impact:

- With this research, transit agencies will be able to significantly accelerate deployment of automation or partial automation of transit operations.

FTA Funding: $400,000

Title: *Rides to Wellness*

Grantee: (I) Transportation Research Board and the Health and Medicine Division (TRB/HMD); (2) Health Outreach Partners, the cooperative agreement partner for the Community Scan Project; (3) Competitively-selected demonstration grant recipients including states and designated or direct recipients for funds under 49 U.S.C. 5307, 5310, or 5311 that serve as the lead agency of a local consortium that includes stakeholders from the transportation, healthcare, and human service sectors with members of the consortium as subrecipients; (4) Evaluation partner.

Project Purpose:

About 3.6 million Americans miss or delay medical appointments every year because they lack a ride. The FTA Rides to Wellness Initiative aims to increase access to care, improve health outcomes, and lower healthcare costs. We know that public transportation can be a literal lifeline to patients to help them maintain good health. Rides to Wellness focuses on improving the health of those with chronic conditions and ensuring that at-risk populations can more easily get to wellness appointments, healthy food, and community services.

To do this, FTA launched the Rides to Wellness initiative in March 2015 with the vision that "Through Rides, People and Community Health Thrive." It is accomplishing this through a three-pronged strategy that includes building commitment, driving change, and stimulating investment. It continues to build commitment through its Regional Forums hosted by the National Center for Mobility Management. In addition, it is driving change through the Community Scan Research Project while stimulating investment through the Rides to Wellness Demonstration and Innovative Coordinated Access and Mobility Grants. Transportation is for ensuring improved health for those with chronic conditions, ensuring access to preventive care, and reducing missed appointments, which can lead to hospital readmissions. The goals of the Rides to Wellness initiative are to increase access to care, improve health outcomes, and reduce healthcare costs.

Rides to Wellness is a major new initiative from FTA to build partnerships, stimulate investment, and drive change across the health and transportation sectors to ensure that everyone can get a ride to the health and wellness services they need. The total amount of funding spent on Rides to Wellness by FTA to date is $7.9 million. These funds derived from funds for 49 U.S.C. 5310

at almost $2 million in FY 2016 and Section 5312 at over $5.9 million. Four key activities were approved for funding under Rides to Wellness:

- A TRB and Health and Medicine Division project to gather data on the value of partnerships across the health and transportation sectors (FTA Section 5312 funding: $267,097)
- A Community Scan Project to assess the local return on investment when public transportation providers can help reduce missed appointments and unnecessary hospital readmissions and help people get to free health screenings and other preventive services appointments (FTA Section 5312 funding: $223,211)
- Demonstration grants for communities to implement sustainable solutions that integrate health and transportation needs such as technology applications that facilitate scheduling a ride when a health/wellness appointment is made (FTA Section 5312 funding: $5,207,210, Federal public transportation law Section 3006(b) funding: $1,997,931)
- Evaluation to determine if these projects met their goals (FTA Section 5312 funding: approximately $200,000)

The overarching goal of the TRB/HMD project was to help direct a community lens to the issue of transportation access to health and wellness services and identify possible measures of value and sources of data. The project identified value propositions for local community providers in health and transportation to develop partnerships. It also explored what data are available to plan, develop, and track these partnerships and the solutions they engender. Of particular interest were measures that demonstrated the return on investment for these partnerships. Examples included measures such as missed appointments due to transportation and hospital readmissions.

The Rides to Wellness Community Scan Project is developing case studies and fielding surveys to assess the impact of missed medical appointments healthcare costs due to lack of available transportation. A cooperative agreement partner, Health Outreach Partners (HOP), is conducting a national survey to gather community-level data on costs associated with missed appointments due to lack of transportation. The final product will be a report that will include a summary of national data as well as profiles of communities with promising solutions. In addition to FTA, other key partners from the following agencies are helping to guide the project: Health Resources and Services Administration (HRSA), Centers for Medicare and Medicaid Services (CMS), Department of Veterans Affairs (VA), Administration for Community Living (ACL), and United Healthcare, a national health insurance carrier.

The primary purpose of the competitive demonstration grants is to find and test promising, replicable public transportation healthcare access solutions that support the Rides to Wellness goals of increased access to care, improved health outcomes, and reduced healthcare costs. FTA funded a total of over $7.2 million across nineteen projects. Grantees were selected and announced in September

2016, so projects are in the early stages of development. Demand for this program exceeded available funds, as FTA received 78 project proposals requesting $28 million from 34 states. Four of the nineteen projects were funded under a Federal public transportation law Section 3006(b) pilot program for innovative coordinated access and mobility grants with a $1,997,931 investment for FY 2016. The remaining fifteen projects were funded with funding for Section 5312 in the amount of $5,207,210 for FY 2016.

National Relevance of the Research:

Healthcare is seeking to bend the cost curve but improve health outcomes by increasing an emphasis on preventive services to address chronic conditions such as heart disease, diabetes, arthritis, and others. Chronic conditions account for nearly eighty percent of the almost $2.4 trillion spent on healthcare in the U.S. Increased partnerships between public transportation and health/wellness providers hold great promise to improve health outcomes, reduce the cost of care, and expand access to services.

Relevance to the Transit Industry and Community:

As shared services expand and more private assets become integrated with public transportation assets, greater investment in public transportation infrastructure may lead to significantly-improved outcomes for people and providers in the healthcare system. Thus, it is essential to identify the value proposition for collaboration and sustainable solutions that the transit industry can implement in their communities.

Expected Final Products and Delivery Dates:

- Each project will release a detailed final report provided to FTA on their respective results. In addition, within two years of award, a comprehensive evaluation of outcomes and impacts of the projects will be released.

Performance Indicators (Outputs):

- Best practice guide will be developed to disseminate public transportation innovative practices, program models, new service delivery options, findings from activities, and recommendations based on grantee findings.

Performance Goals (Outcomes):

- The demonstration grants are one part of a series of activities supporting the Rides to Wellness initiative and will result in ways to overcome barriers to essential services by leveraging partnerships across transportation, health, and wellness providers. For historically-disadvantaged populations, there are many challenges to maintaining optimal health. Through community partnerships that break down industry silos, leverage existing resources, enhance mobility for targeted groups, and develop a person-centric model,

these nineteen projects will provide ladders of opportunity that improve the health of targeted groups.

Project/Program Impact:

- The development of replicable, innovative, sustainable solutions to healthcare access challenges bring about fundamental change. The program fosters local partnerships among health, transportation, home and community-based services, and other sectors to collaboratively develop and support solutions that increase healthcare access. The program will also demonstrate the impacts of transportation solutions on improved access to healthcare and health outcomes and reduced costs to the healthcare and transportation sectors.

FTA Funding: $5,927,518 million in research funds with an additional $1,997,931 million added from Section 5310, totaling $7,925,449 for Rides to Wellness for FY 2016. Table 7 shows the list of community grants that totaled approximately $7.2 million. The remaining projects funded out of the $7.9 million total were for the three additional activities noted above: the TRB/HMD event, the Community Scan, and the Evaluation for the grants.

Table 7. *Rides to Wellness Community Grants Funded by FTA*

Rides to Wellness Community Grants			
Project Title	**Project Recipient**	**City and Sate**	**FTA Award**
Blythe Wellness Express*	Riverside County Transportation Commission	Riverside, CA	$185,753
Rides To Wellness: Coordinating Inpatient Medical Transportation for San Diego County	San Diego Association of Governments	San Diego, CA	$160,000
1-Click to Wellness for Medical Appointment Scheduling to Public Transit	Jacksonville Transportation Authority	Jacksonville, FL	$399,200
Rides for Wellness	Atlanta Regional Commission	Atlanta, GA	$337,628
Delaware County Connections Program	Iowa DOT	Ames, IA	$130,560
Transportation Coordination and Mobility Management for Patients in Southern and Southeastern Illinois*	Rides Mass Transit District	Harrisburg, IL	$518,844
Medicaid, Paratransit and Council on Aging Rides Integration project	Montachusett Regional Transit Authority	Fitchburg, MA	$200,000
Allegany County Mobility Management Program - Coordinated Non-Emergency Medical Transportation*	Maryland Transit Administration	Baltimore, MD	$103,344
Michigan Access to Wellness Project	Michigan Department of Transportation	Lansing, MI	$1,000,000
Rides2Wellness Detroit	Detroit Department of Transportation	Detroit, MI	$509,475
MTA Rides to Health and Wellness	Flint Mass Transportation Authority	Flint, MI	$310,040

Rides to Wellness Community Grants			
Project Title	**Project Recipient**	**City and Sate**	**FTA Award**
Gateway Program	Bi-State Development Agency	Saint Louis, MO	$940,251
GoTriangle Regional Call Center	Research Triangle Regional Public Transportation Authority	Durham, NC	$65,600
Bridge to Integration Project	New Hampshire Department of Transportation	Concord, NH	$182,880
GO Buffalo Mom	Niagara Frontier Transportation Authority	Buffalo, NY	$468,566
Mommy and Me Ride for Free Program	Ohio DOT	Columbus, OH	$133,000
FindMyRidePA*	Pennsylvania DOT	Harrisburg, PA	$1,190,000
Rides to Wellness in Knoxville, Tennessee	Knoxville Area Transit	Knoxville, TN	$200,000
Improved Access to Health Care through Community Transit	Vermont Agency of Transportation	Montpelier, VT	$170,000
		Total	$7,205,141

*Indicates funding from Section 3006(b) pilot program for innovative coordinated access and mobility grants program funding, which was $1,997,931 million for FY 2016.

