

**U.S. Department of
Transportation
Research, Development, and
Technology Strategic Plan**

FY2012

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
CAAFI	Commercial Aviation Alternative Fuels Initiative
CLEEN	Continuous Lower Energy Emissions and Noise
CMV	Commercial Vehicle
CO2	Carbon Dioxide
CVISN	Commercial Vehicle Information Systems and Networks
DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DSA	Detect, Sense, and Avoid
EEA	Engineering/Economic Analysis
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FY	Fiscal Year
GAO	Government Accountability Office
GDP	Gross Domestic Product

GHG	Greenhouse Gas
GPRA	Government Performance and Results Act
HERS-ST	Highway Economic Requirements System - State Version
HUD	Housing and Urban Development
ICAO	International Civil Aviation Organization
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
LTPP	Long Term Pavement Performance
MARAD	Maritime Administration
MPO	Metropolitan Planning Organizations
NEI	National Emissions Inventory
NextGen	Next Generation Air Transportation System
NHS	National Highway System
NHTSA	National Highway Traffic Safety Administration
ORTA	Office of Research and Technology Applications
OST	Office of the Secretary
PHMSA	Pipeline and Hazardous Materials Safety Administration
PL	Public Law
PTC	Positive Train Control
RD&T	Research, Development and Technology
RITA	Research and Innovative Technology Administration
SHRP	Strategic Highway Research Program
SLSDC	Saint Lawrence Seaway Development Corporation
TRB	Transportation Research Board
UTC	University Transportation Center

V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VALE	Voluntary Airport Low Emission

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EXECUTIVE SUMMARY

The DOT's Research and Innovative Technology Administration (RITA) supervised the preparation of the U.S. Department of Transportation's (DOT) Strategic Plan for Research, Development, and Technology (RD&T) ("RD&T Strategic Plan") for the years 2012 to 2017. This Plan is based on input from other operating administrations through the RD&T Planning Team and RD&T Planning Council; an external panel of experts; and external stakeholders through a period of public comment prior to the development of the plan.

The RD&T Strategic Plan uses the DOT's overall Strategic Plan¹ as a foundation and categorizes research within DOT's five strategic focus areas:

- Safety
- State of Good Repair
- Economic Competitiveness
- Livable Communities
- Environmental Sustainability

For each focus area the RD&T Strategic Plan summarizes expected DOT research outcomes, describes priority research areas for achieving the desired outcomes that are modal-specific or cut across all operating administrations, and lists performance measures to determine the effectiveness of the research.

Even though the RD&T Strategic Plan will be applied over a 5 year period, it is critical that the RD&T Planning Team reviews it annually; in particular the performance measures, and revises the research strategies as needed. It is also important to recognize that the DOT's research vision cannot be limited to a 5 year horizon. The transportation systems of future generations will be based on research that is defined and initiated today.

DOT operating administrations will use the RD&T Strategic Plan internally to refine their RD&T strategic plans. Externally DOT will use it as a critical presentation to Congress when requesting research funding during the annual budgeting process and through various authorization bills. The Strategic Plan is also expected to initiate a discussion of research priorities among transportation community stakeholders. This discussion will play a key role when selecting specific research projects for achieving the outcomes listed in the Strategic Plan.

INTRODUCTION

DOT STRATEGIC GOALS

This document is the U.S. Department of Transportation's (DOT's) Strategic Plan for Research, Development, and Technology (RD&T) ("RD&T Strategic Plan") covering the years 2012 to 2017. This Plan is aligned with, and supports, the DOT's five strategic goals:

Safety: Improve public health and safety by reducing transportation related fatalities and injuries.

State of Good Repair: Ensure the United States proactively maintains its critical transportation infrastructure in a state of good repair.

Economic Competitiveness: Promote transportation policies and investments that bring lasting and equitable economic benefits to the Nation and its citizens.

Livable Communities: Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services.

Environmental Sustainability: Advance environmentally sustainable policies and investments that reduce carbon and other harmful emissions from transportation sources.

The funding and implementation of research based on these five goals must be transparent and accountable to the American public, be performance-based, and focus on achieving the desired outcomes at the same time as maximizing the value of public investment.

As these goals are met, our Nation's transportation infrastructure will be transformed into a truly multimodal integrated system that provides the traveling public and U.S. businesses with safe, convenient, affordable, and environmentally sustainable transportation choices.

21ST CENTURY CHALLENGES

During the twentieth century U.S. highway, transit, and aviation networks fueled unprecedented economic prosperity and individual mobility by connecting our Nation's cities, towns, and regions to the rest of the world. The United States has been well served by our transportation infrastructure that includes highway, aviation, and railway networks, as well as ports, waterways, pipelines, and transit systems.

In the twenty-first century, the U.S. transportation system must begin to adapt to changing social, environmental, energy, and economic challenges. Federal transportation programs face unprecedented fiscal challenges, with current dedicated revenue sources no longer adequate to operate and maintain our existing infrastructure or to fund future investments.

Strategic, cross-cutting research can result in new technologies in materials, designs, maintenance practices, etc. When these technologies are properly implemented and leveraged across the DOT through improved coordination and collaboration, they can help close the funding gap by using dedicated funds more efficiently.

SUPPORTING CROSS-CUTTING RESEARCH

The DOT's RD&T efforts span all modes of transportation, covering improvements to the Nation's transportation system and supporting data-driven decision-making that address national priorities. This RD&T Strategic Plan for FY2012-FY2017 takes a department-wide, systems-level view of the multimodal transportation system and presents strategies, for each of the five research focus areas, that go beyond a modal-oriented and modal-funded perspective. The research focus areas, outcomes, and performance measures described in the Strategic Plan are designed to guide the investment of RD&T in ways that will result in measurable improvements to our Nation's transportation system.

The DOT's Research and Innovative Technology Administration (RITA) supervised the preparation of this Strategic Plan with input from all of the DOT operating administrations and the Office of the Secretary; the RD&T Planning Council, made up of the heads of the operating administrations, the Under Secretary for Policy, and other senior DOT leaders; and the RD&T Planning Team, including the operating administrations' Associate Administrators for RD&T. The result is cross-modal development of research strategies and collaboration at the highest levels of DOT.

The DOT operating administrations are:

- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railroad Administration (FRA)
- Federal Transit Administration (FTA)
- Maritime Administration (MARAD)
- National Highway Traffic Safety Administration (NHTSA)

- Office of the Secretary (OST)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Research and Innovative Technology Administration (RITA)
- Saint Lawrence Seaway Development Corporation (SLSDC).

The National Surface Transportation Policy and Revenue Commission recommended that “dedicated funding of RD&T be provided and be subject to careful planning and review by the transportation industry.”² Going forward, the RD&T planning team will work with stakeholders to ensure consistent and substantive input into the research investment planning process.

THE ROLE OF FEDERAL TRANSPORTATION RD&T

Transportation RD&T has the potential to unlock transformative solutions that can lead to dramatic improvements in our Nation’s transportation systems. Federal investment in transportation RD&T has led to the development of new materials, innovative production methods, and powerful design and planning tools. It also provides decision makers with information and knowledge to make better decisions, and provides operators with technologies and tools to solve problems and enhance the performance of the system.

Because the Federal Government owns and operates only limited portions of the Nation’s transportation system, RD&T investment represents one of the most effective ways the Federal government can contribute to the improvement of our transportation system.

Federal RD&T programs have a unique and critical role to play in overcoming the challenges that face our Nation’s transportation system. Key responsibilities include:

- Developing transportation research policy.
- Creating incentives for collaborative cross-modal research focusing on the interfaces of individual modes.
- Expanding the knowledge base by investing in university transportation centers (UTCs) that advance innovation, research, education, and technology transfer; and prepare the future transportation workforce to face the challenges of the twenty-first century transportation network.
- Encouraging multidisciplinary research.
- Stimulating innovation in transportation services and products through targeted partnerships with key entities, such as States, Metropolitan Planning

Organizations (MPOs), transit operators, ports, counties, cities, academic institutions, and private companies or organizations.

- Funding long-term, exploratory research as well as short-term applied research.
- Identifying, facilitating, and supporting the deployment of emerging technologies and best practices.
- Developing and disseminating tools and techniques that foster greater, more efficient use of technology and innovation.

COLLABORATION

Collaboration, accountability, and performance measurement are essential to all successful research, especially research that cuts across all transportation modes. These principles are promoted within this RD&T Strategic Plan; they are not specific to any one operating administration, but shape the way the DOT operating administrations carry out their research activities. To this end, the DOT is instituting a new collaborative process for coordinating and facilitating its research and development programs and activities. It will allow DOT to:

- Document the alignment of research with National transportation goals.
- Track performance and net benefits of DOT RD&T funds invested.
- Create visibility and transparency for all directed and discretionary research funding.
- Avoid redundancies and duplication of effort.
- Maximize use of available research resources including those within the DOT, at UTCs, at the State level, and with many partners.
- Focus on the *people* managing and conducting the RD&T as well as the *products*.

