NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

NATIONAL TRANSPORTATION TECHNOLOGY PLAN

Committee on Technology
Subcommittee on Transportation Research and Development

May 2000

Prepared by:

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Research and Special Programs Administration
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The purpose of this report is to highlight ongoing Federal research efforts in the transportation technology field and to identify new and promising areas where there might be gaps in Federal support. The report is intended for internal planning purposes within the Federal agencies and as a mechanism to convey to the science and technology community the types of research and research priorities being sponsored and considered by the Federal agencies. The Administration is committed to a broad range of high-priority investments (including science and technology), to deficit reduction, and to a smaller, more efficient Federal Government. These commitments have created a very challenging budget environment—requiring difficult decisions and a well-thought-out strategy to ensure the best return for the Nation's taxpayers. As part of this strategy, this document does not represent the final determinant in an overall Administration budget decision-making process. The research programs presented in this report will have to compete for resources against many other high-priority Federal programs. If these programs compete successfully, they will be reflected in future Administration budgets.

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16. Abstract

This is one of two implementation documents for the National Transportation Science and Technology Strategy. It deals with the development of implementation partnerships intended to bring key technologies addressing thirteen key topic areas into service. The Plan considers the roles of a broad range of parties involved in the transportation enterprise: Federal government agencies; State, local, and tribal agencies; academic institutions, and the private sector. Four of the partnerships represent well-established R&D programs: aviation safety research alliance; next generation global air transportation; national intelligent transportation infrastructure; and the intelligent vehicle initiative. The other nine partnerships require coordination to define and implement integrated actions, many of which will involve existing R&D programs: next generation transportation vehicles; transportation and sustainable communities; transportation infrastructure assurance; enhanced freight and goods movement at gateways; monitoring, maintenance, and rapid renewal of the physical infrastructure; maritime safety research alliance; next generation space transportation technology; accessibility for aging and transportation-disadvantaged populations; and enhanced transportation weather services.

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ABSTRACT

The National Science and Technology Council (NSTC) Committee on Technology, Subcommittee on Transportation Research and Development (R&D), has created a *National Transportation Technology Plan* that builds on the initial *Technology Plan* released in 1998 to present updated implementation strategies for the technology partnerships identified in the 1999 NSTC *National Transportation Science and Technology Strategy*. This national *Strategy* broadened the first *Transportation Science and Technology Strategy*, published in 1997, to incorporate an even greater role for State, local, and tribal agencies; academic institutions; industry; and the larger transportation enterprise.

Like its predecessor, the national *Strategy* provided a direction and framework for transportation R&D rather than a description of all research or a strategic plan. It encompassed the earlier strategy's four-tiered approach: Strategic Planning and Assessment, Private–Public Technology Partnerships, Enabling Research, and Education and Training. This document, the *National Transportation Technology Plan*, identifies the critical elements of the technology partnerships planned for the 2000–2010 time frame. It includes new partnerships on maritime safety and space transportation, broadens the scope of some partnerships, and clarifies the links between the partnerships and specific Federal programs.

Although this document focuses on technology, in many cases non-technological approaches may be equally beneficial to implement. The partnerships fall into two broad categories: (1) those representing existing, well-established Federal R&D activities, and (2) new efforts requiring further definition and interagency coordination. Both categories require broadened collaboration among government, industry, and academia to achieve the improvements in transportation needed in America and globally in the next century.

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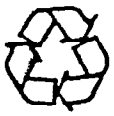

About the National Science and Technology Council

President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This cabinet-level council is the principal means for the President to coordinate science, space, and technology policies across the Federal Government. NSTC acts as a "virtual" agency for science and technology to coordinate the diverse parts of the Federal research and development enterprise. The NSTC is chaired by the President. Membership consists of the Vice President, Assistant to the President for Science and Technology, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other White House officials.

An important objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in areas ranging from information technologies and health research, to improving transportation systems and strengthening fundamental research. The Council prepares research and development strategies that are coordinated across Federal agencies to form an investment package that is aimed at accomplishing multiple national goals.

To obtain additional information regarding the NSTC, contact the NSTC Executive Secretariat at 202-456-6102.

THE DEPUTY SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

Dear Colleague:

In 1997, the National Science and Technology Council released the first *Transportation Science and Technology Strategy*. This landmark document set forth an integrated set of directions for Federal technology development, enabling research, and education and training applicable to transportation. In April 1999, the *National Transportation Science and Technology Strategy* broadened these elements to incorporate an even greater role for the larger transportation enterprise: State, local, and tribal agencies; academic institutions; and the private sector.