Through a $940,251 Rides to Wellness demonstration grant, the Bi-State Development Agency of St. Louis is implementing a Gateway Program, a public health mobile clinic that provides health screenings such as blood pressure and cholesterol tests at MetroLink Public Transportation Stations in north St. Louis County. This public transit and healthcare partnership serves the healthcare needs of public transit riders along their route. The program includes non-emergency medical transportation to and from appointments using transit subsidies and is designed to provide underserved residents with a "bridge" in care until they are able to enroll in health insurance coverage options available through the Affordable Care Act. Project partners include St. Louis County Department of Public Health, Bi-State Development Research Institute, and St. Louis County Department of Public Health. The mobile clinics will serve the North Hanley MetroLink Station, the Rock Road MetroLink Station, and the Wellston MetroLink Station. "These sought-after grants are aimed at building partnerships among health, transportation, and other service providers to address the problem of how to get people without vehicles to doctors and wellness appointments to help them maintain good health," said Bi-State Development President and CEO John Nations. "The mobile clinic program created in partnership with St. Louis County Department of Public Health and the Bi-State Development Research Institute directly addresses that problem, and we are thrilled to secure these funds to support it."

"The Rides to Wellness program and our partnership with the St. Louis County Department of Public Health will allow us to provide up to 15,000 general health screenings for public transit riders in North County over the next year and a half," said John Wagner, director of the Bi-State Development Research Institute. "The mobile clinic will improve access to basic healthcare for public transit-dependent residents living near several MetroLink stations in North St. Louis County. At the same time, the mobile clinic is part of our effort to make transit hubs a more integral part of the community." Image courtesy St. Louis Metro.

Title: *Mobility on Demand (MOD) Program*

Grantee: Providers of Public Transportation

Project Purpose:

The objective of MOD is to enhance personal mobility through a multimodal, integrated, automated, and connected transportation system. In October 2016, FTA announced project selections for almost $8 million in funding for MOD public transportation projects. The MOD Program is part of a larger research effort at U.S. DOT that supports transit agencies and communities as they integrate new mobility tools such as smart phone apps, bike- and car-sharing, and demand-responsive bus and van services. New and innovative shared-use mobility concepts and solutions, from bike- and car-sharing systems to innovative demand-response bus services, are providing travelers with new mobility options, which are already impacting the traditional transit market and could conceivably disrupt current public transit business and funding models. The FTA MOD research program aims to supports transit agencies and communities as they navigate the dynamic, evolving landscape of personal mobility.

MOD can provide travelers with enhanced mobility options, improved travel decision tools, and convenient and seamless travel and fare payment and can provide transit agencies with innovative new operational models such as solutions for first/last mile connections to transit and better leveraging existing investments and improving service quality. To that end, FTA is funding projects in two areas to advance integrated MOD transit solutions. FTA is engaging with MOD stakeholders to better support the transit industry's awareness and readiness for MOD and to understand impediments to implementation. The project will also increase awareness and buy-in from local stakeholders and transportation companies/vendors needed for successful deployments of integrated MOD solutions in communities. FTA received $9,141,080 in funds for MOD in FY 2016 and prior years. From these funds, the following key activities were approved for funding under MOD:

- MOD Stakeholder Outreach with ITS of America (Section 5312 funding: $200,000)
- MOD Performance Metrics Development Transit Center with Booz Allen Hamilton (Section 5312 funding: $250,000)
- MOD Sandbox Independent Evaluation conducted by the Federal Highway Administration's (FHWA) ITS Joint Program Office (Section 5312 funding: $250,000)
- MOD support activities including development of an innovation knowledge accelerator (Section 5312 funding: $510,000)
- MOD Sandbox projects (Section 5312 funding: $7,931,080).

National Relevance of the Research:

The results of these projects will be widely applicable nationwide and help FTA's efforts to promote equitable, accessible, and safe mobility options for all travelers and leverage existing national investments in transit systems.

Relevance to the Transit Industry and Community:

Projects will support developing and demonstrating new models to providing traveler-centric transportation and help transit agencies develop viable models to partner with MOD service providers. The results of these projects will enable transit agencies to incorporate lessons learned from the demonstration projects into their own efforts to improve mobility and measure the impact of the programs with appropriate measurement tools.

Expected Final Products and Delivery Dates:

- One year after award, grantees must identify tangible models for implementing MOD in a transit environment and develop data element recommendations to monitor the effectiveness of various approaches to enhancing mobility in their communities.
- Delivery of final reports is expected two years after each cooperative agreement is awarded (September 2017).

Performance Indicators (Outputs):

- Number of public transit agencies collaborating with shared mobility partners to expand service coverage and hours.
- Number of public transit agencies incorporating additional shared mobility mode(s) to their portfolio of services.

Performance Goals (Outcomes):

- MOD projects help make transportation systems more efficient and accessible, particularly for people who lack access to a car. MOD also:
  - Improves transportation efficiency by promoting agile, responsive, accessible, and seamless multimodal service inclusive of transit through enabling technologies and innovative partnerships.
  - Increases transportation effectiveness by ensuring that transit is fully integrated and a vital element of a regional transport network that provides consistent, reliable, and accessible service to every traveler.
  - Enhances the customer experience by providing each individual equitable, accessible, traveler-centric service leveraging public transportation's long-standing capability and traditional role in this respect.

Project/Program Impact:

- MOD Sandbox projects help transportation systems to be more efficient and accessible through various business models and partnerships between public

transportation and shared mobility providers. The overall impact is a traveler-centric transportation system that is reflective of the MOD guiding principles of system integration, partnership, innovation, and equity of service delivery.

FTA Funding: $9,141,080

Table 8. *MOD Projects Funded by FTA*

Mobility on Demand (MOD) Projects			
Project Title	**Project Recipient**	**City, Sate**	**FTA Award**
Adaptive Mobility with Reliability and Efficiency (AMORE) – Rita Ranch Area Pilot in Tucson	Regional Transportation Authority of Pima County	Tucson, AZ	$669,158
Mobility Platform	Valley Metro Rail, Inc.	Phoenix, AZ	$1,001,000
Bay Area Fair Value Commuting Demonstration	City of Palo Alto	Palo Alto, CA	$1,085,000
Los Angeles County and Puget Sound MOD Partnership	Los Angeles County Metropolitan Transportation Authority	Los Angeles, CA	$1,350,000
Integrated Carpool to Transit Access Program	San Francisco Bay Area Rapid Transit	San Francisco, CA	$358,000
Public-Private-Partnership for Paratransit Mobility on Demand Demonstration (P4-MOD)	Pinellas Suncoast Transit Authority	St. Petersburg, FL	$500,000
Integrated Fare Systems—From Transit Fare to Bike Share	Chicago Transit Authority	Chicago, IL	$400,000
Open Trip Planner Integration of Transit with Shared-Use Mobility Real-Time & Data Enhancements	Tri-County Metropolitan Transportation District	Portland, OR	$678,000
First and Last Mile Solution	Dallas Area Rapid Transit	Dallas, TX	$1,204,000
Vermont Statewide Transit Trip Planner—Fixed and Flex	Vermont Agency of Transportation	VT, Vermont	$480,000
Limited Access Connections	Pierce County Public Transportation Benefit Area Corporation	Lakewood, WA	$205,922
		Total	**$7,931,080**

MOD includes all activities leading to the demonstration of innovative transit integration, such as planning and developing business models, obtaining equipment and service, acquiring/developing software and hardware interfaces to implement the project, and operating the demonstration. FTA will award eleven projects in FY 2017 under the MOD Program to eligible recipients that are providers of public transportation, including public transit agencies, state/local government DOTs, and federally-recognized Indian tribes. FTA's MOD Sandbox Demonstration Program will provide a platform in which integrated MOD concepts and solutions, supported through local partnerships, can be demonstrated in real-world settings. FTA intends to conduct evaluations of each of the demonstration efforts to measure the program impacts and assess how existing FTA policies and regulations may support or impede these new mobility service models.

Title: *Accessible Transportation Technologies Research Initiative (ATTRI)*

Grantee: State Departments of Transportation, Transit Authorities, and Non-Transit Providers

Project Purpose:

The Accessible Transportation Technologies Research Initiative (ATTRI) leads efforts to research, develop, and implement transformative solutions, applications, and systems to help all people—particularly those with disabilities—effectively plan and execute their travel, addressing individual mobility needs. ATTRI leverages recent advances in vehicle, infrastructure, and pedestrian-based technologies, as well as accessible data, mobile computing, robotics, artificial intelligence, object detection, and navigation. ATTRI is a U.S. DOT multi-year, multimodal, multi-agency research and development effort co-led by FTA and FHWA. In FY 2016, FTA contributed $2.5 million to support the development of prototype applications in wayfinding and navigation as part of a broad agency announcement issued by FHWA.

National Relevance of the Research:

ATTRI will specifically benefit people with disabilities, veterans, and older adults. It will develop technological solutions to remove barriers to transportation according to four functional disabilities—visual, hearing, cognitive, and mobility.

Relevance to the Transit Industry and Community:

ATTRI solutions will leverage advances in transit and related industries, including vehicle and infrastructure-based technologies, automation, robotics, and wireless

communications to ensure that the transportation network, including public and human service transportation, best serves the target populations.

Expected Final Products and Delivery Dates:

- Successful prototypes developed for future large-scale demonstration and deployment. Expected deliverable dates pending completion of each project.

Performance Indicators (Outputs):

- Successful development of technologies has shown reduced transportation barriers for ATTRI target populations.

Performance Goals (Outcomes):

- Successful development and utilization of technology solutions that reduce barriers to mobility, with performance goals in relation to the number of technologies developed, tested, and successfully fielded.

Project/Program Impact:

- Reduced barriers to mobility for people with disabilities (including veterans) and older adults.

FTA Funding: $2,500,000

Title: *Veterans Transportation and Community Living Initiative (VTCLI)*

Grantee: State Departments of Transportation and Transit Authorities as Direct Recipients

Project Purpose:

The purpose of this initiative is to help veterans, military families, and others connect to jobs and services in their communities by improving access to local transportation options. This federally-coordinated partnership makes it easier for U.S. veterans, active service members, military families, and others to learn about and arrange for locally-available transportation services that connect them with work, education, healthcare, and other vital services in their communities. FTA obligated $2,357,907 under Section 5312 program funds in 2011 to provide outreach, communications, planning and other supports for more than $60 million in capital funds for projects in urban, suburban, and rural communities around the nation to strengthen and promote "one-call" information centers and other tools that conveniently simplify arranging transportation services.

