



U.S. Department of Transportation
Federal Transit Administration



FTA National Research Programs

Federal Transit Administration

“Delivering Solutions that Improve Public Transportation”



ANNUAL RESEARCH REPORT 2009

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Introduction

I am pleased to present to you FTA's Annual Research Report for FY 2009. Like last year's report, this one highlights many of the significant achievements the Office of Research, Demonstration, and Innovation (Research Office) has made this past year in support of FTA's vision to "Deliver Solutions that Improve Public Transportation."

In FY 2009, the Research Office completed strategic plans for the International Mass Transit Program and Intelligent Transportation Systems (ITS) Transit Research Program. The Research Office also published the following important reports:

- *Feasibility Study on the Use of Personal GPS Devices in Paratransit*
- *Washington State Ferries Wireless Connection High Speed Data Project*
- *Side Object Detection Systems (SODS) Evaluation Report*
- *Efficient Deployment of Advanced Public Transportation Systems (EDAPTS) Project*
- *Light Rail Vehicle (LRV) Active Bumper Prototype Study*
- *Regional Rail On-board Electronic Payment Project Report*
- *A Report on Worldwide Hydrogen Bus Demonstrations, 2002 – 2007.*

The success of FTA's National Research Program in FY 2009 is a testament to the hard work and quality of the researchers and support staff in the Research Office. By working closely with customers and stakeholders, the Research Office remains committed to developing and executing a comprehensive transit research program that delivers results to the American public and provides practical solutions to the transit community.

Given the large number of research projects underway in the Research Office, this report can highlight only some of them. I encourage you to visit the Research, Technical Assistance & Training section of FTA's public website at <http://www.fta.dot.gov/research.html> to learn more about the Research Office's many programs.



Vincent Valdes
Associate Administrator for
Research, Demonstration, and Innovation

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Highlights and Expectations

This annual report is prepared for public transit agencies, congressional committees and staff, public transit business leaders, public transit researchers, DOT modal administrations, and FTA staff. Many of the projects highlighted in FY 2009 will continue in FY 2010 and beyond.

Highlights from 2009

In FY 2009, the Research Office completed strategic plans for its International Public Transportation Program and for its Intelligent Transportation Systems (ITS) Research Program.

The Research Office also completed the light rail vehicle (LRV) active bumper prototype study, developed a functional prototype of a low-floor small bus for rural transportation, and developed and piloted a training course for state safety oversight (SSO) of rail transit systems.

In addition, in FY 2009, the Research Office published the following important research reports:

- *Feasibility Study on the Use of Personal GPS Devices in Paratransit*
- *Washington State Ferries Wireless Connection High Speed Data Project*
- *Side Object Detection Systems (SODS) Evaluation Report*
- *Efficient Deployment of Advanced Public Transportation Systems (EDAPTS) Project*
- *Light Rail Vehicle (LRV) Active Bumper Prototype Study*
- *Regional Rail On-board Electronic Payment Project Report*
- *A Report on Worldwide Hydrogen Bus Demonstrations, 2002 – 2007.*

Expectations for 2010

The Research Office will continue to examine how it can better provide national research leadership to the public transit community. As part of this effort, the Research Office will produce the *FTA Multi-Year Research Program Plan (FY10 – FY14)*. The Research Office will also review its current *Strategic Research Plan* to ensure that it continues to support FTA and DOT strategic goals and objectives.

In addition, in 2010, the Research Office expects to:

1. Performance test the Proterra Inc. fuel cell bus in British Columbia during the 2010 Winter Olympics
2. Publish the final rule 45 Code of Federal Regulations (CFR) Part 665, Bus Testing, adding braking performance and emissions tests to the existing tests under the bus testing program
3. Sponsor three transit stakeholder workshops to support safety and mobility under the IntelliDrive program, and begin plans for a test-bed demonstration in the San Francisco area

4. With the National Transit Institute (NTI), the American Public Transportation Association (APTA), and others, sponsor workshops, webinars, and training to raise awareness of the Federal Communications Commission's (FCC) narrowbanding requirements¹
5. Publish the results of the integrated corridor management (ICM) demonstration program, select two sites for full-scale ICM system deployment, and complete design of the two systems
6. Develop a procurement and implementation resource document for public transit operations decision support systems (TODSS)
7. Deploy two travel management coordination centers (TMCC) to demonstrate the efficacy of ITS and the scalability of "one-call" centers
8. Publish a report about customer satisfaction with kiosk services at bus and rail stations and airports
9. Complete system evaluations and publish final reports for the Los Angeles Orange Line and the Cleveland Health Line bus rapid transit (BRT)
10. Publish a LRV interior passenger protection guidelines study
11. Publish the *Transit Greenhouse Gas Management Compendium*
12. Complete more than 20 voluntary standards documents for public transit systems
13. Participate in the 2010 International Transportation Forum in Leipzig, Germany
14. Sign a United States–France Urban Mass Transportation Memorandum of Cooperation and select technical areas for discussion
15. Initiate development of public transportation standards with the Ministry of Transport of the People's Republic of China
16. Host a delegation from Maharashtra, India, learning about U.S. public transit organizations, planning, and development processes.

In addition, as a direct result of its participation in the Research Office's National Fuel Cell Bus Technology Development Program (NFCBP), Proterra Inc. is expected to open an advanced technology bus manufacturing facility in Greenville, SC. The facility will provide up to 1,200 jobs.

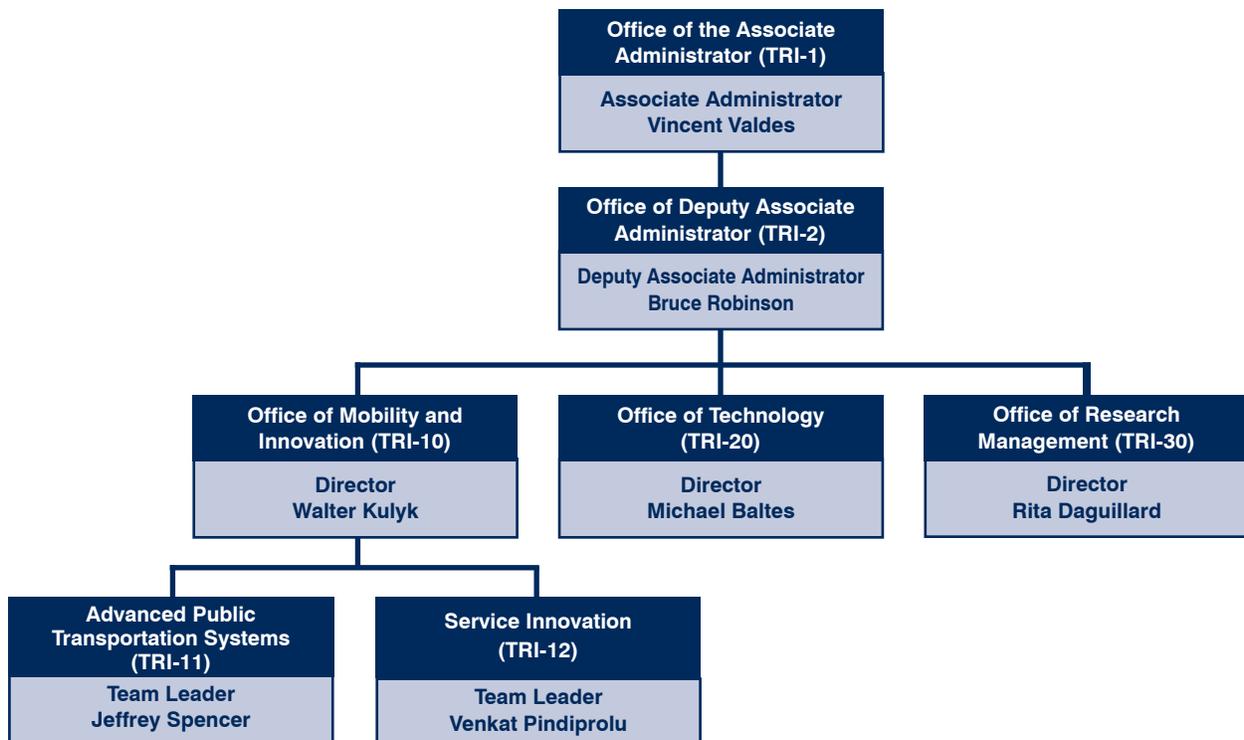
¹FCC Order 05-9, WT Docket No. 96-86, January 7, 2005: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-9A1.pdf. FCC Order 04-292, WT Docket No. 99-87 and RM-9932, December 23, 2004: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-292A1.pdf. FCC Report and Order 05-69, ET Docket No. 04-243, March 11, 2005: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-69A1.pdf.