A driving principle of DOT's new collaborative process is to have performance-based outcome measures and retrospective reviews of all RD&T. The DOT will engage in a collaborative process to establish relevant performance measures for each relevant research area. Research planning should include a peer review of likely outcomes and benefits. Project plans should also incorporate early on how they will identify and reconcile likely factors that could affect eventual deployment. The goal is to measure the effectiveness of research by its implementation in the private sector, State DOTs, or other Federal agencies. If implementation is not an appropriate measure for the research, researchers should use an alternative performance outcome. Finally, all research should include a retrospective look at effectiveness. For those projects that result in deployment, did the technology actually improve an outcome? For example,

after accounting for other factors that cause accidents, did a technology improve safety?

By including crosscutting RD&T priority areas this Strategic Plan supports an approach to research that encourages collaboration across operating administrations and government agencies, and promotes consultation and partnership with stakeholders in industry and academia. The development of cross-modal research projects requires discussions with stakeholders, rigorous examination of cross-cutting transportation issues and problems, and the incorporation of ideas from peers and experts within the research, asset owner, and user communities.

DOT will continue to collaborate with other agencies, such as the Environmental Protection Agency (EPA), Department of Energy (DOE), Housing and Urban Development (HUD), Department of Homeland Security (DHS), and the Department of Defense (DOD) (including the U.S. Army Corps of Engineers), to provide the most effective transportation system for our Nation. While each agency and DOT operating administration has research priorities that are unique to its mission, there are many areas where the subject matter is cross-cutting, such as alternative fuels, human factors, simulation, pavement, and structures. Collaborative work that supports multiple Federal agencies is the most effective route to successful solutions.

In addition to collaborating with its Federal partners, the DOT collaborates with and performs joint research with stakeholders and partners across the entire transportation sector, including State and local agencies, academia, industry, and not-for-profit institutions, such as the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), and the American Public Transportation Association (APTA). DOT will continue to consult and coordinate with transportation research partners and the general public to promote an integrated and effective transportation system that takes full advantage of all modal resources.

The Norman Y. Mineta Research and Special Programs Improvement Act (PL 108-426) created RITA and made it responsible for coordinating and facilitating collaborative cross-modal RD&T programs and activities across the DOT.³ The DOT, supported by RITA, is enhancing the transparency of DOT research programs and creating additional opportunities for stakeholder communication and input. By providing greater visibility and transparency into the DOT's research programs, the DOT aims to foster greater collaboration and leveraging of resources with transportation research stakeholders.

Collaboration Tools

RITA has developed the Research Clusters⁴ and Research Hub programs that use web-based technologies to encourage information sharing on important research topics, promote cooperation, and foster technology transfer among the hundreds of DOT-funded researchers and program managers within the DOT and across the Nation.

DOT Research Clusters include senior research professionals from each operating administration. Cross-modal research working groups and online forums have been established within each Research Cluster. There are Research Clusters in the following areas:

- Infrastructure and Materials
- Human Factors
- Energy Sustainability
- Risk-Based Analysis to Address Safety Issues
- Data-Driven Decision Making
- Multimodal Intelligent Transportation Systems
- Livability
- Modeling and Simulation
- Positioning, Navigation, and Timing
- Transportation Implications for an Aging Population and Those with Special Needs
- System Resilience and Global Logistics
- Policy Analysis
- Travel Behavior
- Economics

RITA, in partnership with the operating administrations, also created an online searchable database of transportation RD&T activities—the DOT Research Hub. The tool assimilates RD&T data that are currently stored among many agencies into one database as recommended in the Government Accountability Office (GAO) report *Transportation Research: Opportunities for Improving the Oversight of DOT's Research Programs and User Satisfaction with Transportation*.⁵ The database allows policymakers, program managers, researchers, partners, stakeholders, Congress, and the public to search for RD&T information by research topic, funding level, research description, contractor or grantee, State, and more. It is a tool that will create an efficient national transportation research enterprise by encouraging collaboration and reducing duplicate research.

RITA has also initiated a technology transfer program to support implementation of the Technology Transfer Commercialization Act of 2000 and the Stevenson-Wydler Technology Innovation Act of 1980.⁶ Technology transfer can be described as the process of transferring research and scientific information to stakeholders and users who may further develop it for public or private needs. The technology transfer program supports activities within the operating administrations, such as the deployment of emerging technologies and dissemination of innovative tools and techniques. The intent of the program is to ensure the full use of the DOT's investment in research and development and to protect intellectual property by securing patents and issuing licenses.

The organization of the DOT into operating administrations, each with its own statutory requirements and missions, makes collaborative cross-modal research a challenge. Federal policies for surface transportation, aviation, pipeline, and rail are established through separate legislation and draw funding from separate sources. Many operating administrations must allocate a substantial share of their RD&T budget to research supporting their internal regulatory rulemaking activities.

Even though operating administrations are interested in addressing cross-modal issues, they have limited flexibility in allocating resources to this type of research. The RD&T Strategic Plan recognizes the structural limitations to cross-modal research and emphasizes strategies that use existing resources and facilitate cross-modal research cooperation and collaboration.

INFORMING TRANSPORTATION POLICY THROUGH RESEARCH

Research projects that support the goals discussed in the following chapters can have short- or long-term policy implications. Research results can inform policymakers about costs and benefits of DOT actions, and can help shape policy initiatives that last decades and affect millions of lives.

For example, safety-related research can result in the development of cost-effective methods of reducing incidents. In turn, these methods can shape future regulations and alter investment decisions. Similarly, research on measuring the benefits of investments that improve freight flow and reliability can provide the economic justification to make major investments that improve the Nation's economic competitiveness.

As DOT promotes the development of more livable communities, research results can provide insights on the benefits of livable communities and transit-oriented development. This can help transform the way Americans live, work, and spend their leisure time. Research results can also shed light on different techniques and models for measuring cost-effective construction and maintenance practices, and better ways of prioritizing investments to maintain infrastructure in a state of good repair.

Research results can help DOT find innovative and cost-effective ways of meeting performance measures for goal-based outcomes under DOT's Strategic Plan. Given scarce budgetary and staff resources, effective research can help policymakers prioritize resources more effectively. In doing so, it can lead to revolutionary breakthroughs such as Next Generation Air Transportation System (NextGen) air traffic control technologies. In another example, effective research can result in practical asset management tools that help States allocate their scarce resources where they are most cost beneficial.

RD&T Priority Areas for Supporting Transportation Policy

- Policies to promote a better integrated National Transportation System.
- Policy decisions regarding future funding mechanisms for system development and maintenance.
- National transportation energy policies to support decisions for efficient utilization of domestic energy resources for energy independence, and to foster the growth of the domestic transportation energy infrastructure.
- National transportation environmental policies to support decisions that minimize the impact of transportation on the natural environment.

STRATEGIC PRIORITIES, OUTCOMES AND PERFORMANCE MEASURES

Priorities and Outcomes

The DOT priority research areas, research outcomes, and performance measures described in the RD&T Strategic Plan are grouped according to the five strategic focus areas described in the DOT Strategic Plan. Each focus area contains an overview of the strategic goal, followed by cross-cutting RD&T research priorities and modal-specific RD&T research priorities to achieve the prescribed outcomes, and concludes with performance measures relating to the research outcomes.

Performance Measures

Quantifiable, objective performance measures are necessary to gauge DOT progress in meeting the RD&T strategic outcomes. The data collected through these performance measures may also identify areas in the RD&T Strategic Plan where the Planning Team needs to make adjustments during its annual review process.

Even though quantifiable performance measures of RD&T strategic outcomes are essential to determine the long-term impact of research, such as annual highway fatalities or injuries, it may be difficult to determine how well current research programs are using these data. Alternatively, it is critical to have performance measures in place that also measure quantifiable milestones for achieving a strategic outcome. For example, the number of times when a specific driver assistance technology is used in

vehicles would be a milestone towards reducing highway deaths and injuries. Including this type of data as a measure will be useful in identifying needed adjustments not only to the RD&T Strategic Plan but also to research programs specific to individual operating administrations.

Performance measures relating directly to strategic outcomes and to measuring quantifiable milestones for achieving a strategic outcome are listed in the following sections for each of the five DOT focus areas.

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FOCUS AREAS

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SAFETY

“Improve public health, safety, and security by reducing transportation-related fatalities and injuries”– DOT

Improving safety is the primary strategic goal of the DOT, with an ultimate goal of a perfectly safe transportation system. Even though DOT’s working with its partners has made significant progress in reducing the number of transportation-related fatalities and injuries across all modes of transportation, all operating administrations continue to face challenges in improving transportation safety.

STRATEGIC OUTCOMES OF SAFETY RESEARCH

- Reduction in transportation-related fatalities.
- Reduction in transportation-related injuries.