National Relevance of the Research:

One-call and one-click projects have been initiated and supported nationally to help not only veterans, but also all rural and targeted populations who are in need of transportation to and from jobs, medical services, and recreational activities. The work done under this program to connect transportation modes and populations has carried forward to the Mobility Services for All Americans program and FTA's work to advance Mobility on Demand.

Relevance to the Transit Industry and Community:

By understanding the transportation needs and interests of the local veterans' community, VTCLI grantees were able to develop tools that make local transit options more accessible to veterans and their families, thereby encouraging them to use those transit options more frequently, and reach key destinations.

Expected Final Products and Delivery Dates:

- Report outlining the impact of the VTCI program to be completed in FY 2017.

Performance Indicators (Outputs):

- VTCLI projects used a variety of technologies and methods, including call centers, websites, automatic vehicle location devices and other on-board vehicle technologies, and others, to support the implementation or development of one-call, one-click services. Research program funds used to support these projects allowed communities to ensure that their efforts were designed in partnership with the local veterans and related communities and to promote use of the systems to their benefit.

Performance Goals (Outcomes):

- Increased ease of access to transportation resources among veterans and members of the military community, while benefiting overall community mobility.

Project/Program Impact:

- Advances the state of the art information exchange between providers of transportation and establishes interfaces to provide that information to consumers to aid in their mobility. The partnerships established through the program have resulted in improved local coordinated planning of services to meet specialized goals.

FTA Funding: $2,357,907

The Idaho Transportation Department and the Community Transportation Association of Idaho received $50,000 in Section 5312 research funds to help develop FindMyIdahoRide.org, a statewide resource that connects Idahoans with a range of transportation options including public fixed-route, demand-response, volunteer driver, and others able to meet their needs. The site allows users to input their origin and destination and information about accommodations they require in traveling. Users can indicate needs ranging from wheelchair accessibility to hand-to-hand assistance or the ability to travel with a bike. Travel options can also be identified by means of payment.

Title: *Mobility Services for All Americans (MSAA)*

Grantee: State Departments of Transportation and Transit Authorities as Direct Recipients

Project Purpose:

The purpose of MSAA is to increase mobility and transportation accessibility and to engage in the deployment planning and preparation of coordinated Human Service Transportation (HST) systems that use ITS capabilities. MSAA is targeted for communities of any size or definition and includes public entities currently establishing, operating, coordinating, or brokering general public transportation and HST, including public transit agencies, state/local government departments of transportation, health and human service agencies, federally recognized Indian tribes, and metropolitan planning organizations in the U.S. MSAA was funded through the U.S. DOT ITS Joint Program Office by $795,545 in FY 2014 and FY 2015. It provides the opportunity to design a replicable, scalable, and interoperable Travel Management Coordination Center (TMCC) and allows agencies to use a coordinated system to easily book rides and transfers

for customers across service areas, improving the customer experience and minimizing duplication. The project will build upon a centralized data exchange capability that allows multiple providers to share information about availability, capacity, rider needs, and useful data such as real-time vehicle locations and schedules. Table 9 displays projects approved by FTA.

National Relevance of the Research:

This project enhances accessibility and mobility for persons who are transportation disadvantaged. The MSAA initiative focuses on applying ITS solutions to advance human service transportation delivery.

Relevance to the Transit Industry and Community:

This project showcases promising technologies and practices that improve travel planning and coordination for people who need specialized transportation. It will help the transit community by providing vital services for veterans, older adults, people with disabilities, and others who rely on community transportation providers to access everyday needs such as employment, medical care, and groceries.

Expected Final Products and Delivery Dates:

- Final report to FTA expected in December 2017.

Performance Indicators (Outputs):

- Performance indicators will be a direct product of the project or program. Examples include reports, webpages, new technology, and new processes. Additional performance indicators include:
  - Model concepts of operations for regions seeking to deploy TMCCs
  - MSAA initiative outreach presentations, fact sheets, webinars, website, peer-to-peer guidance
  - Technical assistance and KTT to the MSAA planning and development grantees in Atlanta, Denver, San Louis Obispo, and Madison, Wisconsin

Performance Goals (Outcomes):

- Results and specific changes to the project or program that are expressed as a tangible, measurable, or quantitative standard, value, or rate in the short term:
  - Concept development for TMCCs
  - Stakeholder needs, requirements, and architecture models shared and used as baselines for TMCC systems nationwide
  - TMCC evaluations and lessons learned
  - KTT tools and guidance for future TMCC systems across the country
  - Improving service and expanding travel opportunities for Americans with mobility challenges to provide a better quality of life for travelers

- Optimizing paratransit operations by modernizing their scheduling systems to provide efficiencies in operations and reduce costs for transit agencies and providers
- Facilitating improved methods for TMCC acquisitions and transferring that knowledge to improve stakeholder understanding and capabilities with general ITS deployments

Project/Program Impact:

- Fundamental change occurring as a result of the program in the long term.
  - MSAA program works to improve the travel experience for all Americans and especially targets those who are disadvantaged.
  - Some locations have already improved their systems based on the concepts proposed by MSAA. Others are in the process of planning and developing their systems. Some locations have already improved their systems enough to improve the traveler experience.

FTA Funding: $795,545

Table 9. *MSAA Projects Funded by FTA*

Mobility Services for All Americans (MSAA) Projects			
Project Title	**Project Recipient**	**City, Sate**	**FTA Award**
San Luis Obispo County Travel Management Coordination Center	United Cerebral Palsy of San Luis Obispo County/Ride-On Transportation	San Luis Obispo, CA	$186,850
Atlanta Region Platform for One Click, Phase II	Atlanta Regional Commission	Atlanta, GA	$140,250
2015 Via MSAA Grant	Via Mobility	Denver, CO	$275,125
Travel Management Coordination Center (TMCC) of Southern Wisconsin	Greater Wisconsin Agency on Aging Resources	Madison, WI	$193,320
		Total	**$795,545**

The San Luis Obispo County Travel Management Coordination Center Project sponsored by Ride-On Transportation and United Cerebral Palsy of San Luis Obispo County designed and demonstrated a Ride Coordination System that examined how to break down institutional barriers to efficiently manage more than 882,000 passenger trips annually. Ride-On and its project partners plan to use innovative technologies to link databases and services in real time, allowing customers to enjoy better and more integrated service from the county's public, private, and non-profit transportation providers. The Ride-On TMCC system will improve specialized transportation services for older adults, persons with disabilities, and the economically-disadvantaged by providing centralized access to many independent service providers and consolidating multiple payment services into a single payment resource. Often, customers have to contact multiple case workers for multiple funding programs; trip requests have to be made well in advance; scheduled trip times are inconvenient; pick-up wait times are long and difficult to estimate; trip travel times are long, and accessibility to transit for older adults and persons with disabilities is limited. The Ride-On TMCC system offers users a single, web based portal to provide them with greater travel options (e.g., accommodates their schedule, wheelchair accessibility, etc.) and the ability to choose the options that are most affordable to them. The TMCC will provide a software system to allow individuals and agencies to make a ride request for a paratransit ride and see all their options by cost and travel time. Once the provider of choice is selected, the ride will be scheduled and confirmed. People will be able to access the TMCC software by computer or smart phone, and several agencies will be available to assist riders over the phone to make the reservation. The TMCC will also have a billing component that will offer several methods of payment for the ride. The software will also offer a platform for transferring rides between public and private operators to handle peak demand periods. The TMCC will allow riders to establish their individual profile, so they see all the social service transportation options that they are qualified to use, such as the Senior Shuttle and Veterans Express.

Promoting Asset Innovation and Asset Management

Objective:

This program directly addresses the U.S. DOT's environmental sustainability strategy to promote the development and deployment of technologies to reduce the energy consumption and greenhouse gas (GHG) emissions of transit systems. FTA will undertake research on zero emission vehicles, facilities, and technologies research and will identify innovative and sustainable uses of transit vehicles and services. FTA also expects to invest in projects that study how lifecycle costs impact asset investment decisions.

Description:

With a nearly $100 billion and growing national backlog of transit infrastructure maintenance, FTA has a goal of bringing transit into a state of good repair. The goals of the transit asset management program are to conduct research for developing and demonstrating various asset management technologies and tools and to provide guidance and best practices to assist transit agencies, large or small, to establish transit asset management plans. In addition to asset management, FTA has a long history of asset innovation, specifically related to vehicle technologies and supporting cleaner technology. A new low and no emissions component testing program will provide critical information to reduce negative environmental impacts and improve operational efficiencies. FTA has previously and will continue to conduct research on and demonstrations of zero emission vehicles, facilities, and technologies to identify innovative and sustainable uses of transit vehicles and services.

Outputs:

- Research, develop, and deploy zero emission transit vehicles, facilities, and technologies.
- Identify innovative and sustainable use of transit vehicles and services through practices and technologies.
- Develop partnerships with other federal agencies involved in energy and environmental research.

Outcome/Impact:

To identify innovative and sustainable uses of transit vehicles and services to reduce the energy consumption and GHG emissions of transit systems.