The Office of Research, Demonstration, and Innovation

Responsible for maintaining the national perspective for public transit research, the Research Office manages and oversees FTA's transit research program and provides industry and policy-makers with the information and skills to make good business decisions about investments in technology, capital, and operations.

The Research Office has seven divisions that administer and oversee FTA's overall research agenda and disseminate research results and information to the public transit community.

FTA Office of Research, Demonstration, and Innovation



Progress toward Strategic Research Goals

The Research Office has 3 specific goals and 12 objectives for a comprehensive national transit research program aligned with industry and public needs as well as DOT's strategic goals. In 2009, FTA successfully completed projects under each of these goals. Descriptions of selected projects in progress and completed in 2009 are provided below, indexed by FTA strategic research goal and objective.

Goal 1: Provide national transit research leadership

Goal 1 Objectives

- 1.1 Provide vision and prepare the nation for transit advancements
- 1.2 Explore strategic partnerships to achieve transit research goals
- 1.3 Synthesize research results to provide useful bodies of knowledge for transit industry decision makers and to shape the national transit research agenda

As the only federal agency with responsibility for assisting with the operation, maintenance, and growth of the nation's public transit systems, FTA is responsible for addressing public transit research from a national perspective. Further, FTA research programs must support national multimodal transportation goals. FTA coordinates its research with other DOT modal administrations such as the Federal Highway Administration (FHWA). In addition, because FTA's research funds are limited, FTA contributes to, leverages, and builds on the research of others. Besides leading and supporting domestic research, FTA also shares international best practices with the U.S. public transit industry and provides decision-makers with the tools and information needed to make informed decisions.

In FY 2008, the Research Office worked with the public transit industry to complete the strategic plan for its Electric Drive Research Program. The *Electric Drive Strategic Plan* (EDSP) was the initial step in developing a body-of-knowledge for electric drive transportation (bus and rail) for the transit industry. In 2009, the Research Office began synthesizing and incorporating the results of the research outlined in the EDSP into a body-of-knowledge which, when complete, will guide future research and research planning for FTA.

In 2009, the Research Office completed strategic plans for the ITS Research Program and International Public Transportation Program. The Research Office will use strategic planning over time to support the development of bodies of knowledge for all areas of its transit research, including information dissemination.

Highlights of FY 2009 Accomplishments

Objective 1.1 Provide vision and prepare the nation for transit advancements

Laying Out the Public Transit Research Agenda. The *FTA Multi-Year Research Program Plan (FY10 – FY14)* provides descriptive summaries of existing and proposed research products and links them to the goal and objectives of FTA’s Strategic Research Plan.

Transit Research Analysis Committee. The Transit Research Analysis Committee (TRAC) provides independent review and assessment of FTA’s research agenda. TRAC also works with the Research Office to recognize and respond to changing research needs affected by changing social, economic, and environmental conditions. In 2009, the Research Office met twice with TRAC to discuss FTA’s current research programs and processes.

ITS Strategic Plan

Completed in FY 2009, the *ITS Strategic Plan* establishes a 20-year ITS vision, sets strategic research goals and objectives for the next five years, and identifies research needs and success metrics. The Plan is based on literature reviews and outreach meetings with the transit industry in several venues, including the APTA Bus and Paratransit Conference, APTA Rail Conference, ITS America Annual Meeting, Texas Transportation Summit, and a Talking Technology and Transportation (T3) webinar. Goals include:

- Safety – Reductions in public transit-related vehicle crashes, fatalities, injuries, and property damage.
- Mobility – Increases in mobility and enhanced systems performance. Increases in service coverage without fleet expansion.
- Environmental Stewardship – Reductions in fuel use and in green house gases (GHG) and other pollutants due to “transit as a first choice.”
- Security – Increases in use of technologies to protect public transit information, networks, and assets as well as customer and employee security.
- Livability – Increases in community livability standards through accessible, high-quality, responsive public transit.

The *ITS Strategic Plan* is the second in a series of research-driven strategic plans that FTA has undertaken. The first, completed in FY 2008, was the EDSP.

IntelliDrive. In 2009, the Research Office completed a program plan for transit IntelliDrive that outlined proposed development and testing of transit-related ITS applications, and formed the IntelliDrive steering committee, a stakeholder group to coordinate and share research with the public transit industry.

Objective 1.2 Explore strategic partnerships to achieve transit research goals

United States and China Reach Consensus for Technical Work. In June 2009, the Research Office met with representatives from the Urban Congestion Working Group of the U.S.–China Transportation Forum and agreed to work in the following technical areas: public transit policy to reduce congestion, development of public transit standards, BRT, ITS services, logistics distribution management, and management of operational safety.

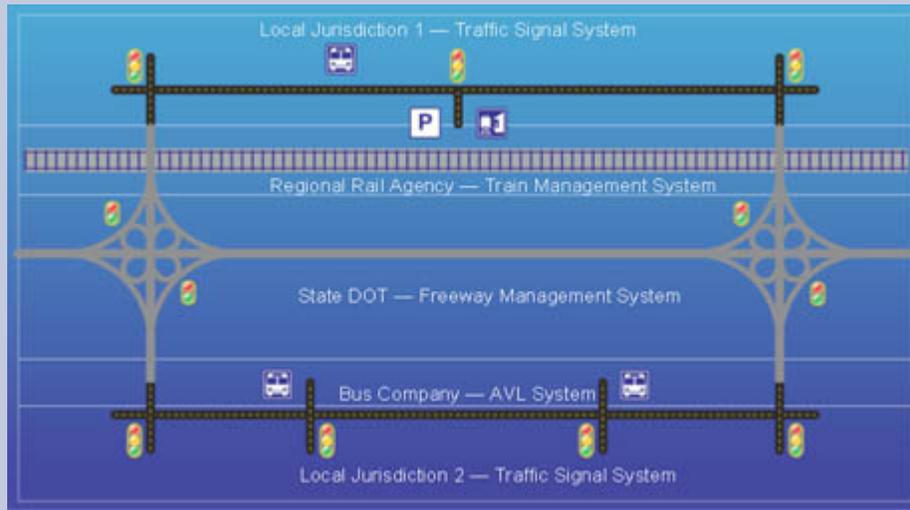
Joint Council on Transit Wireless Communication. Staff from the Research Office are chairing the Industry Committee of the Joint Council on Transit Wireless Communication. The committee considered the impacts of Federal Communication Commission’s (FCC) narrow banding requirement on public transit land-mobile radios.

Conference on United Nations Treaty. In July 2009, the Research Office collaborated with the U.S. International Council on Disabilities (USICD) and APTA to host a conference on the United Nations Convention on the Rights of Persons with Disabilities. The conference brought together international perspectives on the drafting, ratification, and implementation process of the treaty. Participants gained an understanding of the treaty; its history, context, and status; the substantive content of the convention; and the opportunities for implementation.

Integrated Corridor Management

In May 2006, DOT’s then-Secretary Norman Mineta announced a national strategy to reduce congestion within the U.S. transportation network. This strategy provided the framework for the government, private sector, and public users to eliminate traffic congestion. ICM is a five-year DOT program (FY 2006 – FY 2011) to evaluate ITS concepts and technologies that improve productivity of existing transportation systems to reduce traffic congestion.

Many cities have invested significant resources in ITS infrastructure for highways and public transit systems. The ICM program is leveraging this investment to operate transportation systems in a coordinated manner that encompasses technical, operational, and institutional coordination. Concepts and technologies being tested include providing real-time traveler information, multi-modal operations, and technologies to reduce congestion. DOT is currently developing and demonstrating these concepts and technologies in corridors at eight “pioneer” sites: Dallas; Houston; Minneapolis; Montgomery County, MD; Oakland, CA; San Antonio; San Diego; and Seattle.



This example corridor shows the multi-modal nature of ICM.

Figure adapted from U.S. Department of Transportation (DOT) Research and Innovative Technology Administration (RITA) Intelligent Transportation System (ITS) at http://www.its.dot.gov/icms/about_icm.htm.

In October 2008, DOT held a workshop with the pioneer sites to discuss demonstration plans; experimental plans for site tests; and examination of transit and arterial data gaps, decision support systems, and center-to-center communication standards. DOT plans to test a modeling process for ICM strategies and scenarios using operational data collected from 3 of the 8 pioneer sites: Dallas; Minneapolis; and San Diego. This real-world test will enable DOT to assess the potential impacts from a demonstration of an ICM system and to validate the ICM analysis, modeling, and simulation (AMS) process.