CROSSCUTTING RD&T PRIORITY AREAS FOR IMPROVING TRANSPORTATION SAFETY

The DOT can improve transportation safety by using a systemwide approach to collecting and evaluating multimodal safety data. By managing the collection of these data, DOT will be able to standardize data collection, utilize resources for processing and performing data analysis, and ultimately make data-driven decisions to improve transportation safety. With insight from cross-modal safety data, there will be benefits in such areas as operator fatigue, safety culture, distracted vehicle operation, heavy vehicular safety issues, and hazardous material transportation. These insights could ultimately lead towards zero deaths.

DOT RD&T multimodal safety priority areas are:

- Advanced research into the causal role of human factors in safety issues, specifically impairment issues such as alertness, operator capability and readiness, and fatigue.
- Transportation system design to improve safety and efficiency, focusing on safety risk, detection, and warning system reliability.
- Standardization of transportation safety data collection and terminology.

- A multimodal DOT safety incident and close call data collection system, to help evaluate and analyze transportation safety performance and address transportation safety issues.
- Freight and hazardous material cargo routing to improve safety and reduce environmental risks.

RD&T PRIORITY AREAS FOR IMPROVING SAFETY ON HIGHWAYS AND ROADWAYS

Highway travel in the United States is the safest it has been since the 1950s, although motor vehicle crashes remain the leading cause of death for Americans ages 2 through 24.⁷ Nationwide, the cost of motor vehicle crashes is estimated to be more than \$230 billion a year.⁸

DOT RD&T highways and roadways safety priority areas are:

- Driver distraction issues associated with highway design and operations.
- Innovative highway safety countermeasures that can be implemented by State, Tribal, and local highway agencies to reduce motor vehicle fatalities and injuries associated with roadway departures, intersections, pedestrians and bicyclists, speed, motorcycles, rural and local roads, and limited visibility.
- Intelligent transportation systems designed to monitor vehicle and infrastructure conditions and communication between vehicles and infrastructure in order to reduce the risk of and severity of collisions.
- Technologies that enable State, Tribal, and local highway agencies to make more effective and strategic data-driven safety investment decisions by improving the quality of data, enhancing analytical tools, and promoting more rigorous evaluation methods.
- Strategic Highway Research Program II (SHRP 2) safety research and implementation.

RD&T PRIORITY AREAS FOR IMPROVING SAFETY OF COMMERCIAL MOTOR VEHICLES

About 12 percent of all motor vehicle fatalities in the United States involve crashes with large trucks.⁹ Reducing this number is a challenge for DOT as truck miles of travel are growing faster than passenger vehicle miles traveled.¹⁰ DOT RD&T commercial motor vehicle safety priority areas are:

- Partnerships that support the Federal Motor Carrier Safety Administration's (FMCSA's) mission to promote safe commercial motor vehicle (CMV) operations through education, regulation, and enforcement.

- CMV driver risk factors, such as distracted driving, driver fatigue, inattention, and other driver conditions and impairments to support rulemaking and to promote a health, wellness, and safety culture in motor carriers.
- Safer vehicle production through developing wireless communication technologies, onboard safety technologies, energy saving systems, and alternative fuels.
- Deployment of onboard safety systems through promoting benefits to fleets and insurance carriers and testing next generation onboard safety systems in partnership with technology providers and other DOT agencies.
- CMV industry demographics and market segmentation studies of crash causation and safety data analysis; deployment of the Commercial Vehicle Information Systems and Networks (CVISN); and identification, testing, and deployment of smart roadside technologies in partnership with Federal, State, and local safety agencies.

RD&T PRIORITY AREAS FOR IMPROVING SAFETY OF TRANSIT SYSTEMS

Per passenger-mile, transit is one of the safest modes of transportation. In 2009, a total of 290 fatalities occurred in all modes of transit.¹¹ The challenge for DOT is to further reduce the number of transit-related fatalities and injuries even as the total number of people using transit increases.

DOT RD&T transit safety priority areas are:

- Materials and technologies to reduce transit fatalities and the number and severity of transit-related injuries.
- Development of transit safety standards.
- Quantified safety benefits of rail transit, including barriers to its expanded use and approaches to overcome those barriers.

RD&T PRIORITY AREAS FOR IMPROVING SAFETY OF AVIATION SYSTEMS*

The aviation industry has reached unprecedented levels of safety — in calendar year 2010, there were two fatalities on scheduled and nonscheduled Part 121 carriers and 17 Non-scheduled Part 135 fatalities.

* The National Aviation Research Plan describes the R&D targets and the method of validation in order to achieve these milestones.

www.faa.gov/about/office_org/headquarters_offices/ato/service_units/nextgen/research_tech_dev/research_planning/narp/

General aviation showed continued improvement as the number of accidents and fatalities dropped almost 25 percent over the past 10 years.¹²

DOT RD&T aviation safety priority areas are:

- Technologies for using the U.S. airspace in safer, more efficient, and more environmentally sound ways.
- Delineation of roles and responsibilities between pilots and controllers and between humans and automation for implementing NextGen.
- Performance characteristics and operational requirements for unmanned aircraft systems' sense and avoid (SAA) technologies to integrate unmanned aircraft systems into the national airspace.
- Prevention and mitigation of potential accidents within the airport operational environment through improved safety training, airport design, and advanced technology implementation.

RD&T PRIORITY AREAS FOR IMPROVING SAFETY OF RAIL SYSTEMS

Every day, trains in America travel more than 1.5 million miles, safely transporting passengers to their destinations and delivering goods to the marketplace. 2010 data show that rail safety continues to improve, with a 32 percent decline in rail-related incidents from 16,919 in 2000 to 11,515 in 2010.¹³

DOT RD&T rail safety priority areas are:

- Derailments caused by equipment and infrastructure failures.
- Methods to reduce accidents at highway-rail grade crossings and to reduce trespassing on railroad property.
- Pilot intervention projects, such as the Close Call Confidential Reporting System, to encourage the development of a positive safety culture within the railroad industry.
- Frequency of train collisions and the consequences if collisions occur.

RD&T PRIORITY AREAS FOR IMPROVING SAFETY OF PIPELINE SYSTEMS AND HAZARDOUS MATERIALS

Pipelines carry two-thirds of the Nation's energy supplies. Over the past 20 years pipeline incidents involving fatalities or major injuries have declined by 50 percent due to improvements in risk management and technology, such as integrity management, excavation damage prevention, and advances in pipeline materials.¹⁴ Pipelines continue

to have a low-probability of failure since they are the safest mode for transporting the enormous quantities of gas and liquid hydrocarbons this Nation requires.

Between 2005 and 2009, there was a downward trend in hazardous materials incidents involving fatalities or major injuries and in the total number of hazardous materials fatalities and injuries.¹⁵ At least three-fourths of all hazardous material incidents with multiple fatalities involved a commercial motor vehicle rollover or crash.¹⁶ Of particular concern for hazardous materials is the risk of low-probability, high-consequence accidents.

DOT RD&T pipelines and hazardous materials safety priority areas are:

- Prevention of damage to pipelines from excavation and identification of critical pipeline defects before failure.
- Remote condition assessment of pipeline defect severity.
- Technical information, analyses, and research to evaluate the public risk associated with hazardous materials transportation.
- Prevention and mitigation of potential hazardous material incidents within the transportation system, including key low-probability, high-consequence risks such as fire on board aircraft, release of bulk quantities of materials that are toxic-by-inhalation, and tank truck rollovers.

RD&T PRIORITY AREAS FOR IMPROVING SAFETY OF MARITIME SYSTEMS

Over the past century maritime safety has progressively improved with reduced sinkings, groundings, shipboard fires, and port and shipyard safety incidents. In addition, improved equipment on ships, in ports, and in shipyards along with improved safety systems and procedures contribute to improved safety. Although many safety improvements have been realized over the years in the maritime industry, the lack of structured and standardized safety data makes it difficult to accurately measure progress and identify specific areas that need to be addressed to improve maritime safety.

DOT RD&T maritime safety priority areas are:

- Operator fatigue in the maritime industry.
- Safety data standards and terminology to promote the exchange of safety information for better evaluation and analysis.

PERFORMANCE MEASURES FOR RESEARCH TO IMPROVE SAFETY

Strategic Outcomes	Proposed Performance Measures
<p>Reduction in transportation-related fatalities.</p> <p>Reduction in transportation-related injuries.</p>	<ul style="list-style-type: none"> • Advance vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications systems research progress sufficient to support 2013 agency decision on vehicle communications for light vehicles. • Reduced fatalities and injuries attributed to technologies adopted in an operational setting (e.g., adopting the Safety Edge in highways or using the Engineered Material Arresting System in at-risk airports). • Number of planned countermeasures States implement from the Strategic Highway Safety Plans. • Increased number of fleets incorporating a driver focused safety culture centered on driver risk factors, including health, wellness, safety, and fatigue management programs. • Increased market penetration of onboard safety systems (e.g., adaptive cruise control, forward collision warning, lane departure warning, crash imminent braking, and stability control systems). • Increased deployment of electronic data exchange and smart roadside technologies. • Application of systematic methodologies to identify and select research projects and guide program evaluation. • Industry standards and Federal regulations that address passenger rail car interior configuration to reduce the secondary impact force passengers may encounter during train incidents. • Use of response models as the basis for defining refined industry standards and Federal regulations for emergency preparedness and response. • Number of owners and operators adopting revised fire safety standards and/or Federal regulations after floor burn-through analyses are refined and test protocols are developed and proven. • Scale of implementation by railroads, communities, and States of methods and guidelines to decrease trespassing along the railroad right of way. • Availability to industry of positive train control (PTC) technologies. • Number of new commercialized pipeline technology and new or strengthened consensus standards. • Creation and application of knowledge documents to analyze regulatory and outreach activities and multimodal enforcement initiatives, and develop training curriculums. • Industry adoption of behavior-based safety pilot programs that reduce errors, incidents, and accidents.