List of Projects: (12)

1. Effects of Capital Cost Forecasting Study and Research
2. Best Practices and Research for Life-Cycle-Based Management
3. Track Asset Management Demonstration
4. Disadvantaged Business Enterprise (DBE) Demonstration and Study
5. Zero Emission Bus Research
6. Zero-Emission Bus Evaluation and Support
7. Low or No Emission (LoNo) Vehicle Deployment Program
8. Bus Efficiency Enhancements Research and Demonstrations (BEERD) Program
9. U.S.–China Zero Emissions Bus Collaboration
10. Small Business Innovation Research (SBIR)
11. Fuel Cell Bus Evaluation and Support
12. Transit Conditions and Performance

Title: *Effects of Capital Cost Forecasting Study and Research*

Grantee: No contract yet

Project Purpose:

The purpose of this research is to evaluate transit cost estimates versus bid pricing across the period of 1995–2015, which spans two significant periods of economic turmoil and a large range of project conditions. Federal funding for transit capital projects is based on cost estimates provided by project sponsors and reviewed by FTA, usually before construction bids are received. Accurate estimating is required to reliably establish these Federal grants. Anecdotal evidence exists and shows that overall economic conditions or patterns of project conditions may affect the ability of cost estimators to accurately forecast project costs.

National Relevance of the Research:

This research will be used to improve cost estimating by the transit industry. Cost estimating depends upon historical costs that are adjusted using traditional methods that may not reflect unusual economic or project conditions. The discovery of indicators and recommendations for rational adjustments during significant economic variance or under certain project conditions will produce more accurate estimates.

Relevance to the Transit Industry and Community:

Accurate estimates will lead to more effective application of Federal funds, reduced instances of breaches of Federal funding agreements, and reduced funding stress by local transit agencies. Outcomes will include Federal guidance to public agencies to improve project cost forecasting, increased precision of Federal oversight, increased accuracy of project risk assessments and reduction of project risk at the local agency level.

Expected Final Products and Delivery Dates:

- Final report December 2017

Performance Indicators (Outputs):

- Results in final report

Performance Goals (Outcomes):

- In development

Project/Program Impact:

- This project will assist in the improvement of cost estimating by the transit industry. If this project is not implemented, the current state of the art in

forecasting methods will continue to experience that distress without the addition of improved methods of cost estimate forecasting.

FTA Funding: $200,000

Title: *Best Practices and Research for Life-Cycle-Based Management*

Grantee: Volpe Center

Project Purpose:

The purpose of this project is to identify best practices in life-cycle management that could be applied to public transportation. Activities will include a review of the literature regarding methods used by public capital institution managers in other industries (esp. airline and railroad) to effectively address and resolve reliability, supportability, maintainability, and sustainability challenges throughout capital project development; conducting original research/benchmarking in the U.S. and international industries' current best practice processes/procedures in regards to life-cycle management throughout all phases of a project's life beginning with concept definition, through design, engineering construction, fielding, and sustainment with a focus on ensuring effective, efficient and safe operations and maintenances; and production and distribution of recommendations of practice for individual transit systems' use.

National Relevance of the Research:

Most transit lifecycle costs occur during the operations and maintenance (O&M) phase, yet many of these costs are a product of short-term cost decisions made during capital development and equipment acquisition. Currently, deferred maintenance costs exceed $120 billion and grow by $3 billion per year. If one percent of these costs are reduced, the return on investment would be strong.

Relevance to the Transit Industry and Community:

- This study will provide best practices in the industry and recommendations for individual transit agencies on how to reduce their own maintenance costs.

Expected Final Products and Delivery Dates:

- Final report documenting research data, analysis, findings, and recommendations for next steps, December 2017

Performance Indicators (Outputs):

- Results in final report with recommendations

Performance Goals (Outcomes):

- Improvements in contracting/procurement, cross agency teaming, standards & requirements development, management processes, procedures and tools, incentivizing more reliable and maintainable products (especially vehicles and track), through encouraging more efficient life-cycle-focused design and product manufacture of transit systems.

Project/Program Impact:

- Gradual reduction of transit lifecycle costs for the operations and maintenance of transit systems, which will result in additional savings in the long term.

FTA Funding: $200,000

Title: *Track Asset Management Demonstration*

Grantee: Metropolitan Area Rapid Transit Authority (MARTA), Atlanta

Project Purpose:

The purpose of this project is a demonstration of innovative track asset management practices by using an autonomous track inspection system. An autonomous and non-contact Track Inspection System has been introduced and used on passenger and freight railroads for a number of years (vehicle/track interaction, track geometry monitoring system, video inspection mounted under the rail vehicles). The goal is to demonstrate the transferability of such system to transit, demonstrate its effectiveness compared to existing transit track management practices (track inspection, data analysis, data management and maintenance) and evaluate the return on investment of the system.

National Relevance of the Research:

The potential benefits of such inspection technologies coupled with the asset management practices bring additional capabilities for transit agencies to continuously monitor, assess, and trend the track conditions. This will allow the agencies to perform condition based maintenance and not time or mileage based maintenance.

Relevance to the Transit Industry and Community:

This track inspection and asset management project will demonstrate innovative technologies and practice to continuously and autonomously inspect, assess, and perform condition-based asset management in revenue service. The application of this research project uses novel innovation in the freight rails to develop and demonstrate transfer of the technology in transit. The transit industry will benefit immensely by replicating and deploying similar systems.

Expected Final Products and Delivery Dates:

- Completion of Phase I research and demo – installation and test of Autonomous Track Geometry and Monitor System test on revenue service, December 2018

Performance Indicators (Outputs):

- Results in final technical report that will include independent evaluation assessment

Performance Goals (Outcomes):

- Successful development of an autonomous rail inspection and monitoring system that will be an integral function of the overall track inspection and asset management system for the next two phases to proceed.

Project/Program Impact:

- In the long term, the project will complete three phases to provide the following transit agencies with improvements to track crew safety, predictive maintenance practice with computer vision, and data analytics.

FTA Funding: $2,000,000

Title: *DBE Participation in Domestic TVM Supply Chains Research and Demonstrations*

Grantee: TBD

Project Purpose:

This project will develop and implement several Disadvantaged Business Enterprise (DBE) Transit Vehicle Manufacturers (TVM) component supplier participation development demonstrations. The first phase will conduct specific research to identify the barriers for DBEs to becoming major subsystem suppliers for TVMs and the challenges that TVMs face in finding qualified DBE suppliers. The primary product of the first phase will be a report that identifies the most common barriers identified by the DBE suppliers and those identified by the TVMs and that provide specific actionable recommendations to address these barriers. The second phase will be focused on sponsoring demonstration projects with expanded DBE supplier participation that lower or remove the barriers identified in Phase 1. The second phase will also include outreach efforts to create awareness of the program with the greater transit industry.

National Relevance of the Research:

The results of this project will point out the challenges that TVMs face in finding qualified DBE suppliers, recommend ways to expand DBE supplier participation, and demonstrate some of the recommended approaches.

Relevance to the Transit Industry and Community:

This project will provide new opportunities for greater participation and market share by DBEs in supplying the transit industry. The project will also provide increased competition in supply options and potential reduction in costs to TVMs and major component suppliers, ultimately lowering costs to transit agencies and the public.

Expected Final Products and Delivery Dates:

- Perform data collection from industry stakeholders (i.e., TVMs, DBE suppliers, potential DBE suppliers) regarding barriers to participation via interviews, surveys and questionnaires.
    - Compile, organize and review data collected
    - Conduct results analysis based on data, identify trends found in barriers to DBE supplier participation in the industry
    - Prepare report documenting data, analysis and findings, provide recommendations for next steps

Performance Indicators (Outputs):

- This project will result in a white paper that identifies barriers to greater DBE participation in transit vehicle manufacturing supply chains and provides recommendations for lowering these barriers. It will also result in demonstrations of the recommended ways to reduce barriers to DBE participation in TVM supply chains.

Performance Goals (Outcomes):

- Based on the research collected from this project, the researchers will be able to identify TVMs, DBEs, and potential DBEs to participate in demonstrations designed to remove barriers. Through the demonstrations, DBEs will participate directly in increasing their content in transit vehicles.

Project/Program Impact:

- The results of this program will allow investigators and industry partners to develop demonstrations designed to enhance DBE supplier participation within the industry. This will provide increased competition in supply options and potential reduction in costs to TVMs and major component suppliers, ultimately lowering costs to transit agencies and the public.

FTA Funding: $1,300,000

Title: *Zero Emission Bus Research*

Grantee: Non-Profit Organizations Leading an Industry Consortium

Project Purpose:

The purpose of the zero emission bus research program is to support the research, development, and deployment of zero emission technology for transit buses. With FY 2015 approved funding of $2.75 million, FTA is planning to address the following critical research needs with respect to zero emission bus research: develop integration and fleet deployment tools, model electricity requirements, investigate reducing costs and increasing component durability, and support the validation of more standardized bus charging systems.

National Relevance of the Research:

FTA has been involved for more than 20 years in transit bus research focusing on increasingly cleaner and more energy efficient propulsion systems. It currently supports $100+ million in existing bus technology demonstration and deployment projects through various programs, such as the National Fuel Cell Bus Program (NFCBP) and the Low or No (LoNo) Emission Vehicle Deployment Program. The collected outcomes resulting from this zero emission bus research effort will enable FTA to make informed decisions concerning future research needs and priorities related to zero emission bus technology and applications.

Relevance to the Transit Industry and Community:

The results from this zero emission bus research effort will advance the commercialization of zero emission bus technology and make it less expensive and less risky for transit agencies to procure and operate zero emission buses. The research will also enable transit agencies to make informed procurement and operational decisions, including whether, when, and how to invest in zero emission bus fleet and subsequent deployment strategies, ultimately benefiting the traveling public and communities across the nation.

Expected Final Products and Delivery Dates:

- Documentation of status and forecasted changes in commercially viable zero emission bus technology.
- Research or evaluation reports of advanced bus technology components.
- Studies and analyses of topics relevant to energy efficiency and bus technology.
- Technical and strategic planning-related assignments as requested.

Performance Indicators (Outputs):

- Number of electric drive and zero emission vehicles manufactured in the U.S.
- Number of transit agencies considering the benefits and risks of electric drive and zero emission vehicles for transit fleet operations

Performance Goals (Outcomes):

- Transit agencies make decisions about whether or not to pursue electric drive and zero emission fleets based on data about vehicle and fleet costs and performance.