In September 2009, ICM and the three AMS sites (Dallas, Minneapolis, and San Diego) were featured at the Transportation Research Board's (TRB's) Integrated Corridor Systems Management Best Practices Workshop, where experts discussed challenges, limitations, lessons learned, and next steps with ICM.

Measuring performance with ICM was also a topic at the ITS World Congress in September 2009 in Stockholm, Sweden, where participants discussed developing measures of effectiveness for corridor performance in order to identify the most effective ICM strategies for combatting congestion, maintaining mobility, managing traffic, and encouraging mode shift to public transit.

Developing Sustainable Transportation Systems. In August and September 2009, the Research Office conducted multi-modal transportation workshops in Arusha, Tanzania, and Windhoek, Namibia. The East African Community in Tanzania and the Technology Transfer Centers in Namibia recommended the topics. They included congestions relief, highway and pedestrian safety, multimodal freight shipment, project financing, and technology transfer.

Virtual Trade Mission Webinar. In September 2009, the Research Office conducted its first virtual trade mission webinar, which featured public transit business opportunities in Brazil. The webinar was a pilot for potential future webinars that the Research Office will organize in cooperation with APTA and the U.S. Commercial Service (USCS) to identify public transit business opportunities in other countries. FTA's Research Office, APTA, USCS, and the Brazilian Ministry of Transport were among the participants knowledgeable about trade issues and upcoming tenders.

Local and Regional Funding Mechanisms for Public Transportation. Transit Cooperative Research Program (TCRP) Report 129, *Local and Regional Funding Mechanisms for Public Transportation*, discusses funding mechanisms focused on traditional tax- and fee-based funding and common business, activity, and related funding sources. It includes a comprehensive list of funding sources that are in use or have the prospect of being used at the local and regional levels to support public transit. An online regional funding database and user's guide is also provided.

Transit Systems in College and University Communities. TCRP Synthesis 78, *Transit Systems in College and University Communities*, addresses local and regional transportation systems that serve college and university campuses and describes practices and trends in campus public transit operations, policies, and planning, with a focus on technology and environmental innovations. The report also examines innovative partnership strategies to enhance public transit services for students, faculty, staff, and surrounding communities.

Objective 1.3 Synthesize research results to provide useful bodies of knowledge for transit industry decision-makers and to shape the national transit research agenda

Low-Speed Urban Maglev. In 1999, the Research Office initiated a low-speed urban magnetic levitation (UML) program to develop magnetic levitation (Maglev) technology that offers a cost-effective, reliable, and environmentally sound public transit option for urban public areas in the United States. The Research Office selected five projects for funding under the program: General Atomics Urban Maglev; Maglev 2000 of Florida Corporation; Colorado Department of Transportation; Maglev Urban System Associates of Baltimore, MD; and MagneMotion, Inc.

The UML program is nearing completion; to capture the lessons learned, the Research Office assessed the projects, including team performance, stakeholder participation, risk management, and communications, and summarized the results in *FTA Low-Speed Urban Maglev Research Program: Lessons Learned*.

Integration of Paratransit and Fixed-Route Transit Services. TCRP Synthesis 76, *Integration of Paratransit and Fixed-Route Transit Services*, highlights the experiences of public transit agencies seeking to integrate their fixed-route and paratransit services, including the provision of paratransit feeder services, community buses or circulators, connectors, fixed-route fare incentives, and route deviation. Although it emphasizes feeder and community services, it also discusses other methods for shifting potential paratransit riders to less costly modes. Almost always, the need to manage costs drives setting up integrated services. This synthesis can help the public transit industry understand how the appropriate use of integrated services may help accomplish their mission.

Synthesis of Information Related to Transit Problems. Public transit agency managers, engineers and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information sometimes is fragmented, scattered, and unevaluated. As a consequence, public transit agencies frequently do not have full knowledge about the appropriate solution to apply to a problem. Costly research findings go unused, valuable experience is overlooked, and due consideration is not given to recommended practices for solving or alleviating problems. Each TCRP synthesis addresses, in compact format, the current knowledge and practices surrounding a single problem. TCRP Research Results Digest 91, *Synthesis of Information Related to Transit Problems: 2009*, is an index to syntheses in progress and to the full list of TCRP syntheses.

Track Maintenance Costs on Rail Transit Properties. TCRP Web-Only Document 43, *Track Maintenance Costs on Rail Transit Properties*, discusses public transit agency practices, innovations, and lessons learned in track maintenance costs. It identifies factors that influence these costs, including track inspection and maintenance policies, availability of capital and operating funds, operating characteristics and work windows, and labor and material costs. It presents information useful for public transit agency managers, maintenance and operations staff, and other professionals in developing programs for managing track maintenance costs.

New Ideas for Transit. *New Ideas for Transit: Transit IDEA Program Annual Progress Report 2009* describes the projects funded by the Innovations Deserving Exploratory Analysis (IDEA) program. IDEA supports development of innovative concepts and methods for advancing transit practice. The program funds applied research and development to improve the efficiency, safety, security, maintenance, and ridership of transit systems. For 2009, the four Transit IDEA Program high-priority areas were: (1) increasing transit ridership; (2) improving transit safety, security, or emergency preparedness; (3) improving transit capital and operating efficiencies; and (4) protecting the environment or promoting energy independence. The report includes a list of completed IDEA projects, including summaries of results and potential payoffs.

Goal 2: Support increasing transit's market share

Goal 2 Objectives

- 2.1 Identify methods to increase transit system capacity
- 2.2 Investigate methods to reduce the time needed to plan and build infrastructure
- 2.3 Perform research to improve the rider experience

Goal 2 recognizes and draws attention to a growth area for public transit. Increasing transit's market share from 1.7 percent of all trips and 4.7 percent of commuter (work) trips is important because public transit facilitates a range of societal benefits. These benefits include increasing mobility, improving safety, reducing air pollution, and improving energy efficiency. Increasing mode share also supports the DOT's national initiative to address congestion,² because private vehicles generate more than 32 percent of all U.S. carbon emissions, cost the average U.S. household more than 18 percent of its income each year, and annually cost the U.S. economy more than \$87 billion in lost productivity and fuel.

Highlights of FY 2009 Accomplishments

Objective 2.1 Identify methods to increase transit system capacity

Providing Access to Public Transportation Stations. TCRP Web-Only Document 44, *Literature Review for Providing Access to Public Transportation Stations*, contains the results of a literature review of alternatives for station access for both new and mature high-capacity public transit systems, including heavy rail, light rail, commuter rail, and bus rapid transit. It is divided into six sections: (1) access issues and agency guidelines for transit access; (2) evaluation tools; (3) transit-oriented development; (4) park-and-ride/kiss-and-ride; (5) transfer feeder access; and (6) pedestrian and bicycle access.



Houston METRO LRT provides convenient downtown service.

² National Strategy to Reduce Congestion on America's Transportation Network. DOT. May 2006.

Objective 2.2 Perform research to improve the rider experience

Increasing Transit Advertising Revenues. Public transit advertising is currently less than 0.5 percent of U.S. advertising spending. As a small source of operating revenue for transit agencies, transit advertising has traditionally not received much attention. However, with the current shift of media dollars out of traditional media such as television, transit agencies may be able to leverage advertising assets to contribute more to operating revenues. TCRP Report 133, *Practical Measures to Increase Transit Advertising Revenues*, discusses strategies to increase transit's share of total advertising dollars. It examines advertising decision makers' perceptions about current and future public transit advertising products and highlights a strategic responsive communications plan designed to improve those perceptions and increase public transit revenue.

Objective 2.3 Investigate methods to reduce the time needed to plan and build infrastructure

Traveler Information Systems. In 2009, the FTA deployed, demonstrated, and evaluated a multi-modal trip itinerary traveler information system called Goroo. The system provides side-by-side comparisons of trip itineraries using transit, driving, or a combination of non-motorized modes comprising biking and walking. It is the first web-based door-to-door multi-modal trip planner in the United States. Goroo was developed and demonstrated at Chicago's Regional Transportation Authority (RTA) to provide regional coverage of the six-county RTA region of Northeast Illinois.



Senior citizens in Richmond, VA, plan their trip on GRTC Transit System's trip planner.