STATE OF GOOD REPAIR

“Ensure the U.S. proactively maintains its critical transportation infrastructure in a state of good repair.” – DOT

The condition of our Nation’s transportation infrastructure falls short of a *‘State of Good Repair.’* In an era with scarce resources, DOT takes the position that stewardship of transportation infrastructure rises to the level of a strategic goal to draw attention to the need to preserve transportation reliability, capacity, and efficiency. DOT works through its government and industry partners to proactively apply asset management principles and maintenance regimes to all transportation infrastructure assets and optimize existing capacity while conserving resources for infrastructure of critical importance. Improving the state of repair of our Nation’s transportation infrastructure requires not only commitments from all levels of government and the private sector, but a dialog about the tradeoffs between building a new infrastructure versus maintaining existing assets.

A portfolio of research, development, and technology projects is essential in developing analytically sound mechanisms for setting targets and identifying which investments are the most useful for improving the state of repair of transportation assets.

It is not practical or necessary to replace all infrastructure assets with new ones. RD&T investment must also focus on improved ways to repair and rehabilitate existing systems.

Modern inspection methods are required to determine the condition of assets in a cost-effective manner. Data from inspection systems are used by government regulators to check compliance with standards and by asset owners to inform maintenance and replacement decisions.

Cross-modal research activities have improved professionals’ understanding of asset management strategies, tools, and resources. For example, FHWA’s Long Term Pavement Performance (LTPP) Program, a 20-year effort to assemble comprehensive pavement performance data under a wide variety of conditions, is now providing objective and statistically based analyses to help highway agencies select more cost-effective pavement designs for their applications.

The FTA has spearheaded an effort to systematically document current conditions and convene “summit” meetings to address implementation of research findings

and innovative approaches to asset management. The agency has identified broad categories of research — including engineering, best practices, and life cycle costs — and documented a need to investigate specific topics, such as improved and new materials, new generations of condition measurement systems, vehicle and rail systems equipment diagnostics, structural health monitoring technologies, and information technology systems for data management.

Building on current activities from multiple stakeholders and taking a cross-modal approach to RD&T investments related to conditions measurement, asset management, and system maintenance and repair can achieve positive impacts on the entire transportation network.¹⁷

STRATEGIC OUTCOMES OF STATE OF GOOD REPAIR RESEARCH

- Increased proportion of U.S. transportation infrastructure that is in good or better condition, including:
 - Highways and bridges
 - Transit systems
 - Aviation systems
 - Railroads and rail stations
 - Pipelines
 - Waterways and ports
- Improved asset management processes to maximize efficient use and maintenance of new and existing infrastructure.

CROSSCUTTING RD&T PRIORITY AREAS FOR IMPROVING THE STATE OF GOOD REPAIR OF THE NATION'S TRANSPORTATION SYSTEM

- Technologies for both long- and short-term targeted sensing and monitoring, and for nondestructive inspection and evaluation of transportation assets.
- Economic analysis and alternative financing methods, including the economic benefits of utilizing asset management and maintenance tools.¹⁸
- Performance-based methods for improving state of good repair in transportation facilities, including design and construction approaches and specifications that aim toward long-term performance.
- Implementation of new and emerging technologies to improve project delivery times and superior project quality.

- Increased longevity of transportation assets through more efficient use of the transportation system for heavy cargo.

RD&T PRIORITY AREAS FOR IMPROVING THE STATE OF GOOD REPAIR OF HIGHWAYS AND BRIDGES

- Monitor, analyze, and improve highway infrastructure condition and durability through conduct of the FHWA Long Term Bridge Performance, Long Term Pavement Performance, and other programs.
- National system performance indicators, focusing on the National Highway System (NHS), the Strategic Highway Network, and other major arterials and intermodal connectors.
- Development of a truck weight research agenda to study the trends in permits for weights in excess of legal limits, the pavement and bridge damage costs associated with those loads, and identifying feasible strategies to address this issue.
- Implementation of highway design and construction procedures, innovative quality assurance, performance-based contracting practices, innovative materials, and asset management practices to reduce the frequency and duration of onsite repairs, rehabilitation, reconstruction, and project lifecycle costs, especially through the Every Day Counts initiative.

RD&T PRIORITY AREAS FOR IMPROVING THE STATE OF GOOD REPAIR OF TRANSIT SYSTEMS

- Data collection and analysis of the condition of a cross-section of the Nation's transit systems to determine the investment needed to bring transit infrastructure to a state of good repair.
- Management, maintenance, and financial practices that address the state of repair of transit capital assets.
- Improved public transportation maintenance practices.
- Development of methods, tools, and guidance to improve capital asset assessment and maintenance management.

RD&T PRIORITY AREAS FOR IMPROVING THE STATE OF GOOD REPAIR OF AVIATION SYSTEMS[†]

- Standards and action plans for runway procedures (e.g., end-around taxiways) and databases and data collection tools to improve airport flight operations.
- Improved airport planning and design through the Airport Cooperative Research Program.¹⁹
- Pavement standards that support safe international operation of next generation heavy aircraft and the availability of pavement design standards to users worldwide through the Airport Technology Research Program.²⁰

RD&T PRIORITY AREAS FOR IMPROVING THE STATE OF GOOD REPAIR OF RAIL SYSTEMS

- Improved understanding of railroad track and railroad structures to allow defects to be detected before failure, an understanding of defect formation and growth rates, and development of new concepts and tools to assess track condition.
- Design and maintenance guidelines related to shared track usage between passenger and freight trains.
- Tools for the asset owner to monitor conditions and identify maintenance or replacement needs in advance.

RD&T PRIORITY AREAS FOR IMPROVING THE STATE OF GOOD REPAIR OF MARITIME SYSTEMS

- Technologies and tools to identify the condition of our waterways and what is required for their increased and effective use.
- Potential expanded use of the waterways to help the longevity of other modal systems.

[†] The National Aviation Research Plan describes the R&D targets and the method of validation in order to achieve these milestones.

www.faa.gov/about/office_org/headquarters_offices/ato/service_units/nextgen/research_tech_dev/research_planning/narp/

RD&T PRIORITY AREAS FOR IMPROVING THE STATE OF GOOD REPAIR OF PIPELINE SYSTEMS

- Pipeline facility integrity, enhanced design methods, improved construction quality; and enhanced repair tools, materials, techniques, and processes.
- Technologies for remotely assessing pipeline condition.

PERFORMANCE MEASURES FOR IMPROVING STATE OF GOOD REPAIR

Strategic Outcomes	Proposed Performance Measures
Increased proportion of highways and bridges in good or better condition	<ul style="list-style-type: none"> • Increased percentage of travel on National Highway System (NHS) roads with pavement performance standards rated good (FY2016 target is 63.8 percent). • Decreased percentage of bridges with deck area (the roadway surface of a bridge) rated structurally deficient (FY2016 target 9.1 percent).
Increased proportion of transit systems in good or better condition	<ul style="list-style-type: none"> • Reduced percentage of transit assets with a marginal or poor rating by 2 percentage points in 6 years.
Increased proportion of aviation systems in good or better condition	<ul style="list-style-type: none"> • Maintenance, in good, fair or excellent condition, of the pavements of at least 93 percent of the paved runways in the National Plan of Integrated Airport Systems.
Increased proportion of railroads and rail stations in good or better condition	<ul style="list-style-type: none"> • Comparison of asset conditions before and after improvements based on federally funded research.
Increased proportion of pipelines in good or better condition	<ul style="list-style-type: none"> • New commercialized pipeline repair products and new or strengthened consensus standards.
Increased proportion of waterways and ports in good or better condition	<ul style="list-style-type: none"> • New research projects designed to increase utilization of maritime modal assets in transportation.
Improved asset management processes to maximize efficient use and maintenance of new and existing infrastructure.	<ul style="list-style-type: none"> • Increased use of software applications for inventory, data management, and decision-support by asset owners. • Increased average lifespan of transportation assets (including roadway pavements, railroads and railcars, pipelines, and others). • Reduced time for rehabilitation projects (e.g., stretch of roadway, segment of railway, runway, pipeline, etc.).