Project/Program Impact:

- Transit agencies are able to make well-informed decisions about the costs and benefits of acquiring electric drive and zero emission transit vehicle fleets.

FTA Funding: $2,750,000

Title: *Zero Emission Bus Evaluation and Support*

Grantee: U.S. Department of Energy (DOE), National Renewable Energy Laboratory (NREL), Golden, CO

Project Purpose:

This project continues the work begun under the Fuel Cell Bus Evaluation and Support Project and expands it to include evaluations of advanced technology propulsion projects awarded under other FTA and U.S. DOT programs, including FTA's LoNo Program. This project consists of an Interagency Agreement to U.S. DOE's National Renewable Energy Lab to support evaluation of new technology buses. This project evaluates zero emission bus technologies in transit and coordinates information and data-sharing among demonstration efforts. NREL evaluates zero emission bus demonstration and deployment efforts and selected low emission bus demonstration efforts, funded by the LoNo Program, the National Fuel Cell Bus Program, and the Transportation Investment Generating Economic Recovery (TIGER) program, to determine the status of these technologies and provide lessons learned to aid other fleets in implementing the next generation of zero emission buses into transit operations.

National Relevance of the Research:

Independent, consistent evaluation of new technology demonstration efforts is essential to understanding the outcomes of federal research investments. The evaluation also provides input to identifying additional research needs necessary for successful commercialization of zero emission buses.

Relevance to the Transit Industry and Community:

Independent evaluation provides meaningful information to the industry on expected benefits and costs related to implementing new technologies for bus fleets. Information from the evaluations aids the transit industry in determining

which technologies to implement and which technology investments may be beneficial for their operations.

Expected Final Products and Delivery Dates:

- Ongoing analysis and publication of data of program-wide impacts and outcomes of individual bus evaluation efforts.
- Ongoing reports detailing evaluation projects and evaluation efforts.

Expected Final Products and Delivery Dates:

- Project reports expected at the completion of the evaluation.

Performance Indicators (Outputs):

- Project reports and data shared with project teams.

Performance Goals (Outcomes):

- Share information about the performance of new technology buses.

Project/Program Impact:

- Program allows transit agencies, vendors, and other industry stakeholders to be able to make informed decisions regarding the costs and capabilities of new technology transit buses.

FTA Funding: $1,400,000

Title: *Low or No Emission Vehicle Deployment (LoNo) Program*

Grantee: Transit Agencies; Project teams comprising transit agencies and bus manufacturers to deploy clean technology buses that are largely proven in testing and demonstrations but not widely deployed in transit fleets

Project Purpose:

The purpose of this project is to lower the cost and increase the quality and availability of cleaner buses, increase private investment in cutting-edge U.S. transit bus development, and increase the number and capabilities of people involved in U.S. bus design and manufacturing. FTA's LoNo Program aims to advance deployment of the cleanest and most energy-efficient U.S.-made transit buses. The program targets bus models largely proven in testing and demonstrations but not yet widely deployed in transit fleets. The LoNo Program provides funding for transit agencies for capital acquisitions and leases of zero emission and low emission transit buses, including acquisition, construction, and leasing of required supporting facilities such as recharging, refueling, and maintenance facilities.

National Relevance of the Research:

These competitively-selected projects will implement a provision of Federal public transportation law authorizing the LoNo Program. National applicability, including whether the proposed project could be replicated by other transit agencies regionally or nationally, is a specific proposal evaluation criterion. Applications are limited to those from areas designated as non-attainment for ozone or carbon monoxide under Section 107(d) of the Clean Air Act or a maintenance area, as defined in 49 U.S.C. 5303, for ozone or carbon monoxide. Many transit agencies nationwide are located in either a non-attainment area or a maintenance area. This program will result in lower cost and increased availability of cleaner buses, more private investment in transit bus development, and new jobs in U.S. transit bus design and manufacturing.

Relevance to the Transit Industry and Community:

The results of these projects will enable transit agencies to incorporate lessons learned from the initial deployment of low or no emission buses into their future plans for bus procurements. They will also result in lower cost, improved quality, and increased availability of more efficient buses.

Expected Final Products and Delivery Dates:

- Data on emissions, energy use, operational performance, and maintenance requirements of LoNo buses is expected in 2017-2018.

Performance Indicators (Outputs):

- Number of new low and no emission buses manufactured.
- Number of U.S. workers designing and building advanced technology electric drive buses.

Performance Goals (Outcomes):

- Advanced technology bus lifecycle costs lowered enough to make electric drive buses the public transportation vehicle of choice.

Project/Program Impact:

- U.S. becomes a world leader in transit bus design and manufacturing.

FTA Funding: $76,969,249

Table 10. *LoNo Projects Funded by FTA*

LoNo Projects Funded through Section 5312 Prior to the Date of Enactment of the Federal Public Transportation Law			
Project	**Sponsor**	**State**	**FTA Award**
Purchase 5 fuel cell electric buses	Sunline Transit Agency under Southern California Association of Governments	CA	$9,803,860
Purchase 5 fuel cell electric buses	Stark Area Regional Transit Authority	OH	$8,877,405
Purchase 17 E-series hybrid Gillig buses	Red Rose Transit Authority	PA	$2,638,400
Purchase 5 60-ft electric buses on the Silver Line Bus Rapid Transit System	Massachusetts Bay Transportation Authority	MA	$4,139,188
Purchase 5 battery electric buses and a fast charging station	Transit Authority of River City (TARC)	KY	$3,321,250
Purchase 5 battery electric buses and a charging station	San Joaquin Regional Transit District (RTD)	CA	$4,702,011
Purchase 6 battery electric buses and 3 charging facilities	Duluth Transit Authority	MN	$6,343,890
Purchase 7 battery electric buses	Dallas Area Rapid Transit (DART) Authority	TX	$7,637,111
Purchase 5 battery electric buses and a fast charge station	Lexington Fayette Urban County Government	KY	$6,003,534
Purchase one electric bus fast charger with Emergency Power Generation	Worcester Regional Transit Authority	MA	$1,002,600
Purchase 5 battery electric buses, and install 8 charging stations	LACMTA under Southern California Association of Governments (SCAG)	CA	$4,275,000
Install additional electric bus charging facilities	Foothill Transit under Southern California Association of Governments (SCAG)	CA	$1,310,000
Purchase 5 battery electric buses and related equipment	AC Transit Under the Metropolitan Transportation Commission	CA	$1,551,611
Purchase 3 fuel cell electric buses	Stark Area Regional Transit Authority	OH	$4,015,174
Purchase 25 battery electric buses	Southeastern Pennsylvania Transportation Authority	PA	$2,585,075
Purchase 5 battery electric buses	Utah Transit Authority	UT	$5,427,100
Purchase 8 battery electric buses	King County Metro	WA	$3,336,040
		Total	**$76,969,249**

Title: *Bus Efficiency Enhancements Research and Demonstrations (BEERD) Program*

Grantee: Providers of Public Transportation and Non-Profit Organizations

Project Purpose:

The purpose of the program is to promote the development and demonstration of targeted energy efficiency-enhancing technologies – specifically enhanced electrification of accessories and improvements in thermal management of bus bodies – for buses utilized in public transportation. In addition to reducing energy use by transit buses, projects funded can have favorable impacts on meeting the needs of the riding public, public transportation operators, and the American bus industry and its supplier base. The program simultaneously advances U.S. DOT's research goals, which include but are not limited to improving safety, enhancing the state of good repair of transit systems, providing more effective and efficient public transportation service, increasing capital and operating efficiencies, developing and deploying advanced vehicle designs and technology, reducing harmful emissions, and increasing energy efficiency.

National Relevance of the Research:

This program supports an overarching FTA goal of developing and deploying new and innovative ideas, practices, and approaches for transit buses. This program supports the U.S. DOT goals of environmental sustainability, economic competitiveness, quality of life in communities, and state of good repair.

Relevance to the Transit Industry and Community:

This program invests in promising technologies that could help save energy, reduce emissions, and bring cost savings to transit providers across the country by increasing the electrification of transit bus powertrains.

Expected Final Products and Delivery Dates:

- New technologies to FTA in 2017:
  - Thermoelectric waste heat generator installed on a transit bus.
  - Reduced Engine Idle Load (REIL) system developed, laboratory tested, and final evaluation report delivered. REIL market evaluation and trade study delivered.
  - Development and in-service demonstration of an electric heating/air conditioning system integrated with a high-power alternator and energy storage, to enable paratransit buses to provide comfortable cabin air during engine-off stops.
  - Beltless alternators (DC/DC converters) retrofitted to 41 existing diesel hybrid-electric buses and demonstrated in service.

Performance Indicators (Outputs):

- Prototype thermoelectric waste heat generator expected to generate 1000W of 24V power to support bus systems, recovering energy that would otherwise be lost out the tail pipe.
- REIL system removes the load of vehicle accessories, such as the HVAC system, power steering pump, air compressor, and cooling fans from a bus's diesel or compressed natural gas engine. The system architecture also allows periods of engine-off accessory operation for as long as 30 minutes, which is especially beneficial on routes with layovers and dwell periods.

Performance Goals (Outcomes):

- Electrified accessory system on the paratransit bus will enable continued provision of cabin comfort to riders while the engine is shut off for up to 30 minutes during waiting and loading/unloading.
- Retrofitting of beltless alternators to hybrid-electric buses will result in substantial fuel economy improvements (approximately twenty percent) and more than $6,000/year per bus in combined fuel and maintenance savings.

Project/Program Impact:

- Program supports demonstrations of four different technologies that are expected to achieve substantial improvements in energy efficiency while supporting a pathway to greater electrification of transit and paratransit bus powertrains.