A key element of the *National Strategy* and its predecessor is private - public partnerships to foster innovative technology solutions to meet the nation's transportation goals of safety, mobility, economic growth and trade, an improved human and natural environment, and national security. This document, the *National Transportation Technology Plan,* builds on the initial *Technology Plan* released in 1998 to present updated implementation strategies for these partnerships. In particular, this plan includes new partnerships on maritime safety and space transportation, broadens the scope of some partnerships, and clarifies the links between the broader technology partnerships and specific Federal programs. Like the first *Technology Plan*, this national plan is the main vehicle for setting these crucial private – public partnerships into action.

Science and technology will be key to meeting the diverse transportation challenges of a new century. This *National Transportation Technology Plan* is yet another step in a process that brings together all partners in the transportation enterprise to ensure that we have the safe, secure, efficient, and sustainable transportation system that we need.

Sincerely,

Mr. Mortimer Downey
Chair

Dr. Henry Kelly
White House Co-Chair

Committee on Technology, Subcommittee on Transportation R&D
National Science and Technology Council

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EXECUTIVE SUMMARY

The National Science and Technology Council (NSTC) developed the first *Transportation Science and Technology Strategy* in 1997 to help Congress and the Administration establish national transportation research and technology priorities and coordinated research activities. Published in 1999, the NSTC's *National Transportation Science and Technology Strategy* broadened these elements to incorporate an even greater role for State, local, and tribal agencies; academic institutions; industry; and the larger transportation enterprise. Like its predecessor, the national *Strategy* provided a direction and framework for transportation research and development (R&D) rather than a description of all research or a strategic plan. It encompassed the earlier strategy's four-tiered approach:

Strategic Planning and Assessment
Private–Public Technology Partnerships
Enabling Research
Education and Training

This document, the *National Transportation Technology Plan,* builds on the initial *Technology Plan* released in 1998 to present updated implementation strategies for the private–public technology partnerships in the national *Strategy* and its predecessor. It differs from the 1998 plan in four ways:

It includes new partnerships on maritime safety and space transportation.

It renames and broadens the scope of the partnerships on next generation vehicles and transportation security.

It clarifies the links between the broader technology partnerships and specific Federal programs.

It increases the time span shown on the partnerships' technology roadmaps from eight years to ten.

As defined in the *Strategy*, the technology partnerships in this plan meet three criteria: (1) they address national needs; (2) they focus on technology; and (3) they could rely on the private sector for implementation. Each partnership benefits the country as a whole and could not proceed without some cost-shared Federal support. The partnerships are intended to focus ongoing Federal activities to address national transportation goals—with any new support to be developed within the overall funding limits and constraints already established.

The partnerships fall into two broad categories: (1) those representing well-established Federal R&D activities, and (2) new efforts requiring further definition and interagency coordination.

Four partnerships represent well-established R&D programs. For these, the focus has been on relating the partnership to a broader research agenda; folding it in with other Federal programs; and, where appropriate, expanding its scope or coupling activities that have natural linkages. The partnerships are:

Aviation Safety Research Alliance
Next Generation Global Air Transportation
National Intelligent Transportation Infrastructure
Intelligent Vehicle Initiative

Although many encompass existing R&D programs, the other nine partnerships require coordination to define and implement integrated actions. Future progress will depend on the continued encouragement of such efforts. These nine partnerships are:

Next Generation Transportation Vehicles[1]
Transportation and Sustainable Communities
Transportation Infrastructure Assurance[2]
Enhanced Goods and Freight Movement at Domestic and International Gateways
Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure
Maritime Safety Research Alliance[3]
Next Generation Space Transportation Technology[4]
Accessibility for Aging and Transportation-Disadvantaged Populations
Enhanced Transportation Weather Services

This document is available on the World Wide Web at:

http://scitech.dot.gov

[1] Formerly Next Generation Surface and Marine Transportation Vehicles.
[2] Formerly Total Terminal Security.
[3] New technology partnership.
[4] New technology partnership. Named "Space Transportation Technologies" in the NSTC *National Transportation Science and Technology Strategy.*

1. INTRODUCTION

The National Science and Technology Council (NSTC) developed the first *Transportation Science and Technology Strategy* in 1997 to help Congress and the Administration establish national transportation research and technology priorities and coordinated research activities. Published in 1999, the NSTC's *National Transportation Science and Technology Strategy* broadened these elements to incorporate an even greater role for State, local, and tribal agencies; academic institutions; industry; and the larger transportation enterprise. Like its predecessor, the national *Strategy* provided a direction and framework for transportation research and development (R&D) rather than a description of all research or a strategic plan. It encompassed the earlier strategy's four-tiered approach:

Strategic Planning and Assessment
Private–Public Technology Partnerships
Enabling Research
Education and Training

This document, the *National Transportation Technology Plan,* builds on the initial *Technology Plan* released in 1998 to present updated implementation strategies for the private–public technology partnerships in the national *Strategy* and its predecessor.[1] As Figure 1 shows, the plan is just one of the supporting documents presenting detailed information on *Strategy* implementation.