ECONOMIC COMPETITIVENESS

“Foster transportation policies and investments that serve the traveling public and freight movement, and bring lasting economic and social benefit to the Nation.” – DOT

An efficient, reliable, robust, and adaptive transportation system is essential to maintaining the global competitiveness of our industries and sustaining our citizens’ current standard of living.

The performance, connectivity, and effective use of our Nation’s highways, ports, waterways, railways, airports, public transportation, and intermodal facilities directly impact the productivity of the U.S. economy and the costs of goods and services.

International trade is increasing and businesses are outsourcing supply, reorganizing logistics, and retailing directly to the consumer through the Internet. Between 1990 and 2000, U.S. international trade value more than doubled (in inflation-adjusted terms), rising from about \$900 billion to \$2.2 trillion.²¹

These changes have raised demand for reliable freight transportation, but the growth in freight movement is placing enormous pressure on an already congested transportation system. Congestion increases travel times and unreliability, drives up logistics costs, and imposes a high cost on the Nation’s economy and productivity. Bottlenecks in managing high volumes of freight can cause significant delays in intermodal freight shipments by rail, truck, air, or in ports, as well as delays in moving goods between these modes. In 2001, the average amount of time that had to be budgeted for trucks to cross the border into the United States at major border crossings was 26.8 minutes.²²

These capacity constraints and bottlenecks affect all modes of transportation. For example, between 1980 and 2002, truck travel grew by more than 90 percent while lane-miles of public roads increased by only 5 percent.²³ In 2008, nearly 24 percent of all passenger flights failed to arrive at their destinations on time.²⁴ The cost to the airline industry was an estimated \$9.6 billion in direct operating costs (not including the cost to travelers).²⁵ In 2010, more than 20 percent of Amtrak trains arrived late.²⁶ There are indications that the Nation’s deep-water ports and inland locks are also increasingly congested.²⁷

“European countries ... and India and China are making massive investments in their transportation systems”

- The Economist

Freight transportation demand has outpaced the growth in transportation supply leading to rising shipping costs, increasing shipping times, increasingly unreliable travel times, and growing inventories that result in higher storage costs for freight customers.²⁸

National prioritization of specific modal improvements — such as high-speed and intercity rail and crosscutting intermodal projects — can be the target of strategic investments in the RD&T portfolio. Research and development is required to develop the tools and resources for evaluating modal and multimodal opportunities with long-term capacity to most cost effectively handle vastly increased movements of cargo and people.

Current projects, such as development of the Next Generation Air Transportation System (NextGen),²⁹ are focusing on reducing gridlock, both in the sky and at the airports, and creating a competitive air transportation network. Other projects, such as the Intelligent Transportation Systems Joint Program Office's (JPO) Connected Vehicle Program,³⁰ are engaging in high-level research and testing, development, and deployment of technologies that can improve safety and reduce roadway congestion (and by extension its economic costs).

STRATEGIC OUTCOMES OF ECONOMIC COMPETITIVENESS RESEARCH

- Maximum economic returns from transportation infrastructure investments.
- Improved operations of transportation systems in order to increase competitiveness and responsiveness to consumer needs.
- Advancements of U.S. transportation industry interests in targeted markets around the world.
- Expanded opportunities for U.S. businesses in the transportation sector, especially small, women-owned, and disadvantaged businesses.

CROSSCUTTING RD&T PRIORITY AREAS FOR IMPROVING ECONOMIC COMPETITIVENESS

- Financial policies and practices that affect the overall efficiency and competitiveness of the transportation system.

- Freight transportation data collection and analysis to better inform freight time reliability and investment decisions to support projected capacity and resilience needs.
- Technologies and operational approaches to increase operational efficiency, improve multimodal connectivity, and reduce noise and air pollution of national freight networks, using all transportation resources and collaborating with freight systems owners and operators.
- Policies that encourage the most efficient use of transportation assets through comparisons of safety, fuel, and environmental benefits between and among modes.

RD&T PRIORITY AREAS FOR IMPROVING ECONOMIC COMPETITIVENESS THROUGH HIGHWAYS

- Operational strategies to reduce the impact of planned and unplanned events, including effective traffic incident management; improved traveler information systems; arterial, corridor, and network management; and technologies that manage the safety and mobility impacts of work zones and consider user impacts in engineering lifecycle analyses.
- Allowing State and Federal motor carrier regulatory agencies to perform their regulatory functions (compliance with size, weight, credentials, and safety requirements) while allowing commercial motor vehicles (CMVs) to operate at highway speeds.

RD&T PRIORITY AREAS FOR IMPROVING ECONOMIC COMPETITIVENESS THROUGH TRANSIT

- Improved transit services and increased transit capacity, such as improvements to bus and rail operations, vehicles and infrastructure, and transit industry analysis.

RD&T PRIORITY AREAS FOR IMPROVING ECONOMIC COMPETITIVENESS THROUGH AVIATION

- Airspace access and separation standards to increase capacity and safely allow more efficient use of congested airspace.

- Efficient and timely compliance with regulatory environmental requirements on proposed airport capacity projects in metropolitan areas to enhance environmental sustainability while reducing total system delays.

RD&T PRIORITY AREAS FOR IMPROVING ECONOMIC COMPETITIVENESS THROUGH RAIL

- Methods for projecting freight traffic demand.
- Costs and benefits of alternative infrastructure investment strategies that would provide greater freight rail capacity.
- Development of a domestic passenger rail equipment manufacturing base.
- Effect of environmental assessment requirements on delaying infrastructure investments and making appropriate improvements to the environmental review process.

RD&T PRIORITY AREAS FOR IMPROVING ECONOMIC COMPETITIVENESS THROUGH MARITIME TRANSPORT

- Tools and activities that evaluate modal and multimodal opportunities that can provide increased capacity to move cargo and people most cost effectively in the short and long term.

PERFORMANCE MEASURES FOR IMPROVING ECONOMIC COMPETITIVENESS

Strategic Outcomes	Proposed Performance Measures
Maximum economic returns from transportation infrastructure investments.	<ul style="list-style-type: none"> • Number of major projects assessed for appropriateness of innovative financing, procurement, or revenue-generating approaches. • Number of projects that apply innovative technologies to improve project delivery times during project development, design, or implementation. • Reduction of delay duration and variability throughout the freight transportation system.
Improved operations of transportation systems in order to increase competitiveness and responsiveness to consumer needs.	<ul style="list-style-type: none"> • Targets met for deployment and implementation of NextGen system components.
Advancement of U.S. transportation industry interests in targeted markets around the world.	<ul style="list-style-type: none"> • Increased level of foreign market penetration of U.S. transportation technologies and services. • Forty percent of all commercial aircraft from the top 25 aviation States are using fully interoperable NextGen technologies and capabilities by 2018. • Increase harmonization of vehicle communication standards to support vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) safety applications across international vehicle manufacturers.
Expanded opportunities for U.S. businesses in the transportation sector, especially small, women-owned, and disadvantaged businesses.	<ul style="list-style-type: none"> • Number of new U.S. businesses in the transportation sector that qualify as small, women-owned, or disadvantaged.

LIVABLE COMMUNITIES

“Foster livable communities through place-based policies and investments that increase transportation choices and access to transportation services.” – DOT

Fostering livable communities — places where transportation, housing, and commercial development investments are coordinated so that people have access to adequate, affordable, and environmentally sustainable travel options — is a transformational DOT policy shift.

Over the last 50 years U.S. transportation investment has frequently not been well coordinated with other infrastructure investments, such as housing and commercial development. This has contributed to the growth of low-density, scattered, automobile-dependent communities and disinvestment in many of our Nation’s core urban centers. Single-use zoning that separates housing from shopping, work, and schools has also intensified the trend. This type of zoning emphasizes wide streets, ample off-street parking, and large front and side yard setbacks. Federal programs for road construction have also promoted broad, high-speed roadways, even in quiet residential communities.

In communities with transportation alternatives, households can save an estimated \$8,700 per year on transportation costs.

- Transportation For America

Livable communities have higher economic resilience and more economic opportunities through reliable and timely access to employment centers, educational opportunities, services, and other basic needs. They provide expanded business access to markets—mainly through increased accessibility and mobility choices.

Many communities are located on navigable waterways. By using ferries and other maritime transportation, and ensuring there are convenient links to other modes of mass transit, it may be possible to relieve congestion on bridges, tunnels, and associated roadways and improve the mobility and quality of life for members of the community.

Seniors (and others who cannot or do not drive) face similar mobility limitations. According to U.S. Census projections, by 2020, 53 million Americans will be over the age of 65, and 25 percent of those seniors will be unable to drive,³¹ making alternatives to driving essential for access to essential destinations (e.g., medical services, grocery stores, and retail locations).

The Housing and Urban Development (HUD), DOT, and the Environmental Protection Agency (EPA) Interagency Partnership for Sustainable Communities has created a platform for high-level leadership in each agency to guide critical research efforts to understand the connections between transportation, housing and community development initiatives, and the use of land, energy, and water resources.