FTA Funding: $3,000,000

Table 11. *BEERD Projects Funded by FTA*

Bus Efficiency Enhancements Research and Demonstrations (BEERD) Projects		
Project Title	**Grantee**	**FTA Award**
Thermoelectric Generation Demonstration, in partnership with Central Florida Regional Transportation Authority (LYNX)	Center for Transportation and the Environment (CTE)	$532,258
Utah Transit Authority Paratransit Accessory and Electrification	CTE	$697,185
MARTA, development and demonstration of a BAE Systems prototype Reduced Engine Idle Load System	CTE	$1,274,936
Development and demonstration of retrofit of 35 hybrid buses with a hybrid beltless alternator and support equipment to monitor fuel savings and impact on house batteries	Maryland Transit Administration (MTA)	$495,621
	Total	**$3,000,000**

Title: *U.S.–China Zero Emissions Bus Collaboration*

Grantee: CALSTART, Inc.

Project Purpose:

This program builds upon the efforts of the National Fuel Cell Bus Program, the new LoNo Program, and CALSTART's zero emission bus programs to fully develop and design the Race to Zero Emissions (R2ZE) initiative by engaging key stakeholders in both China and the U.S., and conducting outreach and education activities to provide the most effective and far-reaching benefits to the vehicle industry, transit agencies, and communities.

National Relevance of the Research:

R2ZE is a new initiative to foster enhanced bilateral efforts between the U.S. and China to reduce GHG emissions in the heavy-duty vehicle sector. The initiative provides a framework for cooperation between the world's two largest GHG-emitting countries and provides an opportunity for shared economic benefits.

Relevance to the Transit Industry and Community:

Communities within China and the U.S. will be designated to participate, with successful teams achieving a specified percentage of their transit bus fleet powered by zero emission technologies. Any bus technology that achieves zero tailpipe emission will be eligible, including battery electric buses and fuel-cell-powered buses. In addition to enormous benefits for these highlighted communities in realizing a significant zero emission milestone, all communities in China and the U.S. could benefit from accelerated commercialization of zero emission buses and related technologies and focused national attention on zero emission transit. Zero emission buses can provide superior, clean, quiet transportation options for communities, help improve the local air quality, and significantly reduce GHG emissions.

Expected Final Products and Delivery Dates:

- Final deliverable will occur when transit operators in both the U.S. and China become participants in the R2ZE program. Outcome will be an international network designed to bolster and support greater deployment of buses that significantly reduce GHG emissions.

Performance Indicators (Outputs):

- R2ZE initiative was developed and designed in close collaboration with key stakeholders in both countries and conducted outreach and education activities at national and international events including the U.S.-China Transportation Forum in Los Angeles; the U.S.-China Climate Change Working Group in Beijing; the 2016 Smart Urban Transportation Conference

in Xi'an; and the International Forum on Innovation and Transformation of Urban Transport in Beijing.

- R2ZE guidelines and criteria for participation in the challenge were jointly developed by the U.S. and China and will identify successful teams that achieve a specified percentage of their transit bus fleet powered by zero emission technologies.
- A R2ZE website was created that provides information on the Challenge and gives an opportunity for additional agencies to join: www.dot.gov/r2ze
- Display booth was prepared and outreach presentations were made at domestic and international public transportation conferences that identify the purpose and implementation of the Challenge and provide an opportunity for transit agencies to participate.
- Session on the R2ZE was developed and conducted for leaders from 49 Chinese municipalities and 17 U.S. cities, states, and counties who met in Beijing on June 7–8 to discuss progress on climate change reduction efforts. A resulting signed declaration committed the signatories to reduce their region's greenhouse gas emissions and goals which support R2ZE.

Performance Goals (Outcomes):

- As a result of the above output activities, transit agencies began to express their interest and commitment to participating in the Challenge.
- With the participation by these transit agencies and other agencies that will be joining the Challenge as the outreach activities continue, the vehicle industry, transit agencies, and communities will see effective and far-reaching environmental benefits due to the reduction of GHG.
- The R2ZE initiative provided a framework for cooperation between the world's two largest GHG-emitting countries through meetings and conferences that were conducted and provided an opportunity for shared benefits.

Project/Program Impact:

- R2ZE created an incentive for U.S. transit agencies to acquire zero emission buses which minimize bus-related GHG emissions.
- Stimulated China to organize a cooperative relationship with the U.S. to reduce bus emissions and also provided a mechanism for related Chinese Ministries to become engaged with one another to address a common issue.
- In conjunction with the FTA LoNo Program, R2ZE accelerated commercialization of zero emission buses and related technologies and focused national attention on zero emission transit which provides superior, clean, quiet transportation options for communities, helps to improve the local air quality, and significantly reduces GHG emissions.

FTA Funding: $500,000

DOT launched the U.S.-China Race to Zero Emission (R2ZE) Challenge at the U.S.-China Transportation Forum in Los Angeles, CA on June 3, 2016. The R2ZE Challenge was described as a collaborative and friendly competition that encourages transit agencies to take ambitious actions to put a new generation of advanced, non-polluting zero emission buses on the road in communities across the U.S. and China. The R2ZE initiative was developed and designed in close collaboration with key stakeholders in both countries and conducted outreach and education activities at national and international events. A display booth was prepared and outreach presentations were made at domestic and international public transportation conferences that identify the purpose and implementation of the Challenge and provide an opportunity for transit agencies to participate.

Title: *Fuel Cell Bus Evaluation and Support*

Grantee: U.S. DOE, NREL, Golden, CO

Project Purpose:

This project is being changed and continued under the Zero Emission Bus Evaluation and Support program to accommodate the range of vehicles being purchased under the LoNo Program. NREL assists FTA in implementing clean energy research projects by providing unbiased, expert technical input in analysis and assessment of demonstration projects. NREL analyzes data collected from National Fuel Cell Bus Program (NFCBP) demonstration projects, develops interim and final reports on individual projects for publication, and provides consultation on evaluation procedures.

National Relevance of the Research:

FTA's primary clean energy research program has been the NFCBP, a $90 million, multi-year, cost-shared research program for developing and demonstrating commercially-viable fuel cell technology for transit buses. NREL provides unbiased evaluations to assess the success of the individual fuel cell bus projects and the overall program.

Relevance to the Transit Industry and Community:

As fuel cells and other zero emission technologies move closer to commercialization and are adopted by transit agencies in increasing numbers, unbiased information on their costs and performance is essential. NREL's analysis and reports on zero emission technologies provide valuable insight into the commercial readiness of these technologies and their performance in the rigors of transit service. Evaluation efforts are coordinated with U.S. DOE hydrogen vehicle research program efforts through a joint evaluation plan.

Expected Final Products and Delivery Dates:

- Analyses of NFCBP projects and evaluations of nationally-significant fuel cell bus projects.
- Support for evaluating buses from NFCBP continues under a related agreement that incorporates evaluation of the buses funded through the Federal public transportation law LoNo Program.

Expected Final Products and Delivery Dates:

- Fuel cell bus project reports.

Performance Indicators (Outputs):

- Project reports.

Performance Goals (Outcomes):

- Share information about the performance of new technology buses.

Project/Program Impact:

- Transit agencies, vendors, and other industry stakeholders are able to make informed decisions about the capability of new technology transit buses.

FTA Funding: $1,125,000

Title: *Transit Conditions and Performance*

Grantee: Booz Allen Hamilton Inc.

Project Purpose:

The purpose of this project is to provide a report quantifying the conditions and performance of the transit industry in the U.S. and to develop and maintain the Transit Economic Requirements Model (TERM) to support infrastructure investment needs analysis. TERM is a PC-based computer application designed to estimate the nation's transit capital investment needs over an extended

horizon. The model estimates the total amount of annual capital expenditures required over a 20-year period to maintain or improve the physical condition and performance of the nation's transit infrastructure. The results are combined with those produced by FHWA into a biennial report to Congress on the status of the nation's highways, bridges, and transit systems.

National Relevance of the Research:

The report provides general investment benchmarks as a basis for the development and evaluation of transit policy and program options. It enhances understanding of the conditions, performance, and reinvestment needs of U.S. transit systems. The analysis is supported by an extensive inventory of all transit assets in the U.S.; the data included in the inventory are provided by transit agencies and are periodically updated to reflect the current state of the national inventory.

Relevance to the Transit Industry and Community:

TERM-Lite, which this work supports, is widely used by transit agencies for projecting their long-term capital investment needs. TERM-Lite estimates the total amount of annual capital expenditures required over a 20-year period to maintain, achieve a State of Good Repair, and improve the physical condition and performance of the agency's transit infrastructure. TERM-Lite allows agencies to control a wide range of model input parameters to facilitate the analysis of a wide range of investment scenarios.

Expected Final Products and Delivery Dates:

- "2015 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance" (report to Congress).

Performance Indicators (Outputs):

- Report: Conditions and Performance Report to Congress and dynamic Web-based dashboards

Performance Goals (Outcomes):

- Timely deliverable of Report to Congress
- Relevance of topics discussed to assist Congress in defining and setting capital funding polices for the National Transit Infrastructure

Project/Program Impact:

- The C&P is a recurring report, with periodicity of two years. The mid-long term objective of the project is the creation of a web-based business intelligence interface to allow users to do dynamic analysis of data and trends, such as filtering and summarizing data at various aggregate levels. In another area, FTA and FHWA plan the implementation of desirable

enhancements to the capital modeling tools used in the report such as TERM (FTA) and the Highway Economic Requirements System (FHWA).

FTA Funding: $1,017,476

Title: *Small Business Innovation Research (SBIR) Program*

Grantee: Volpe Center

Project Purpose:

Congress established the SBIR Program to stimulate technological innovation, utilize small business to meet federal research and development (R&D) needs, encourage participation by minority and disadvantaged businesses in technological innovation, and increase private sector commercialization of innovations derived from federal research and development objectives. This program continues support of the SBIR program as implemented by U.S. DOT. Through this program, FTA contributes to SBIR, consistent with statutory requirements, for projects related to its research needs that also enhance the international competitiveness and innovative capabilities of small business in the U.S. In November 1982, the Secretary of Transportation chose the Volpe Center to direct the Department's SBIR Program due to its extensive background in innovative programs such as technology transfer, cooperative R&D agreements, outreach projects involving a cross-section of the transportation community, and technical assistance to state and local governments, as well as private organizations. FTA funding for SBIR is made available through Intra-Agency Agreements with Volpe. For FY 2016, the take down is three percent of the FTA R&D budget.