Miami Urban Partnership Agreement. Three premises drive Urban Partnership Agreement (UPA) projects: (1) UPA projects will enhance public transit performance through reduced travel times, increased reliability, and increased capacity; (2) UPA projects will change service usage, increasing ridership and facilitating a mode shift to public transit; and (3) UPA projects will contribute to congestion reduction. In 2009, the Research Office completed the *Miami Urban Partnership Agreement (UPA) Project: Phase 1A – Transit Evaluation Report*, which concluded that the Miami UPA project decreased travel times and increased public transit ridership in the corridor where it was implemented, but had no significant impact on mode share.



Double tracking along the South Florida rail corridor provides for more trains, reduced times between trains, and shorter travel times for commuters.

Electronic Fare Collection for Commuter Rail.

Electronic Fare Collection Options for Commuter Railroads presents six case studies of commuter railroad's experiences in adopting automated fare collection (AFC): New Mexico Rail Runner Express; Virginia Railway Express; Sounder Commuter Rail; San Diego Coaster; Metropolitan Transit Authority New York – Metro-North; and Shore Line East. The lessons learned from these case studies will be useful to public transit agencies considering a move to AFC.

Refurbishment of the 74th Street and Roosevelt Avenue subway station in Queens, NY, included expansion of the Interborough Rapid Transit mezzanine.



Regional Rail On-Board Electronic Payment. The regional rail on-board electronic payment project is a joint effort between Southeastern Pennsylvania Transportation Authority (SEPTA) and Temple University to test the feasibility of electronic fare payment on commuter rail service using a system of hand-held devices that communicate with contactless smart cards. The project used open source software and commercial off-the-shelf equipment to effectively build a simple firmware transit payment system that captures fare payment transactions, stores the information, and downloads the information to a central database. The resulting report, due in FY 2010, will be of interest to transit operators and planners responsible for fare payment and collection.

California Smart Traveler. EDAPTS projects make ITS more available and affordable to small transit systems by providing examples of commercial off-the-shelf ITS systems that meet small public transit agency needs. The California smart traveler project developed an ITS system for the Bronco Express service at California State Polytechnic University (Cal Poly) in Pomona, CA. This system, which is operational, consists of automatic vehicle location and real-time automatic passenger counting capabilities on the Bronco Express fleet, real-time bus location information via the Internet (<http://bruncoshuttle.com>), and dynamic message signs at four bus stops on the Cal Poly campus.

Goal 3: Support improving the condition of transit operations and systems

Goal 3 Objectives

- 3.1 Perform research to improve capital and operating efficiencies
- 3.2 Perform research to improve transit planning and forecasting
- 3.3 Perform research to improve mobility, rural services, and services for targeted populations
- 3.4 Investigate the use of high-efficiency technologies and alternative energy sources
- 3.5 Perform research to reduce transit environmental impacts
- 3.6 Perform research to improve safety, security, and emergency preparedness

Both federal and local governments have invested billions of dollars in U.S. transit systems. These assets must be maintained and smartly expanded to accommodate growing demand for safe, reliable, and affordable public transit, as well as a cleaner environment.

Over the past 15 years, public transit construction costs have escalated rapidly. The American Association of State Highway and Transportation Officials (AASHTO) estimates that construction costs increased nearly 30 percent between 1993 and 2006, and projected that this increase will reach nearly 50 percent by 2010. Public transit operations also face considerable challenges to controlling costs. Primarily due to the addition of new fixed guideway systems and the expansion of existing ones, from 1999 to 2008, operating expenses increased nearly 38 percent to a total of \$26.6 billion.³ The public transit industry needs information to make appropriate decisions on service operations.

Transit agencies have increasingly focused on incorporating new fuels and propulsion technologies to make their systems cleaner and more efficient and to reduce fuel consumption. Alternative fuels and hybrid technologies can also significantly improve operational efficiency.

Although public transit is important for rural America's 30 million transit-dependent persons, currently, 40 percent of America's rural populations have no access to public transit, and another 24 percent have very little access.⁴ The public transit industry needs information to address cost-effective service in rural areas as well as services for targeted populations.

Public transit continues to be one of the safest modes of travel in the United States. Unfortunately, in 2007, public transit agencies reported 288 fatalities. In addition, fatalities associated with commuter rail rose to 124, the highest number in more than 15 years.⁵ Thus, safety remains a top priority for the Research Office, FTA, transit operators, and Congress.

Security involves protection against an intentional act of violence or personal harm from a criminal or terrorist act. By statute, lead responsibility for public transportation security against terrorism threats rests with the U.S. Department of Homeland Security (DHS). FTA works closely with DHS to address protection and preparedness related to terrorism threats. Criminal acts against transit passengers, employees, or property, are addressed directly by the Research Office. In recent years, emergency preparedness for natural disasters has also become a high priority.

Highlights of FY 2009 Accomplishments

Objective 3.1 Perform research to improve capital and operating efficiencies

American Public Transportation Association Recommended Practices. APTA is the designated standards development organization for public transit. APTA currently has 22

³ 2008 National Transit Summaries and Trends. <http://www.ntdprogram.gov/ntdprogram/pubs/NTST/2008/pdf/2008%20National%20Transit%20Summaries%20and%20Trends-Complete.pdf>.

⁴ American Public Transportation Association. 2008. 2008 Public Transportation Fact Book. June.

⁵ Transit Safety and Security Statistics and Analysis Annual Report, Fatalities by Mode and Year. Available at <http://transit-safety.volpe.dot.gov/Data/samis/default.asp?ReportID=2>.

working groups developing all types of standards and recommended practices for bus and rail transportation. In FY 2009, the Research Office provided \$1 million in funding to APTA for the continued development of industry standards (non-ITS) and recommended practices for safe, efficient, and secure transit operations.

In 2009, APTA published security-related recommended practices (RP) in security emergency management (SEM) and security risk management (SRM), as follows:

- General Guidance on Transit Incident Drills and Exercises, APTA-SS-SEM-RP-004-09
- Developing a Contagious Virus Response Plan, APTA-SS-SEM-RP-005-09
- Shelter of Transit Vehicles and Nonrevenue Equipment During Emergencies, APTA-SS-SEM-RP-006-09
- Creating an Alternate or Backup Operations Control Center, APTA-SS-SEM-RP-007-09
- Safe Mail and Package Handling, APTA-SS-SEM-RP-008-09
- Emergency Communication Strategies for Transit Agencies, APTA-SS-SEM-RP-009-09
- Developing a Transit Agency Emergency Management Plan, APTA-SS-SEM-RP-010-09
- Participating in Mutual Aid, APTA-SS-SEM-RP-011-09
- Responding to Threat Condition Levels, APTA-SS-SEM-RP-012-09
- Development and Implementation of a Security and Emergency Preparedness Plan (SEPP), APTA-SS-SRM-RP-001-09
- Conducting Nonrevenue Vehicle Security Inspections, APTA-SS-SRM-RP-003-09
- Identifying Suspicious Behavior in Mass Transit, APTA-SS-SRM-RP-009-09
- Conducting Revenue Vehicle Security Inspections, APTA-SS-SRM-RP-012-09.

APTA's RPs in security are available at <http://www.aptastandards.com/PublishedDocuments/PublishedStandards/Security/tabid/271/Default.aspx>.

Six Sigma for Rail Transit Systems. Transit Six Sigma “is a philosophy about how to link transit agencies intra-departmental processes with inter-departmental processes to execute organizational functions that enable a transit agency to provide effective and efficient customer-focused transit services in a cost-effective manner that maximize [sic] return on capital employed and return on investment of public dollars provide [sic] by FTA.”⁶ This research developed a technical solution for improving the effectiveness of rail transit operations using the Six Sigma method. *A Transit Methodology Using Six Sigma for Heavy Rail Vehicle Maintenance Programs* describes the research steps and the case study for implementing Six Sigma to increase productivity in a public transit environment to improve and sustain capital and operating efficiencies.

⁶ Cook, Kenneth R. and Wendy Tyson-Wood. 2009. *A Transit Methodology Using Six Sigma For Heavy Rail Vehicle Maintenance Programs*. Final Report. August.

Transit Operations Decision Support System (TODSS). TODSS supports dispatchers and other real-time operations managers in responding to incidents, special events, and other conditions to improve operating speeds, reduce passenger wait times, and restore public transit service when disruptions occur. Based on requirements developed by the public transit industry, the Research Office developed and demonstrated a prototype TODSS at Pace Suburban Bus Service. *Transit Operations Decision Support System (TODSS) Core Requirements Evaluation and Update Recommendations* documents the evaluation of this demonstration, including recommended changes and lessons learned for the transit industry to better understand TODSS core requirements for future implementations. The Research Office also presented a T3 webinar to provide the public transit industry and public with information on the project results.