In 2006, the Federal Transit Administration (FTA) and Federal Highway Administration (FHWA) collaborated on revising the Statewide and Metropolitan Transportation Planning requirements that were part of a “livable communities” model implementation. These requirements were comprehensive and featured new components, such as the required coordination between human service agencies and transit service providers to ensure that underserved populations had adequate and expanded mobility options. Many of the proposed changes in the planning requirements were based on DOT research studies.

A 2006 Non-Motorized Transportation Pilot Program funded four diverse communities to enhance bicycle and pedestrian infrastructure, planning, and public outreach activities.³² Each pilot community used a share of available funding to rigorously evaluate the effect of the program on travel behavior. Pilot research projects like this show the effectiveness of innovative transportation alternatives and “livable communities” approaches.

STRATEGIC OUTCOMES OF LIVABLE COMMUNITIES RESEARCH

- Increased access to convenient and affordable transportation choices.
- Improved public transit and rail transportation experience.
- Improved networks that accommodate pedestrians and bicycles.
- Improved access to transportation for people with disabilities and older adults.

CROSSCUTTING RD&T PRIORITY AREAS FOR PROMOTING LIVABLE COMMUNITIES

- Access to human services and transportation providers for older adults, people with disabilities, low income individuals, and suburban and rural residents, allowing them to live and travel independently.
- Transportation systems designed to promote connectivity and multimodalism.
- Technologies and systems that provide relevant information to transportation users and help them make informed travel decisions.

- Tools and information to enhance local planning processes for livability assessment, including synthesizing existing State and local measures and metrics on livability, especially those that quantify the nontransportation benefits of livability.

RD&T PRIORITY AREAS FOR PROMOTING LIVABILITY THROUGH RESEARCH IN HIGHWAYS

- Integration of bicycle and pedestrian pathways into vehicular and roadway design guidelines and standards.
- Walkability index to rate an area's pedestrian friendliness and allow more effective funding decisions to enhance walking.
- Technical assistance to State, Tribal, and local agencies to enhance measurements of livability status and improvements.
- A forecasting model of variables that affect an area's non-motorized trips.

RD&T PRIORITY AREAS FOR PROMOTING LIVABILITY THROUGH RESEARCH IN TRANSIT

- Access to convenient, connected, affordable, and extensive public transportation (coverage and interconnectivity).
- Public transportation convenience and reliability (service quality).
- Synergies between public transportation, land use, housing, and communities.

RD&T PRIORITY AREAS FOR PROMOTING LIVABILITY THROUGH RESEARCH IN AVIATION[‡]

- Reduction of significant aviation noise and emissions impacts on human health, climate change and social welfare in absolute terms to enable the air traffic system to handle growth in demand.
- Improved access to surface transportation systems at airports.

[‡] The National Aviation Research Plan details the R&D targets and the method of validation in order to achieve these milestones.

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RD&T PRIORITY AREAS FOR PROMOTING LIVABILITY THROUGH RESEARCH IN RAIL

- Potential negative impacts of rail service or expanded rail service on livability (e.g., train noise and grade crossings) and methods to address them.
- Methodologies to evaluate the costs, benefits, and feasibility of creating rail freight “by-passes” around cities and using former freight routes for commuter or light rail service.
- Barriers to expanded commuter and light rail service and alternatives to address them.

RD&T PRIORITY AREAS FOR PROMOTING LIVABILITY THROUGH RESEARCH IN MARITIME TRANSPORTATION

- Methods and technologies to increase access to convenient, affordable waterborne transportation options for passengers and cargo.
- Methods and technologies to improve maritime modal connectivity with other modes of mass transit.
- Application of technology to reduce congestion and environmental impacts around maritime ports.

PERFORMANCE MEASURES FOR PROMOTING LIVABLE COMMUNITIES

Strategic Outcomes	Proposed Performance Measures
Increased access to convenient and affordable transportation choices.	<ul style="list-style-type: none"> • Number of people using public transportation and other forms of desired transportation that promote livable communities. • Increase in transit trips in nonurbanized areas. • Maintenance of continuous air service at 98 percent of Essential Air Service eligible communities. • Increase in transit seat-miles by urbanized area transit systems. • Increase (in the average percent change) in transit boardings per transit market (150 largest transit agencies). • Availability of intermodal connection options at transit facilities. • Number of intermodal connections made with single fare payments or within unified payment systems.
Improved public transit and rail transportation experience.	<ul style="list-style-type: none"> • Reduction in average commute time. • Increased transit vehicle reliability.
Improved networks that accommodate pedestrians and bicycles.	<ul style="list-style-type: none"> • Number of States with policies to improve transportation choices for walking and bicycling. • Increased number of States and MPOs that address walking and bicycle activities in planning documents. • Improvements in walkability index.
Improved access to transportation for people with disabilities and older adults.	<ul style="list-style-type: none"> • Percent of bus fleets compliant with the Americans with Disabilities Act (ADA). • New designs of vehicles for increasing weight and size of wheelchairs.

ENVIRONMENTAL SUSTAINABILITY

“Advance environmentally sustainable policies and investments that reduce carbon and other harmful emissions from transportation sources.” – DOT

The transportation of passengers and goods is central to our economy and quality of life; however, there are adverse effects on the environment from building, operating, and maintaining the transportation system. The DOT must work to achieve a balance between environmental challenges and the need for a safe and efficient transportation network. The transportation sector is a significant source of greenhouse gas (GHG) emissions, accounting for 27 percent of total U.S. GHG emissions in 2008.³³

Transportation activities account for a large percentage of emissions from the major criteria air pollutants regulated by the EPA: 78 percent of carbon monoxide emissions, 58 percent of nitrogen oxide emissions, and 36 percent of volatile organic compounds emissions.³⁴

The transportation sector consumes 28 percent of U.S. energy, almost all of which is in the form of petroleum.³⁵ This share continues to grow rapidly compared to other major end-user sectors. Transportation accounts for 72 percent of U.S. oil consumption.³⁶ The extraction, distribution, refinement, and subsequent transportation of petroleum-based fuels and products contribute to spills, pollution, and adverse safety issues.

Over the past four decades, substantial progress has been made in reducing emissions of urban air pollutants both nationally and from the transportation sector in particular. From 1970 to 2008, the United States reduced transportation sector emissions: carbon monoxide by 67 percent, volatile organic compounds by 68 percent, and nitrogen dioxide by 38 percent,³⁷ largely by progressively strengthening regulations of emissions under the Clean Air Act of 1963 and the Clean Air Act Amendments of 1990. This is a significant achievement since during the same period there was a 50 percent increase in the U.S. population, a tripling of gross domestic product (GDP), and a 150 percent increase in passenger-miles traveled.³⁸

Nonetheless, as of 2007, some 158.5 million Americans lived in counties or regions that exceeded health-based national ambient air quality levels for at least one regulated air pollutant.³⁹ Significant challenges remain, particularly as new national ambient air quality standards are revised to be more protective of public health. These challenges also apply to individual neighborhoods, travel corridors, and local facilities.

Much like the Safety strategic focus area, solutions to these issues may be found in many places: laws, policies, economic systems, and often in innovative technologies and scientific advancements attained through research.

To encourage innovation, the DOT currently funds a number of RD&T programs that address environmentally sustainable transportation while maintaining a safe and efficient transportation network. Research in this area is improving our understanding of the broad environmental impacts of aviation, highway, rail, pipeline, and hazardous materials transportation activities.

RD&T programs are seeking ways to reduce the adverse impacts from transportation through mitigation measures and through improvements to environmental standards, innovative planning tools, and engineering analyses that incorporate sustainability. RD&T programs are also proactively developing greener methods and materials for infrastructure construction.

In addition, we also need to take a systems approach to reducing transportation environmental impacts and increasing our overall energy efficiency and independence. This includes research and development to generate tools and resources for evaluating modal and multimodal opportunities to better integrate modal shifts for improved environmental stewardship and energy efficiency.

STRATEGIC OUTCOMES OF ENVIRONMENTAL SUSTAINABILITY RESEARCH

- Reduction in transportation-related carbon emissions, improved energy efficiency, and reduction in use of oil in the transportation sector.
- Reduction in transportation-related air, water, and noise pollution and impacts on ecosystems and human welfare.
- Increased use of environmentally sustainable practices and materials in the transportation sector, especially for DOT-owned or controlled transportation assets.

CROSSCUTTING RD&T PRIORITY AREAS FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY OF THE TRANSPORTATION SYSTEM-AT-LARGE

- Infrastructure and distribution systems for advanced transportation energy sources, including electricity and alternative fuels, and research into energy generation and distribution through existing public rights-of-way.
- Policy development through the DOT Center for Climate Change and Environmental Forecasting⁴⁰ to reduce transportation-related greenhouse gases

(including cap-and-trade, carbon taxes, modal shifts, and other measures) and to mitigate the effects of global climate change on the transportation network.

- Materials, technologies, and practices to reduce energy consumed for, and the environmental impacts of, transportation infrastructure construction and rehabilitation; this includes material construction and placement.
- Policies and programs to encourage industry to develop and implement innovative technologies that are more sustainable and processes to apply lifecycle analysis to products and systems.