National Relevance of the Research:

This program supports small businesses that favor research and have the potential for commercialization through products and applications sold to the private sector transportation industry, state departments of transportation, U.S. DOT, or other federal agencies.

Relevance to the Transit Industry and Community:

The FTA SBIR Program supports innovations in public transit. Statutory requirements and the program are authorized until 2017.

Expected Final Products and Delivery Dates:

- Successful Phase I grantees have the option to propose a Phase II project for funding
- Final project report required for each grantee when their project complete

Performance Indicators (Outputs):

- Small businesses that participate in U.S. DOT's SBIR program develop numerous new and innovative technologies that benefit the department and the public.
- Number of small business initiatives in development.

Performance Goals (Outcomes):

- Increase percentage of SBIR programs that result in business growth and technological innovation.
- Stimulate technological innovation.
- Use small business to meet federal Research/Research and Development (R/R&D) needs.
- Foster and encourage participation by socially- and economically-disadvantaged small business companies (SBCs) and SBCs that are fifty-one percent owned and controlled by women, in technological innovation.
- Increase private sector commercialization of innovations derived from federal R/R&D, thereby increasing competition, productivity, and economic growth.

Project/Program Impact:

- Drive new business development and stimulate the growth of small business.
- Solve problems in the transportation industry through innovations driven by small businesses.
- Small businesses in America are engines of creativity and employment opportunities, but it can sometimes be difficult for small businesses to turn their innovations into reality. That is why U.S. DOT's highly competitive SBIR program awards contracts to small businesses to pursue research and development to find solutions to our nation's biggest transportation challenges.

FTA Funding 2016: $1,090,000

Table 12. *SBIR Projects Funded by FTA*

Small Business Innovation Research (SBIR) Projects			
Project Title	**Project Recipient**	**City and State**	**FTA Award**
Pedestrian and Cyclist Detection Devices for Buses	Novateur	Sterling, VA,	$149,927
Multi-pedestrian Counting System Using Fusion of Stereo Camera and Laser Scanner	Migma Systems	Walpole, MA	$749,999
Future SBIR project	Volpe Center	Cambridge, MA	$190,074
		Total	**$1,090,000**

Supporting Programs and Initiatives

Objective:

To help address cross-cutting issues associated with the three research priorities – Safety, Asset Management and Asset Innovation, and Mobility – and support research to practice implementation.

Description:

Programs under this section support FTA with dissemination, evaluation, and additional industry driven and selected research.

Outputs:

- Develop evaluation frameworks and models to evaluate the effectiveness of research projects, priorities, and programs within a three tiered concept.
- Support industry driven research projects.
- Disseminate research findings.
- Ensure accessibility and 508 compliance of all FTA documents that will be posted on the FTA website.

Outcome/Impact:

Evaluate the effectiveness of research programs and support research to practice to enable the public transit industry to improve operations, safety, asset management, leverage asset innovation, and enhance mobility. Overall, ensure that research advances public transportation innovation.

List of Projects: (3)

1. Information Dissemination and Evaluation Program
2. Workforce Development Program Evaluation and Dissemination
3. Transit Cooperative Research Program (TCRP)

Title*: Information Dissemination and Evaluation Program*

Grantee: University of South Florida, Tampa

Project Purpose:

The purpose of this program is to assist FTA in developing an evaluation framework for demonstration programs and projects as required by Federal public transportation law Act and to continue the information dissemination and communication outreach efforts by FTA. Federal public transportation law requires that, no later than two years after the date on which a project receives assistance under Section 5312, a comprehensive evaluation will be conducted to evaluate the success or failure of the project and any plan for broad-based implementation of the innovation promoted by successful projects. Evaluation activities also include the development of three frameworks to support FTA's three tiered evaluation concept. This program also includes the development of a five-year research strategic plan to define the priorities, goals, and objectives of FTA's research program, which provides technical assistance to FTA's program evaluation activities. This project also assists FTA in driving research to practice by disseminating the results and products of research and technology programs. Ensuring the development of useful materials and resources provides technical assistance to the public transportation industry to utilize the findings of research projects.

National Relevance:

The new five-year research strategic plan will chart a future within the horizon of the U.S. DOT's most recent five-year authorizing legislation and Federal public transportation law. The research strategic plan will guide investment priorities and funding decisions at FTA associated with advancing innovative public transportation research and development. Based on the priorities, goals, and objectives defined within the research strategic plan, TRI will create a framework for the evaluation of demonstration, deployment, and evaluation projects, an activity that is required under Federal public transportation law. With regard to dissemination, FTA-sponsored researchers produce a variety of reports on technologies and practices that can be used to improve public transportation. Effective dissemination of the findings of these reports is done through web-accessible reports and electronic messages.

Relevance to the Transit Industry and Community:

To ensure that its research program is relevant, timely, and effective in meeting the diverse and changing needs of the public transportation community, the development of the strategic plan will rely heavily on input from FTA's partners and stakeholders. Transit agencies and communities also benefit from prompt dissemination of FTA research information in clear, concise, and consistent

formats because it enables agencies to implement promising practices and acquire products/technologies that increase the efficiency, effectiveness, and quality of public transportation in our nation.

Expected Final Products and Delivery Dates:

- Five-year research strategic plan with clearly articulated priorities, goals, and objectives is expected by the end of December 2016.
- Tiered evaluation framework capable of assessing research results and outcomes at the project, portfolio, and program levels is expected to be complete by the end of June 2017.
- Evaluations of TRI demonstration, deployment, and evaluation projects may begin as early as September 2017 and continue through the duration of the project, until September 30, 2018.
- On an ongoing basis, project produces professionally-edited, Section 508-compliant, downloadable versions of FTA final reports that are available to the public through FTA's public website as well as several communication tools used by FTA that are consistent and meet current 508 compliance guidelines.

Performance Indicators (Outputs):

The program created templates for FTA research reports and presentations, research topic flyers, and newsletters; reviews, edits, designs, and makes FTA research reports for web distribution that are accessible to people with disabilities; and announces the availability of new reports. This project has produced more than 97 FTA final reports that are available to the public through FTA's public website and also has developed several communication tools such as PowerPoint templates and newsletters used by FTA that are consistent and meet current accessibility (508 compliance) guidelines. It also provides recommendations for process performance measures and began the development of an evaluation framework for research projects.

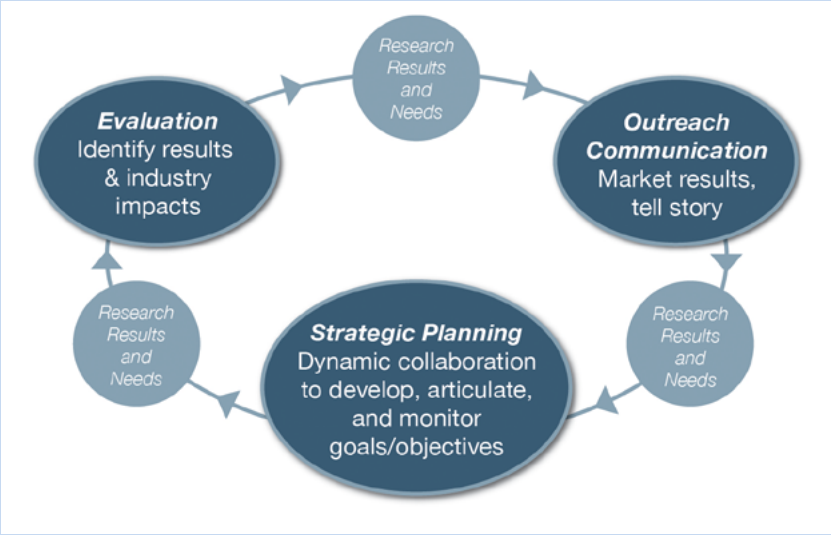
Performance Goals (Outcomes):

- FTA's research program will be relevant, timely, and effective in meeting the diverse and changing needs of the public transportation community.
- Investment priorities and funding decisions at FTA will be made strategically, i.e., guided by the research strategic plan.
- TRI will be able to evaluate demonstration, deployment, and evaluation projects, as required under Federal public transportation law.
- FTA will drive research to practice by effectively disseminating the results and products of FTA research and technology programs.
- FTA will increase the number of its web-distributed research reports that are accessible to people with disabilities.
- FTA program managers as well as grantees will be able to focus more on the technical content of reports rather than time consuming report production.

Project/Program Impact:

- FTA's research program enables agencies to implement promising practices and acquire products/technologies that increase the efficiency, effectiveness, and quality of public transportation in the U.S. Also, by conducting a comprehensive evaluation of the success or failure of the projects, FTA assures the effectives and efficiency of funding provided to its grantees.

FTA Funding: $700,000



The Information Dissemination and Evaluation Program is assisting FTA in creating a program evaluation using research methods to collect and analyze data to assess how well FTA's research program is working and why. Evaluations answer specific questions about program performance and may focus on assessing program operations or results. Evaluation results may be used to assess a program's effectiveness, identify how to improve performance, or guide resource allocation. As illustrated in this image, to create and sustain an integrated, seamless process of discovery and information sharing, FTA intends for the evaluation construct to be incorporated within a holistic outreach, planning, and evaluation model for FTA's research program. Accordingly, the development of the evaluation framework will be informed by the research priorities, goals, and objectives defined and articulated in the research strategic plan.