The New York City Transit rail control center will revolutionize control center operations.

Low Cost Carbon Fiber Technology. Using pitch⁷ as the raw material, FTA developed a low-cost carbon fiber for commercial applications. Many technologies that currently use other synthetic fibers can use high-strength, lightweight, low-cost carbon fibers to reduce weight and improve performance. Low-cost carbon fiber is advantageous for most vehicles, including lightweight automobiles, buses, trains, aircraft, and ships. It also can be used for lightweight body panels and load bearing structures to affect weight and energy savings.

Bus Solutions Prototype. Lightweight modular manufacturing methods can reduce the capital and maintenance costs of public transit vehicles while improving fuel economy and reducing emissions. Automation Alley and Altair Engineering ceased work on its traditional diesel engine and transmission powertrain to pursue a series diesel-hydraulic-hybrid powertrain concept.



Articulated buses operate in downtown Eugene, OR.

Altoona Bus Testing Center. FTA's Altoona Bus Testing Center tests new bus models for maintainability, reliability, safety, performance (including braking performance), structural integrity, fuel economy, emissions, and noise in accordance with 49 CFR Part 665, Bus Testing, and provides test reports to the public. In FY 2009, the center completed installation and commissioning of a testing laboratory to support new tests for emissions and braking in anticipation of the final rule updating FTA's bus testing regulation.

⁷ Pitch is a thick, dark substance commonly used for waterproofing, roofing, caulking, and paving.

National Bus Rapid Transit Institute

The National Bus Rapid Transit Institute (NBRTI) conducts research and disseminates information on BRT operations, including coordinating webinars; publishing a quarterly newsletter; maintaining an information clearinghouse and website; supporting BRT conferences, workshops, and training; and publishing evaluation and research reports.

In 2009, NBRTI conducted a webinar describing the leading service and technical attributes of BRT, supported BRT conferences in six U.S. cities, participated in international information exchange site visits, published three evaluation and research reports, and revised BRT training materials to reflect new information. NBRTI also continued evaluation of BRT operations for the Los Angeles Orange Line and the Cleveland Healthline BRT systems.

The three reports published by NBRTI in 2009 are:

- 1 *Characteristics of Bus Rapid Transit for Decision-Making*. This report describes the physical, operational, cost, performance, and potential benefits of BRT's constituent elements as integrated systems.
- 2 *Quantifying the Importance of Image and Perception to Bus Rapid Transit*. This report identifies the underlying tangible and intangible factors that drive perceived differences between BRT and other forms of rapid transit.
- 3 *The EmX Franklin Corridor BRT Project Evaluation*. This report describes the performance of the Eugene, Oregon, BRT system and operations.

Following publication of *Characteristics of Bus Rapid Transit for Decision-Making*, NBRTI revised "Characteristics and Planning of Bus Rapid Transit" training to reflect new information from the report. The NTI conducts this training.



Eugene, OR, operates a bus rapid transit line with dedicated busways.

Vehicle Assist and Automation Demonstrations. Vehicle assist technologies help drivers maintain lateral control of a bus. Vehicle automation technologies assist with both longitudinal and lateral control. In FY 2009, the Research Office created a vehicle assist and automation (VAA) advisory panel to share information about VAA applications with the public transit industry. A kickoff workshop provided information for three new VAA demonstration projects: Alameda-Contra Costa Transit District (AC Transit) and Lane Transit District VAA applications; Minnesota Valley Transit Authority driver assist system; and San Diego Association of Governments bus on shoulder service.

Construction Project Management Handbook

The *Construction Project Management Handbook* is a comprehensive introduction to construction project management, including the application of the principles of project management and all phases of project development. It provides information for public transit agencies undertaking multimillion-dollar construction projects either for the first time or with little prior experience with construction project management. It is tailored for public transit agencies that are constructing maintenance and operational facilities, intermodal terminals, park-and-ride stations, and other large supporting transit facilities. Project management concepts are illustrated using hypothetical examples for a typical project to plan, design, and build a new bus maintenance facility.

Because it covers project initiation and planning, environmental clearance, real estate acquisition, design, construction, commissioning, and closeout, transit agencies can use the *Construction Project Management Handbook* to help with all aspects of specification, acquisition, and management of contracts for large construction projects.



Construction of the new Grand Avenue Depot and Central Maintenance Facility in Queens, NY, began in 2004.

Shared Use of Railroad Infrastructure with Noncompliant Public Transit Rail Vehicles.

TRCP Report 130, *Shared Use of Railroad Infrastructure with Noncompliant Public Transit Rail Vehicles: A Practitioner's Guide*, examines a business case for the shared use of non-Federal-Railroad-Administration-compliant public transit rail vehicles (e.g., light rail vehicles) with freight operations and highlights a business model for such shared-use operations. The report also explores potential advantages and disadvantages of shared-use operations and the issues and barriers that can arise in the course of implementation.

Evaluation of Project Delivery Methods. TCRP Report 131, *A Guidebook for the Evaluation of Project Delivery Methods*, describes project delivery methods for major transit capital projects. It also evaluates the impacts, advantages, and disadvantages of including operations and maintenance as a component of contracts for project delivery methods. The project delivery methods discussed are design-bid-build, construction manager at risk, design-build, and design-build-operate-maintain. The guidebook presents a three-tiered project delivery selection framework that owners of public transit projects can use to evaluate the pros and cons of each delivery method and select the most appropriate method for their project. The web-only companion document, TCRP Web-Only Document 41, *Evaluation of Project Delivery Methods*, provides background and definitions of project delivery methods, and highlights the existing selection approaches commonly used by transit agencies. It reviews the literature, research findings, and lessons learned for the delivery methods, including case studies.

Transit, Call Centers, and 511. TCRP Report 134, *Transit, Call Centers, and 511: A Guide for Decision Makers*, reviews the operational characteristics of 511 telephone traveler information systems and describes how 511 systems interact with public transit system call centers. It also inventories existing 511 systems throughout the country, documents the extent of public transit participation and experiences with 511, and presents guidance to assist the public transit industry and 511 system administrators in determining a transit-511 telephone strategy.

Rural Demand-Response Transportation. Demand-response transportation (DRT) systems—from large metropolitan services to small, community-based programs—face pressures to improve performance, with increasing demand for service and financial constraints. TCRP Report 136, *Guidebook for Rural Demand-Response Transportation: Measuring, Assessing, and Improving Performance*, is the second of two TCRP publications on DRT systems. The first guidebook, published in 2008 as TCRP Report 124, focused on DRT systems in urban areas; TCRP Report 136 addresses rural DRT. Both provide information for measuring, evaluating, and improving DRT performance using a method that can account for the diversity of DRT services, service areas, and passengers.

Passenger Counting Systems. TCRP Synthesis 77, *Passenger Counting Systems*, documents the state-of-the-practice in analytical tools and technologies for collecting public transit ridership data. It also provides advice for public transit agencies considering automatic passenger counter (APC) systems. The synthesis reports survey results, including public transit agency assessments of the effectiveness and reliability of their methods. Although designed to emphasize APC systems, the synthesis also reports on public transit agencies using manual systems to document the reasons that new technologies are not adopted. Detailed findings

from six case studies characterize best practices and highlight problems common to APC implementation. An appendix summarizes APC implementation, including the percentage of public transit vehicles equipped with APCs, hardware supplier, software supplier, and the procurement process.

Balancing Infrastructure Reinvestment with System Expansion. TCRP Research Results Digest 92, *Balancing Infrastructure Reinvestment with System Expansion*, discusses how public transit agencies in Australia are increasing capacity and expanding service while maintaining and upgrading their existing infrastructure. It addresses bus, tram, rail, and ferry systems in Sydney, Melbourne, Adelaide, Perth, and Brisbane.

Objective 3.2 Perform research to improve transit planning and forecasting

Controlling System Costs. TCRP Report 135, *Controlling System Costs: Basic and Advanced Scheduling Manuals and Contemporary Issues in Transit Scheduling*, updates TCRP Report 30, *Transit Scheduling: Basic and Advance Manuals*. It addresses contemporary issues in public transit scheduling and provides new information on available scheduling tools and methods and their capabilities. TCRP Web-only Report 45 contains the five appendixes to TRRP Report 135. The appendixes include: (1) literature review, (2) public transit agency survey results, (3) vendor survey results, (4) additional research needs, and (5) case studies. An interactive scheduling manual is available as an International Organization for Standardization image.