RD&T PRIORITY AREAS FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY OF HIGHWAYS

- Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies and data from vehicles on emissions and fuel consumption to better manage the transportation network for reduction in greenhouse gases.
- Promote environmentally friendly highways through use of recyclable techniques, renewable materials, permeable surfaces, and storm water runoff mitigation techniques.
- Provide educational materials, especially through the Every Day Counts Initiative, to ensure Federal, State, Tribal and local partners have the capacity to address climate change in their transportation plans and programs, and develop Agency Climate Action Plans.

RD&T PRIORITY AREAS FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY OF TRANSIT SYSTEMS

- Technologies to reduce the energy consumption and greenhouse gas emissions of transit systems, including bus and rail electric drive, facility improvements, and alternative fuel technologies for buses.
- Alternative fuel buses, including hydrogen fuel cell buses and diesel-electric hybrid buses.
- Alternative fuels infrastructure investment for transit and bus rapid transit systems across the United States.

RD&T PRIORITY AREAS FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY OF AVIATION SYSTEMS

- International aircraft noise and emissions standards; practices and guidance materials for solutions that are technologically feasible, economically reasonable, provide measurable benefits, and consider the interdependencies between emissions, noise, and fuel burn.⁴¹
- Lower energy consumption, emissions, and noise through accelerated aircraft technology maturation and improved operational procedures; advance and demonstrate use of aviation alternative fuels through the Continuous Lower Energy Emissions and Noise (CLEEN) Program and by continuing to support the Commercial Aviation Alternative Fuels Initiative (CAAFI).⁴²
- Low-emission airport technology through the innovative Voluntary Airport Low Emission (VALE) program, ranging from alternative fuel vehicles and aircraft ground support equipment to various infrastructure improvements (like gate electrification) to reduce aircraft emissions at the gate.⁴³

RD&T PRIORITY AREAS FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY OF RAIL SYSTEMS

- Technologies that can be retrofitted to improve locomotive and power car energy efficiency while reducing harmful emissions.
- Alternative fuels to lower locomotive energy for traction consumption and emissions.
- Electrically powered passenger and freight rail transportation.
- Releases of hazardous materials from tank cars.

RD&T PRIORITY AREAS FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY OF PIPELINE SYSTEMS

- Reduced volume of pipeline product released to the environment.
- Safe transportation of alternative fuels in pipelines.

RD&T PRIORITY AREAS FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY OF MARITIME SYSTEMS

- Maritime environment and compliance activities that improve marine air emissions, energy efficiency, and alternative energy usage.

- Effective ballast water treatment systems and compliance monitoring methods.

PERFORMANCE MEASURES FOR ADVANCING ENVIRONMENTAL SUSTAINABILITY

Strategic Outcomes	Proposed Performance Measures
Reduction in transportation-related carbon emissions, improved energy efficiency, and reduction in use of oil in the transportation sector.	<ul style="list-style-type: none"> • Number and scale of projects funded or implemented by DOT related to alternative fuels for private vehicles and transit vehicles.
Reduction in transportation-related air, water and noise pollution and impacts on ecosystems and human welfare.	<ul style="list-style-type: none"> • Number of States, Tribal, or local agencies with a Climate Action Plan to reduce greenhouse gas emissions from transportation.
Increased use of environmentally sustainable practices and materials in the transportation sector, especially for DOT-owned or controlled transportation assets.	<ul style="list-style-type: none"> • Number of new commercialized pipeline technologies and new or strengthened consensus standards.

PLAN IMPLEMENTATION

The implementation, evaluation, and modification of this RD&T Strategic Plan is a four-step process:

- 1) Identify program priorities.
- 2) Gauge success of research outcomes based on performance measures.
- 3) Modify Strategic Plan RD&T Priority Areas.
- 4) Update performance measures.

By successfully carrying out this process, DOT ensures that the RD&T Program follows its commitment to: (1) funding and undertaking relevant research; (2) carrying out high-quality, peer-reviewed research; (3) disseminating the results of research through technology transfer and stakeholder outreach; and (4) helping to implement successful new technologies or processes.

IDENTIFY PROGRAM PRIORITIES

Based on the desired outcomes and global areas of research described in this Strategic Plan, each operating administration will develop their own strategic plans and/or roadmaps and use them as a guide in allocating research resources and initiating research programs.

The Planning Team will use RITA's cross-modal research collaboration tools, such as the Research Clusters and Research Hub, to help identify and facilitate multimodal research. Multi-modal research projects will be coordinated through the Research Clusters and assigned to specific Research Clusters based on the individual projects. The Planning Team will use the DOT Research Hub where feasible in order to identify potential areas of multimodal research activity within the clusters. By facilitating multimodal research and identifying any duplicate efforts, the Research Hub will increase the efficiency of research programs within individual operating administrations.

GAUGE SUCCESS OF RESEARCH OUTCOMES BASED ON PERFORMANCE MEASURES

Each year the RD&T Planning Team will use performance measures listed in the RD&T Plan to review progress made toward meeting the strategic outcomes in the Plan.

MODIFY STRATEGIC PLAN RD&T PRIORITY AREAS

As needed, the RD&T Planning Team will modify the RD&T Priority Areas of Effort based on their annual review of the Plan. This may lead to changes in direction for research programs, particularly at the cross-modal level.

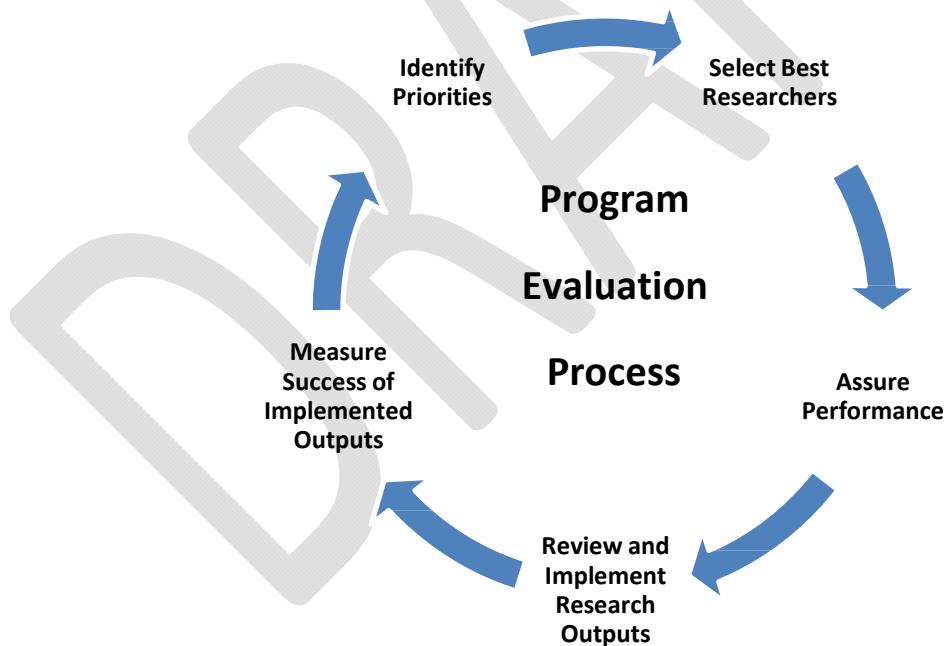
UPDATE PERFORMANCE MEASURES

The RD&T Planning Team will review and update performance measures when priority areas of effort are modified or when new sources of data are developed or identified and used to effectively gauge the success of research outcomes.

PROGRAM LEVEL EVALUATION

Program evaluation is one of the mandatory elements of the Government Performance and Results Act (GPRA). The statute calls for agencies to use program evaluations to assess the manner and extent to which their programs achieve intended objectives; include a summary of the findings of program evaluations completed in their Performance and Accountability Reports with a notation if no evaluations were completed; and present a schedule for future program evaluations in Strategic Plans. This plan employs a five-step program evaluation process in alignment with the objectives of GPRA.

The five-step research program evaluation process is similar to the four-step RD&T Strategic Plan evaluation process, but provides more detail, as shown below:



Identify Priorities

Based on the DOT RD&T Strategic Plan, operating administration RD&T strategic plans and research roadmaps, the operating administrations will develop research programs and projects within programs. The intent is to achieve the strategic outcomes listed in

the DOT RD&T Strategic Plan. Project selection and development should also include input from interested stakeholders.

Select Best Researchers

The selection of researchers to execute specified research projects is expected to follow best practices of the scientific research community, including open competition and peer review. It is essential that qualified, capable, and responsible researchers or research teams are selected to perform DOT-funded research projects.

Assure Performance

Monitoring of researchers by qualified program managers is required to guarantee research results in a timely manner. It will also ensure an efficient use of DOT funds. This monitoring will include periodic in-depth reviews of research progress, including presentations by the researchers when needed.