Title: *Workforce Development Program Evaluation and Dissemination*

Grantee: Axiom Corporation

Project Purpose:

FTA has awarded more than $20 million for the demonstration of successful Workforce Development/Ladders models and programs that have not been provided to the public for dissemination, review, use, or replication. The purpose of this project is to initiate evaluations for FTA's 2012 and 2015 awarded Workforce Development projects and determine the dissemination of workforce models for use by the transit industry. The evaluation will determine if the

individual projects met the deliverables/goals that were set for each respective activity as well as the grantee's ability to level investments of strategic partners and will showcase innovative methods of youth outreach. In addition, it will determine where the recipients have achieved performance measures and goals relating to recruitment, retention, and development of career pathways that support movement of targeted populations into career opportunities within transit. The recipient will inventory each project to determine trends, best practices, and recommendations for possible funding and priority areas of funding. Issues related to front-line workers will be highlighted and further examined. Finally, the recipient will provide technical assistance and support to FTA in the development of its first Workforce Strategic Plan as FTA develops its future workforce map. This evaluation will enable FTA to respond to Congressional requests, inquiries, and reports.

National Relevance of the Research:

With the resurgence of public transportation in recent years, transit systems face a number of challenges, including rapidly-changing technologies, an aging workforce, and retention of new and current employees. These challenges make attracting and preparing new talent increasingly important. To help address these challenges, in 2011, FTA initiated its Innovative Public Transportation Workforce Development program and provided a total of $20 million in three iterations. These funds have been used to provide training, curriculum development, community outreach, and job placement services. To date, a program evaluation has been conducted for all 2011 FTA Workforce Development projects; FTA's 2012 and 2015 Workforce projects have not yet been evaluated. This project will enable the FTA to conduct the evaluations.

Relevance to the Transit Industry and Community:

This project will enable FTA to showcase, through one mechanism, replicable models and lessons learned from the three unique workforce development competitions. This project provides an opportunity to showcase FTA's successes, as well as provide technical assistance on a new use of Federal public transportation law funds for workforce development activities.

Expected Final Products and Delivery Dates:

- Evaluation of FY 2012 Workforce projects, November 2016
- Evaluation of FY 2015 Workforce projects, December 2017
- Conduct meeting with industry partners to gain input into a Workforce Strategic Plan's goals and objectives, June 2017
- Develop dissemination mechanism for providing outreach to industry partners, June 2017

Performance Indicators (Outputs):

- Axiom developed a workforce trends report that provided information for one of FTA's workforce reports to Congress.
- Axiom collected initial information to support the evaluations for the FY 2012 and FY 2015 Workforce Projects. Additional items after the evaluations are finished will include recommendations and lesson learned in public transportation workforce development.

Performance Goals (Outcomes):

- Identify the most promising workforce practices and projects that can help public transit agencies recruit and retain workers – especially addressing frontline workforce shortages and increasing opportunities for diversity.

Project/Program Impact:

- This project will enable FTA to gain a return on its $20 million investment in 40+ Workforce Development projects. Such an evaluation will enable FTA to showcase and deliver models to stakeholders and industry partners, while providing ladders of opportunity to earning a living wage for members of the American workforce.

FTA Funding: $250,000

Title: *Transit Cooperative Research Program (TCRP)*

Grantee: National Academy of Sciences (NAS)

Project Purpose:

TCRP is a multidisciplinary industry driven research initiative crossing all of FTA's research priorities of improving safety, enhancing mobility, promoting asset management, and expanding asset innovation. The objectives of TCRP are to:

- Lead and complete research that is consistent with, and supportive of, FTA's strategic research goals and TCRP strategic priorities through a process guided by a broad group of industry stakeholders.
- Support the growth and continued excellence of the nation's public transportation infrastructure to meet the mobility, environmental, safety, and energy objectives of public transportation systems.
- Solve operating problems, help public transportation adapt to new technologies, meet service area/frequency needs, and introduce innovations into the transit industry.
- Field approaches to research that are local, problem-solving in nature, and are able to easily transfer into useful practice for public transit providers and the broader transportation industry.

The problem statement process results in a host of projects. TCRP's mission is to promote, select, and conduct research and disseminate research findings to improve the practice and performance of public transportation.

National Relevance of the Research:

TCRP is a yearly cooperative agreement with the NAS to carry out activities to support FTA's public transportation innovation projects, especially relating to ensuring research to practice and projects recommended by an independent governing board. 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.

Relevance to the Transit Industry and Community:

TCRP serves as one of the principal means by which the transit industry can develop innovative yet immediate solutions to the demands for service placed upon it. Through NAS projects, public transportation industry needs are identified and addressed through practical, applied research activities and products that public transportation providers can immediately use.

Expected Final Products and Delivery Dates:

- Reports published by TCRP, research reports, journals

Performance Indicators (Outputs):

- Number of problem statements
- Number of presentations that are done by TCRP
- Number of research programs selected by TCRP Oversight and Project Selection (TOPS) committee
- Number of research reports issued

Performance Goals (Outcomes):

- Every research project is used by the industry to address the problem noted.
- Project panels find that the contractor selected and the results of the request for proposals effectively address the research problem.
- Extent to which the panel agree that research projects in fact are successful.

Project/Program Impact:

- TRCP conducts research that solves the transit industry's business problems and supports research activities that directly support emerging challenges in the public transportation industry. TCRP is a continuing program of practical, operator-oriented, problem-solving applied research that examines short-term, high priority topics of common interest to the transit industry.

FTA Funding: $5,000,000

FY 2017 Budget: Proposed Allocation of Appropriated Funds

FTA has requested $28 million for Public Transportation Innovation research programs for FY 2017. This includes research projects that advance innovative public transportation in safety, mobility, asset management and asset innovation, and analyzing low or no emission vehicle components intended for use in low or no emission vehicles. Funding is also requested, per statute, to fund the National Academy of Science to administer a public transportation cooperative research program.

FY 2017 project ideas were developed through an open and participatory process. In FY 2017, a small number of critical projects were identified by FTA leadership for immediate funding. The remaining project ideas will be reviewed with the incoming administration and await selection. In the future, once new leadership is in place, FTA will share the draft research strategic plan, gather feedback, and refine based on that feedback. At that point, the remaining selections for FY 2017 funding will be completed. FTA will also continue to use the pipeline phased approach of public transportation innovation research, in combination with the new five year upcoming strategic plan in a dynamic and participatory way with strong public transit industry input. This process leverages the flexibility and discovery nature of research and the importance of broad stakeholder engagement to stay abreast of critical industry research needs.

Figure 3. *Pipeline Phased Approach of Public Transportation Innovation Research*

How Do We Know The Research Program Works?

To address Federal public transportation law research priorities, FTA's research portfolio is focused to:

- improve the delivery of efficient transit service that is safe;
- ensure expanded mobility for everyone, especially people with disabilities, older adults, and low-income populations;
- support effective asset management; and innovate to ensure environmentally sound LoNo vehicles.

As the primary source of public transportation assistance in the U.S., FTA and research partners funded under Section 5312 are in a unique position to lead

the industry to address emerging trends, overcome challenges, and support FTA's priority areas. FTA will also increase the research to practice activities to highlight research results so that public transportation agencies can put them into practice.

What Benefits Will Be Provided to the American Public through this Request?

The findings of FTA's research, innovation, and demonstration programs benefit riders, providers, and all members living in communities with public transit services. New safety technologies and solutions that public transit agencies can implement will mitigate injuries and fatalities. New, more energy efficient capital will continue to reduce harmful emissions and reduce energy costs.

Advancements in mobility through shared public and private services mean more people can get a ride when and where they need it. Operational processes that track important data for transit agency operational efficiency reduce provider costs. Innovations in capital stimulate the economy and boost private sector businesses. FTA's SBIR Program provides seed funding to launch entrepreneurial initiatives and create new jobs. The major benefits of public transportation innovative research is that FTA works to stay ahead of trends and ensure the long-term viability of public transit systems that constantly improve service to travelers and stimulate social, economic, environmental, and financial benefits for all transportation stakeholders.

Acronyms and Abbreviations*

ATTRI	Accessible Transportation Technology Research Initiative
BEERD	Bus Efficiency Enhancements Research and Demonstrations
CTE	Center for Transportation and the Environment
CUTR	Center for Urban Transportation Research at the University of South Florida
DBE	Disadvantaged Business Enterprise
DOE	Department of Energy
DOT	Department of Transportation
FAST	Fixing America's Surface Transportation Act (Public Law 114-94)
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
FY	Fiscal Year
GHG	Greenhouse Gases
HMD	Health and Medicine Division
HST	Human Service Transportation
ITS	Intelligent Transportation Systems
LoNo	Low or No Emission
MAP-21	Moving Ahead for Progress in the 21st Century Act (Public Law 112-141)
MARTA	Metropolitan Atlanta Rapid Transit Authority
MOD	Mobility on Demand
MSAA	Mobility Services for All Americans
NAS	National Academy of Sciences
NFCBP	National Fuel Cell Bus Program
NREL	National Renewable Energy Laboratory
R&D	Research and Development
R/R&D	Research/Research and Development
R2ZE	Race to Zero Emissions
REIL	Reduced Engine Idle Load
ROW	Right-of-Way
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (Public Law 109-59)
SBC	Small Business Company
SBIR	Small Business Innovation Research
SOW	Statement of Work
SRD	Safety Research and Demonstration
SRER	Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations
TCRP	Transportation Cooperative Research Program
TERM	Transit Economic Requirements Model
TMCC	Travel Management Coordination Center

TRAC	Transit Research Analysis Committee
TRB	Transportation Research Board
TRI	FTA's Office of Research, Demonstration, and Innovation
TSO	FTA's Office of Safety and Oversight
TVM	Transit Vehicle Manufacturer
VAA	Vehicle Assist and Automation
VTCLI	Veterans Transportation and Community Living Initiative

* *This list contains acronyms and abbreviations used more than once throughout the document.*

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