Planning Resources on Transportation Hazards. Transportation officials are concerned about the potential impacts of disasters on our nation's transportation infrastructure and are working to reduce those impacts. However, these officials often do not communicate comfortably with hazards professionals and they typically do not access the same resources. TCRP Research Results Digest 90 and National Cooperative Highway Research Program (NCHRP) Research Results Digest 333, *A Guide to Planning Resources on Transportation and Hazards*, begins to bridge that gap between these professions by providing a framework for thinking about the stages of a disaster from a transportation perspective, describing current hazards-related research, and introducing research from fields other than transportation.

Preparing Coordinated Transportation Research Plans. NCHRP Research Results Digest 331, *Preparing Coordinated Transportation Research Plans: A Guidebook for State Departments of Transportation*, identifies state departments of transportation (SDOT) that have designed coordinated planning processes to meet FTA's requirements, and summarizes information that will be useful to other SDOTs as they develop or revise their own planning processes. The guidebook includes a review of FTA's requirements, a survey of SDOT and transit agencies' local coordination plans, and case studies highlighting different methods and best practices.

Uses of Fees or Alternatives to Fund Transit. TCRP Legal Research Digest 28, *Uses of Fees or Alternatives to Fund Transit*, assesses the use of impact fees for public transit in the United States, discusses policy and legal considerations relating to the use of impact fees and developer exactions for transit, discusses strategies and methods currently used by states, municipalities, and transit systems to develop and implement impact fees, and presents case studies of impact fees and other exactions either enacted or considered in various jurisdictions. The report will be of interest to state and local transportation officials, planners, and policy makers, and to professionals who consider impact fees as a potentially valuable alternative funding source.

Objective 3.3 Perform research to improve mobility, rural services, and services for targeted populations

Handheld Global Positioning System Devices in Paratransit. Conventional paratransit pickup entails telephone or Internet reservations for drivers to meet passengers at designated locations. Drivers may miss pickups if address information is ambiguous or if they cannot find the designated locations. The *Feasibility Study on the Use of Personal GPS Devices in Paratransit* discusses the results of a research study on the use of personal mobile global positioning system (GPS) devices to create more efficient paratransit services. Results indicated that most public transit agencies are interested in adopting GPS devices to improve their paratransit services.

Remote Infrared Audible Signage. Remote infrared audible signage (RIAS) is an orientation and mobility technology to eliminate barriers to accessibility for people who are visually impaired or are cognitively or developmentally disabled. In 2009, the Research Office completed its evaluation of a RIAS pilot program in the Puget Sound region of Washington State. The Research Office evaluated the impacts of RIAS technologies on multi-modal accessibility, transit ridership, transit operators, and quality of life, and reported its evaluation methods, findings, lessons learned, conclusions, and recommendations in a *Remote Infrared Audible Signage Pilot Program* evaluation report. The Research Office also submitted a summary of its evaluation to Congress.

Enhanced Human Service Transportation Models

Under the Mobility Services for All Americans (MSAA) initiative, the United We Ride (UWR) program brings together users, service providers, and funding institutions to enhance access and improve the cost-effectiveness of public transit. The goal of the MSAA initiative is to establish models of ITS-enhanced transportation systems that provide efficient, accessible, and quality transit services to all, by integrating the transportation disadvantaged community and the general public.

In 2007, MSAA began a demonstration to test the technical and institutional feasibility of an enhanced transportation system. The demonstration project will plan, design, and deploy coordinated TMCCs at eight sites around the United States: Aiken, SC; Atlanta, GA; Camden County, NJ; Fitchburg, MA; Kent, OH; Louisville, KY; Orlando, FL; and Paducah, KY. *Enhanced Human Service Transportation Models Joint Demonstration: Phase 1 – System Planning and Design* evaluates the processes used by these eight sites to develop designs for their TMCCs, and discusses findings in four major areas: (1) project management; (2) stakeholder collaboration; (3) technology; and (4) best practices, including lessons learned.

Final systems planning and design reports for five of the eight sites are available at FTA's "Reports and Publications" website⁸:

- Aiken, SC. *United We Ride/Mobility Services for All Americans Joint Demonstration: Phase One – System Planning and Design*
- Atlanta, GA. *Demonstration of Enhanced Transportation Models: Phase I – System Development and Design*
- Fitchburg, MA. *UWR/MSAA Demonstration of Coordinated Human Service Transportation Models: Phase 1 - System Development and Design M-ITS: Mart's Integrated Traveler Services*
- Orlando, FL. *MORE-TMCC: Model Orlando Regionally Efficient Travel Management Coordination Center*
- Paducah, KY. *Demonstration of Enhanced Human Service Transportation Models: Phase 1 - System Development and Design: The Purchase Area Regional Travel Management Coordination Center (TMCC).*

The National Center for Transportation Needs of Special Populations supports FTA's UWR program by coordinating human services transportation information into a standardized and uniform database. The database allows policymakers, stakeholders, and service providers to monitor trends and performance and to identify areas for improvement.

⁸ http://www.fta.dot.gov/assistance/research/research_8850.html

Advanced Small Transit Vehicle Program. As part of FTA’s advanced small transit vehicle (ASTV) demonstration program, West Virginia University (WVU) provides program coordination and management support for multiple demonstration projects. In FY 2009, WVU developed data collection methods for the ASTV demonstration sites. The methods are tailored to the individual vehicles and technologies being demonstrated.



Santa Rosa, CA, received \$5 million in American Recovery and Reinvestment Act of 2009 funds for paratransit services, solar bus shelters, and two hybrid buses.

Assessing the Outcomes of Increased Funding for Rural Passenger Services under SAFETEA-LU. TCRP Research Results Digest 93, *Rural Transit Achievements: Assessing the Outcomes of Increased Funding for Rural Passenger Services under SAFETEA-LU*, assesses the changes in rural public and inter-city bus transportation that resulted from the increases in funding made available through the Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU). It describes the extent to which federal funding for passenger transportation in rural areas grew after SAFETEA-LU was passed, including the funding levels that were authorized, obligated, and spent; the ways in which the increased funding affected rural public and intercity bus transportation; the impacts on local communities; and the major barriers that states and local transit agencies identify to developing new or expanded public transit services in rural areas.

Objective 3.4 Investigate the use of high-efficiency technologies and alternative energy sources

Delaware Fuel Cell Bus Program. The University of Delaware (UD) is designing, building, and demonstrating a fleet of fuel cell buses and creating a network of refueling stations in Delaware. In FY 2008, UD operated its first 22-foot public transit bus on a daily route on the UD campus and designed a second 22-foot public transit bus with a dual stack and advanced lightweight lithium titanate batteries. In 2009, EBus of California fabricated and delivered UD's second fuel cell bus, and UD began design of a 30-foot fuel cell public transit bus for delivery in 2010.



Roaring Fork Transportation Authority operates hybrid buses in the Rocky Mountains near Aspen, CO.

National Fuel Cell Bus Program

To facilitate the development of commercially viable fuel cell bus technology and related infrastructure, in August 2005, Congress established the NFCBP as part of a four-year surface transportation authorization, SAFETEA-LU⁹. The Act authorized \$49 million in capital funding as part of a competitive grant program for up to three geographically diverse non-profit organizations. The program required at least a 50-percent cost share for all projects, which made its size nearly \$100 million.

Through FTA, the DOT released the solicitation for the NFCBP in April 2006. Both FTA and the U.S. Department of Energy (DOE) participated in selecting 14 projects, which included partners from industry, government, and transit and provided a balanced portfolio for the NFCBP to advance fuel cell bus commercialization. FTA and DOE then selected three non-profit consortia to lead the NFCBP projects:

1. CALSTART Advanced Transportation Technologies (CALSTART) – a non-profit consortium headquartered in Pasadena, CA
2. Center for Transportation and the Environment – a non-profit consortium headquartered in Atlanta, GA
3. Northeast Advanced Vehicle Consortium – a non-profit, public-private partnership headquartered in Boston, MA.

Currently, the NFCBP supports 8 development and demonstration projects (\$43 million); 2 component development projects (\$300,000); 4 analysis, outreach, and coordination projects (\$1.25 million); and 2 technical support projects. Up to 12 new fuel cell buses are expected to roll out in the next 2 years.