Review and Implement Research Results

The results of completed research projects must be reviewed not only by program managers and DOT experts, but also by research peers and end users. These reviews are essential to maintain research quality and integrity and to introduce any new technologies or processes developed to those implementing the research results.

It is important to note that not all research produces a positive result when a new technology or process is developed. There are times when research results are negative and the decision is made that the technology or process is not feasible or does not work. This information is still very important, even though there is no implementation, and must be disseminated to eliminate any future research effort that would unnecessarily duplicate previous efforts.

The implementation of new technologies and processes will require a major commitment from the DOT in both policy and funding. In cooperation with infrastructure owners and operators, the DOT will develop approaches to streamline approval procedures and to identify sources of funding to cover the initial higher costs of implementing new technologies or processes.

Measure Success of Implemented Outcomes

The success of implemented outcomes will be measured using the performance measures listed in the tables in each of the five Focus Areas. Based on the results, strategic outcomes or RD&T priority areas may be changed within the RD&T Strategic Plan as part of the annual review. As these measurements are incorporated into the setting of priorities this will close the program evaluation process feedback loop (illustrated on the previous page) and initiate a new cycle.

The RD&T Strategic Plan is reviewed each year but many research outcomes will not take effect for years. This means there will be little data with which to adjust priorities in the first two or three years, but more data in later years that can be used to make major adjustments in strategic outcomes and RD&T priorities. This does not mean the Plan should not be reviewed early in its lifecycle. DOT must conduct annual reviews, starting with the first year, to maintain the validity and usefulness of the Plan.

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APPENDICES

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APPENDIX A: STAKEHOLDER INVOLVEMENT IN PLAN DEVELOPMENT

Stakeholders both inside and outside the Federal Government bring a unique perspective to research needs and strategies. Stakeholders include staff members at other Federal agencies, the private sector and industry associations, academic institutions and academic researchers, nonprofit advocacy organizations, State and local governments, and the general public.

RITA used the following approaches to obtain input for the RD&T Strategic Plan from stakeholders:

- Meeting with stakeholder groups to announce the development of the Strategic Plan;
- Opening a Federal docket to collect comments from stakeholders prior to developing the plan;
- Using an expert panel to review and analyze stakeholder comments and ensure comments were addressed in subsequent drafts of the plan; and
- Requesting comments from RD&T planning team members, their staff, and colleagues.

REFERENCES

- ¹ U.S. DOT Draft Strategic Plan FY2010 – FY2015, http://www.dot.gov/stratplan/dot_strategic_plan_10-15.pdf
- ² *Transportation for Tomorrow: Report of the National Surface Transportation Policy and Revenue Study Commission*, p. 31, http://transportationfortomorrow.com/final_report/index.htm.
- ³ *The Norman Y. Mineta Research and Special Programs Improvement Act* (P.L. 108-426, Nov. 30, 2004, the “Mineta Act”) created the Research and Innovative Technology Administration (RITA) and assigned it these responsibilities.
- ⁴ For more information on DOT Research Clusters see http://www.rita.dot.gov/rdt/dot_research_clusters.html
- ⁵ Government Accountability Office, “Transportation Research: Opportunities for Improving the Oversight of DOT’s Research Programs and User Satisfaction with Transportation,” August 2006, <http://www.gao.gov/new.items/d06917.pdf>
- ⁶ The Stevenson-Wydler Technology Innovation Act of 1980 directs large Federal laboratories to establish Offices of Research and Technology Applications (ORTA) to support technology transfer activities. RITA’s Technology Transfer Program intends to fulfill the requirements of the ORTA.
- ⁷ Center for Disease Control, *National Vital Statistics Reports*, Vol. 59, No. 4, Table 7, p. 53. http://www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_04.pdf
- ⁸ National Highway Traffic Safety Administration’s Fatality Analysis Reporting System. *As cited in U.S. DOT Draft Strategic Plan.*
- ⁹ Federal Motor Carrier Safety Administration, *Commercial Motor Vehicle Facts*, <http://www.fmcsa.dot.gov/facts-research/facts-figures/analysis-statistics/cmvfacts.htm>
- ¹⁰ Environmental Protection Agency, MOVES2010 Highway Vehicle, Population and Activity Data, <http://www.epa.gov/otag/models/moves/420r10026.pdf>
- ¹¹ Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 2-34.
- ¹² Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 2-14
- ¹³ Federal Railroad Administration, Office of Safety Analysis, 1.01 Accident/Incident Overview, <http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/statsSas.aspx>

¹⁴ Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 2-50.

¹⁵ Ibid.

¹⁶ U.S. DOT Draft Strategic Plan FY2010 – FY2015,
http://www.dot.gov/stratplan/dot_strategic_plan_10-15.pdf

¹⁷ For example, FHWA's Office of Asset Management also provides technical assistance to State DOTs on best practices, asset inventory development and data management support, decision support tool use and development (e.g., HERS-ST), and workshops, conferences and networking.

¹⁸ See FHWA's HERS-ST (Highway Economic Requirements System - State Version), an engineering/economic analysis (EEA) tool that uses engineering standards to identify highway deficiencies, and then applies economic criteria to select the most cost-effective mix of improvements for systemwide implementation.

¹⁹ For more information on the Airport Cooperative Research Program see
<http://www.trb.org/ACRP/ACRP.aspx>

²⁰ For more information on the FAA Airport Technology Research Program see
<http://www.airporttech.tc.faa.gov/>

²¹ Federal Highway Administration, *Key Freight Transportation Challenges*,
<http://ops.fhwa.dot.gov/freight/publications/fhwaop03004/congest.htm>

²² Texas Transportation Institute, *International Border Crossing Truck Travel Time for 2001*,
http://www.ops.fhwa.dot.gov/freight/freight_analysis/brdr_synthesis/sect_5.htm#fig3.

²³ Federal Highway Administration, *Freight Transportation: Improvements and the Economy*,
http://ops.fhwa.dot.gov/freight/freight_analysis/improve_econ/.

²⁴ Research and Innovative Technology Administration, Bureau of Transportation Statistics, *Airline On-Time Statistics*,
http://www.bts.gov/programs/airline_information/airline_ontime_statistics/.

²⁵ Air Transport Association, *Cost of Delays*, <http://www.airlines.org/economics/cost+of+delays/>.

²⁶ Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-73: Amtrak On-Time Performance Trends and Hours of Delay by Cause, January 2011,
http://www.bts.gov/publications/national_transportation_statistics/html/table_01_73.html

²⁷ Federal Highway Administration, *Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level*, Chapter 1, April 2005,
<http://www.fhwa.dot.gov/environment/freightag/chapter1.htm>.

²⁸ Jones, Crystal, "Perspective on Freight Congestion", *Public Roads*, July/August 2007, Vol. 71, No. 1. <http://www.tfrc.gov/pubrds/07july/06.htm>.

²⁹ For more information on FAA's Next Generation Air Transportation System see <http://www.faa.gov/nextgen/>

³⁰ For more information on ITS JPO Connected Vehicle Research see http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm

³¹ American Medical Association, *Physician's Guide to Assessing and Counseling Older Drivers*, 2nd edition, June 2010, http://www.nhtsa.gov/staticfiles/nti/older_drivers/pdf/811298.pdf

³² For more information on the Nonmotorized Transportation Pilot Program see <http://www.fhwa.dot.gov/environment/bikeped/ntpp.htm>

³³ Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2008*, http://www.epa.gov/climatechange/emissions/downloads10/US-GHG-Inventory-2010_Report.pdf.

³⁴ Environmental Protection Agency, Technology Transfer Network, *Clearinghouse for Inventories and Emissions Factors, National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*, <http://www.epa.gov/ttn/chief/trends/>.

³⁵ U.S. Energy Information Administration, *U.S. Primary Energy Flow by Source and Sector, 2009*, http://www.eia.gov/totalenergy/data/annual/pecss_diagram.cfm

³⁶ Ibid.

³⁷ Environmental Protection Agency, *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*, <http://www.epa.gov/ttnchie1/trends/>

³⁸ Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics*

³⁹ U.S. DOT Draft Strategic Plan FY2010 – FY2015, http://www.dot.gov/stratplan/dot_strategic_plan_10-15.pdf

⁴⁰ For more information about the DOT Center for Climate Change and Environmental Forecasting see <http://climate.dot.gov/>

⁴¹ For example, FAA is conducting a study to identify and assess metrics for carbon dioxide (CO₂) emissions from aircraft that may potentially be used to set standards for the certification of new aircraft and to monitor the operational performance of the commercial aircraft fleet. The results of the study will be provided within the work program of the International Civil Aviation Organization (ICAO)'s Committee on Aviation Environmental Protection for considering development of the aircraft CO₂ standard by the end of 2012.

⁴² CAAFI is a forum for the worldwide commercial aviation community to engage the emerging alternative fuels industry and to work together, share and collect needed data, and direct research on aviation alternative fuels.

⁴³ For more information about the Voluntary Airport Low Emission Program see <http://www.faa.gov/airports/environmental/vale/>