NFCBP accomplishments in FY 2009 included:

- Meeting of the International Fuel Cell Working Group conducted in Vancouver, British Columbia, Canada, involving fuel cell manufacturers and suppliers, and fuel cell bus operators from around the world.
- Beta testing of a website for information on fuel cell bus operations around the world.
- Publication by AC Transit (Oakland, CA) of the *Accelerated Testing Evaluation Report*, an evaluation of the operation of AC Transit fuel cell buses in revenue service since 2006.
- Publication of *A Report on Worldwide Hydrogen Bus Demonstrations, 2002 – 2007* that highlights more than 20 cities in the United States, Europe, China, Japan, and Australia that have demonstrated buses powered by fuel cells or hydrogen-fueled internal combustion engines.
- Delivery and baseline testing of a new bus chassis with existing diesel hybrid system for comparison to BAE Systems' compound hybrid fuel cell bus. The new bus will be operated and tested at San Francisco Muni.
- Completion and testing of two Nuvera fuel cell stacks for deployment on a Boston Logan Airport bus.

⁹ SAFETEA-LU, Section 3045.

- Integration and testing of an innovative battery-dominant plug-in hybrid-electric hydrogen fuel cell system in a 35-foot, lightweight composite body built by Proterra Inc. The bus underwent independent fuel economy testing at the Altoona Bus Testing Center and was delivered to its operating location in Columbia, SC, in August 2009.



The 35-foot Proterra Inc. hybrid electric fuel cell bus has a lightweight composite body.

Objective 3.5 Perform research to reduce transit environmental impacts

Public Transportation's Role in Addressing Global Climate Change. Despite making up only 5 percent of the world's population, the United States produces about 75 percent of the greenhouse gas emissions generated by all human activity on earth, and about half of our emissions come from transportation. The U.S. government wants to slow the growth of GHG emissions leading to global climate change. TCRP Research Results Digest 89, *Public Transportation's Role in Addressing Global Climate Change*, discusses the role of public transportation in addressing global climate change in several European cities, including Dublin, Ireland; Munich and Freiburg, Germany; Milan, Italy; and Bilbao, Spain.



Left: Trax light rail trains pass in the Salt Lake City skyline sunset.

Right: Metropolitan Transit System San Diego State University light rail train at the station.

Objective 3.6 Perform research to improve safety, security, and emergency preparedness

Crash Energy Management of Light Rail Vehicles. Most fatalities that occur from LRV operations are occupants of vehicles that are struck by the LRVs. In developing crashworthiness standards for LRVs, the American Society of Mechanical Engineers' Rail Transit Vehicle Standards Committee considered collisions between LRVs and automobiles. Their standards require LRVs to have smooth, enclosed front-end bumpers to avoid trapping or overriding automobiles. *Collision Safety Improvements for Light Rail Vehicles Operating in Shared Right of Way Street Environments* describes the development and testing of a prototype bumper system design with an improved profile and segmented energy-absorbing corner bumpers. Testing of this design assessed injuries to unbelted side-impact dummies from normal 90-degree and oblique 45-degree impacts. The new design, suitable for retrofit on LRVs, improved automobile passenger safety for a variety of automobile types.

Improving Pedestrian and Motorist Safety Along Light Rail Alignments. TCRP Report 137, *Improving Pedestrian and Motorist Safety Along Light Rail Alignments*, examines pedestrian and motorist behaviors contributing to light rail transit (LRT) safety and explores mitigating measures available designed to improve safety along LRT alignments. The report also includes suggestions to facilitate the compilation of accident data in a coordinated and homogeneous manner across LRT systems. Finally, the report provides a catalog of existing and innovative safety devices, safety treatments, and practices along LRT alignments. The web-only companion document, Web-Only Document 42, contains six appendices for the report: (1) a literature review of the state of knowledge, (2) the list of transit agencies that participated in the

study and contact information for the agency personnel who participated in the study survey, (3) treatment usage as reported by survey participants, (4) survey responses, (5) site-visit memos, and (6) a review of the accident-data collection process.

Light Rail Vehicle Collisions with Vehicles at Signalized Intersections. TCRP Synthesis 79, *Light Rail Vehicle Collisions with Vehicles at Signalized Intersections*, reports on mitigation methods tested and used by public transit agencies to reduce collisions between LRVs and motor vehicles where LRT runs through or adjacent to highway intersections controlled by conventional traffic signals, with particular focus on collisions between LRVs and vehicles making left turns at intersections. It addresses a range of LRT operations and environments including median-running, side-running, contra-flow, and mixed-use LRT alignments; urban and suburban settings; and a variety of U.S. geographic regions. It describes specific actions that public transit agencies have used successfully in reducing collisions.

Transit Security Update. TCRP Synthesis 80 updates *Improving Transit Security*, TCRP Synthesis 21 (1997). It addresses terrorism, which was not included in the earlier volume as well as ordinary crime. It covers counterterrorism and anti-crime security measures and practices, crime and security incident trends, and other major issues and obstacles to security and policing management. It was accomplished through a literature review, a survey of 120 public transit agencies, interviews with industry experts, and a review of the National Transit Database.

First Amendment Implications for Transit Facilities. TCRP Legal Research Digest 29, *First Amendment Implications for Transit Facilities: Speech, Advertising, and Loitering*, discusses regulations, statutes, policies, and case decisions pertaining to permissible and impermissible restrictions on speech and expressive behavior at public transit facilities and aboard transit vehicles. It provides clear discussions on sidewalks and transit facilities as public forums, attempts to regulate advertising on public property, and the enforcement of anti-loitering and anti-panhandling regulations on or near public transit facilities. The information will be useful to attorneys, state and local transportation administrators, researchers, legislators, and others who need information on these topics.

Rail Base Inspection and Rail Condemnation Limits for Corrosion-Induced Material Loss. Public transit systems have reported loss of material at the rail base due to corrosion. This loss is mainly attributed to the presence of stray direct currents that promote the acceleration of rail corrosion mainly under the rail base, where the base makes contact with the tie plates. Corrosion can affect rail integrity by reducing shear and bending strength, reducing fatigue life, and increasing the potential for rollover. TCRP Web-Only Document 47, *Guidelines for Rail Base Inspection and Rail Condemnation Limits for Corrosion-Induced Material Loss*, discusses the maximum allowable material loss in the rail base.

Detection of Radioactivity in Transit Stations. IDEA Project 54 built on the results of the previously completed Transit IDEA Project 42, *Detection of Radioactivity in Transit Stations* (October 2006), and installed, tested, and evaluated a prototype system using security cameras in a metrorail transit station.

Ultraviolet Germicidal Irradiation for Transit Buses. IDEA Project 53, *Ultraviolet Germicidal Irradiation for Transit Buses*, incorporated ultraviolet germicidal irradiation (UVGI) into transit bus air conditioning systems. Three prototype UVGI systems were designed and installed on the transit buses, and UVGI was tested for its ability to protect passengers and employees working on public transit buses against virus, bacteria, mold, and other airborne pathogens. The evaluation showed significant reductions of mold, bacteria, fungi, and harmful viruses within the bus.

Warning Device for Rail Transit Personnel for Approaching Train. IDEA Project 55, *Warning Device for Rail Transit Personnel for Approaching Train*, developed and tested a device to give early warning to rail transit personnel of an approaching train and to give early warning to the train operator that personnel are ahead on the tracks. The device provided a reliable warning to track workers and train operators in enough time to avoid potential accidents, injuries, and deaths. Rail rapid transit agencies may want to consider using such devices to give early warning of approaching trains to track workers, track walkers, track inspectors, first responders, and signal personnel as well as to give train operators early warning of personnel in the track area.

Capacity Building, Training, and Technical Assistance

In addition funding research to achieve the goals and objectives of its research program, FTA also funds capacity building, training, and technical assistance activities out of its National Research and Technology Program account. Highlights of 2009 accomplishments in capacity building, training, and technical assistance are discussed below.

National Transit Institute

Established in 1992, NTI provides training, education, and clearinghouse services to support public transit in the United States. NTI develops and delivers its products and services through partnering with government, industry, and trade associations.

In 2009, NTI provided five advanced technology courses for the transit industry to facilitate the introduction of advanced technologies and innovative practices into transit professionals, and to enhance the knowledge, understanding, and technical skills of transit professionals as they explore, procure, implement, and manage innovative methods, equipment, and systems to improve transit service and operations:

1. **Characteristics and Planning of Bus Rapid Transit.** Urban mobility, limited public financial resources, and the costs of rail transit are causing public transit agencies to examine and implement new technologies to improve service quality in a cost-effective manner. This course provides an overview of NBRTI's 2009 publication *Characteristics of Bus Rapid Transit for Decision-Making*, supplemented with case studies for exploring BRT alternatives. It is designed for planners, engineers, and others involved in transportation planning and decision making.
2. **Implementing Contactless Fare Collection Systems.** Facilitated by industry professionals with experience in implementing fare collection systems, this introductory course can help public transit professionals plan for the complexities associated with implementing new fare collection systems. The course is designed for individuals whose responsibilities include setting policy, establishing direction, procuring systems, and managing and operating fare collection systems.
3. **Implementing Rural Transit Technology.** Assiduously applied in the rural transit environment, technology can facilitate scheduling and dispatching operations and improve safety and customer service. The process for planning and implementing technology-based applications to increase operating efficiencies and improve the safety of rural transit can be challenging. This course presents a structured approach for planning, implementing, and evaluating rural public transit projects. It is designed for public transit professionals, state DOT staff, and regional planners involved in planning and implementing technology-based applications for rural transit operations.

4. Integrating Transit Applications: Defining Data Interfaces Using TCIP.¹⁰ This highly technical course is designed for individuals who identify, procure, and implement ITS for public transit agencies. To fully appreciate the course, participants need a working knowledge of computer systems communication, database structures, and transit business systems interactions as well as experience in writing requirement specifications for transit information systems. The course reviews the TCIP model architecture and associated building blocks to help public transit professionals and vendors define data interfaces between applications using the APTA TCIP-S-01 3.0.3¹¹ standard.

5. Transit ITS Regional Workshop. This introductory workshop is meant for public transit planners, engineers, and operations managers who will be involved in planning, implementing, and managing transit ITS applications. It is designed to increase awareness of ITS and describe how to deploy and deliver safer and more efficient transit service technologies.

Regional Transit Training Consortium. The Southern California Regional Transit Training Consortium (SCR TTC) pilot program is a training resource network of public and private organizations whose goal is to develop learning models to increase the professional and technical competency of the Southern California public transit workforce and to integrate the elements of Intelligent Transportation Systems into training curricula. This year, SCR TTC delivered almost 18,000 hours of training to more than 1,400 public transit employees.

Professional Capacity Building in Transit. The Conference of Minority Transportation Officials implemented a careers-in-transportation-for-youth internship program to develop future public transit industry professionals. Twelve students were selected to participate in the program and three of the students interned at FTA.

Transit Training in Nigeria. Lagos, Nigeria, has a population of almost 18 million and recently established a state-regulated public bus network. In June 2009, the Research Office and NTI assisted the Lagos State Government in establishing a program of continuing public transit education at Lagos State University. The Research Office /NTI team presented teaching materials and advice on course content, and identified research materials for continuing education and degree-granting programs. The Nigerian Higher Education Board accredited NTI's teaching curricula.

Public Transportation Training in Mumbai. In September 2009, the Research Office conducted training for the Mumbai Metropolitan Region Development Authority (MMRDA) in fulfillment of a Public Transportation Memorandum of Cooperation and Cooperative Agreement. Instructors provided training in transportation planning, integrated fare systems, transportation security, and environmental sustainability. In addition, the Research Office and MMDRA discussed future cooperation in ITS, BRT, public-private partnerships, and clean and renewable energy.

¹⁰ Transit Communications Interface Profiles (TCIP) is an APTA standard that provides a library of information exchange building blocks to allow transit agencies and transit suppliers to create standardized tailored interfaces. It includes a concept of operations, model architecture, dialog definitions, and a modular approach to conformance.

¹¹ APTA TCIP-S-01 3.0.3 is available at <http://www.aptastandards.com/StandardsPrograms/ITStandardsProgram/TCIPProgram/tabid/113/Default.aspx>.

Appendix A: Acronyms and Abbreviations

The following acronyms and abbreviations are used in this report.

AASHTO	American Association of State Highway and Transportation Officials	NBRTI	National Bus Rapid Transit Institute
AC Transit	Alameda-Contra Costa Transit District	NCHRP	National Cooperative Highway Research Program
AFC	automated fare collection	NFCBP	National Fuel Cell Bus Program
AMS	analysis, modeling, and simulation	NTI	National Transit Institute
APC	automatic passenger count	Research Office	Office of Research, Demonstration, and Innovation
APTA	American Public Transportation Association	RIAS	remote infrared audible signage
ASTV	advanced small transit vehicle	RITA	Research and Innovative Technology Administration
BRT	Bus Rapid Transit	RP	recommended practice
Cal Poly	California State Polytechnic University	RTA	Regional Transit Authority (Chicago)
CALSTART	CALSTART Advanced Transportation Technologies	SAFETEA-LU	Safe, Accountable, Flexible, and Efficient Transportation Equity Act – A Legacy for Users
CFR	Code of Federal Regulations	SCR TTC	Southern California Regional Transit Training Consortium
DHS	U.S. Department of Homeland Security	SDOT	state department of transportation
DOE	U.S. Department of Energy	SEM	security emergency management
DOT	U.S. Department of Transportation	SEPP	security and emergency preparedness
DRT	demand-response transportation	SODS	side object detection system
EDAPTS	Efficient Deployment of Advanced Public Transportation Systems	SRM	security risk management
EDSP	Electric Drive Strategic Plan	SSO	state safety oversight
FCC	Federal Communications Commission	T3	talking technology and transportation
FTA	Federal Transit Administration	TCIP	transit communications interface profiles
FY	fiscal year	TCRP	Transit Cooperative Research Program
GHG	greenhouse gasses	TMCC	Travel Management Coordination Center
GPS	global positioning system	TOD	transit-oriented development
GRTC	GRTC Transit System, Richmond, Chesterfield County, VA	TODSS	transit operations decision support system
ICM	integrated corridor management	TRAC	Transit Research Analysis Committee
IDEA	Innovations Deserving Exploratory Analysis	TRB	Transportation Research Board
ITS	intelligent transportation system	UD	University of Delaware
LRT	light rail transit	UML	urban magnetic levitation
LRV	light rail vehicle	UN	United Nations
Maglev	magnetic levitation	UPA	Urban Partnership Agreement
MMRDA	Mumbai Metropolitan Region Development Authority	USCS	U.S. Commercial Service
MSAA	Mobility Services for All Americans	USICD	U.S. International Council on Disabilities
		UVG	ultraviolet germicidal irradiation
		UWR	United We Ride
		VAA	vehicle assist and automation
		VTM	virtual trade mission
		WVU	West Virginia University

Appendix B: FTA FY 2009 Reports

Selected FTA FY09 Research Reports. FTA staff and contractors produce reports to assist grantees and/or to highlight a particular issue in the transit industry. Most reports are available at <http://www.fta.dot.gov/research.html> unless otherwise noted. Reports are listed alphabetically by title under their respective FTA goals.

Goal 1: Provide national transit research leadership

FTA Low-Speed Urban Maglev Research Program: Lessons Learned. 2009. FTA-DC-26-7260.2009.01. March. Available at http://www.fta.dot.gov/documents/FTA_LowSpeedMaglev_LessonsLearned.pdf.

Integration of Paratransit and Fixed-Route Transit Services. TCRP Synthesis 76. December 2008. Available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_76.pdf.

Local and Regional Funding Mechanisms for Public Transportation. TCRP Report 129. October 2009. Available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_129.pdf.

Multi-Year Research Program Plan (FY 2010 – FY 2014). FTA-OH-26-7245-2007.1.

New Ideas for Transit: Transit IDEA Program Annual Progress Report 2009. Transportation Research Board. January 2009. Available at http://onlinepubs.trb.org/onlinepubs/sp/TCRP_IDEA_Report.pdf.

Synthesis of Information Related to Transit Problems: 2009. TCRP Research Results Digest 91. January 2009. Available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rrd_91.pdf.

Transit Systems in College and University Communities. TCRP Synthesis 78. December 2008. Available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_78.pdf.

Goal 2: Support increasing transit's market share

Literature Review for Providing Access to Public Transportation Stations. TCRP Web-Only Document 44. May 2009. Available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_webdoc_44.pdf.

Practical Measures to Increase Transit Advertising Revenues. TCRP Report 133. July 2009. Available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_133.pdf.

Goal 3: Support improving the performance of transit operations and systems

A Report on Worldwide Hydrogen Bus Demonstrations, 2002-2007. 2009. FTA-GA-04-7001-2009.01. March. Available at http://www.fta.dot.gov/documents/ReportOnWorldwideHydrogenBusDemonstrations_2002to2007.pdf.

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