PRIVATE–PUBLIC TECHNOLOGY PARTNERSHIPS

As defined in the national *Strategy*, the private–public technology partnerships meet three criteria: (1) they address recognized national needs; (2) they have a technology focus; and (3) they could rely on market forces and the private sector for implementation. Each partnership benefits the country as a whole and could not proceed in a timely fashion without some cost-shared Federal support. The partnerships are intended to focus ongoing Federal activities to address national transportation goals—with any new Federal support to be developed within the overall funding limits and constraints already established.

[1] Although this plan focuses on technology, in many cases non-technological approaches may be equally beneficial to implement. The partnerships described in this plan are only part of the Administration's more comprehensive approach to transportation challenges—one that recognizes the value of both technological and non-technological solutions to transportation problems.

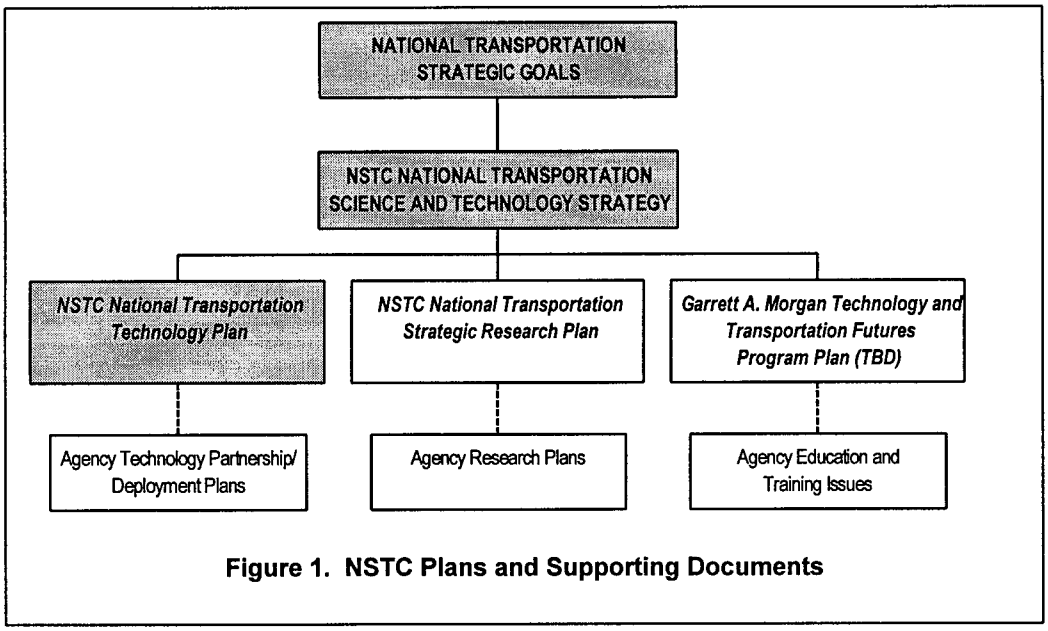


Figure 1. NSTC Plans and Supporting Documents

The technology partnerships fall into two broad categories: (1) those representing well-established Federal R&D activities, and (2) new efforts requiring further definition and interagency coordination. Both categories require broadened collaboration among government, industry, and academia to achieve the improvements in transportation needed in America and globally in the 21st century.

Four partnerships represent well-established R&D programs:

Aviation Safety Research Alliance
Next Generation Global Air Transportation
National Intelligent Transportation Infrastructure
Intelligent Vehicle Initiative

For these, the focus has been on relating the partnership to a broader research agenda; folding it in with other Federal programs; and, where appropriate, expanding its scope or coupling activities that have natural linkages.

The nine other partnerships require coordination to define and implement integrated actions, although many encompass existing R&D programs:

Next Generation Transportation Vehicles[2]
Transportation and Sustainable Communities
Transportation Infrastructure Assurance[3]
Enhanced Goods and Freight Movement at Domestic and International Gateways
Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure
Maritime Safety Research Alliance[4]
Next Generation Space Transportation Technology[5]
Accessibility for Aging and Transportation-Disadvantaged Populations
Enhanced Transportation Weather Services

The NSTC is continuing outreach to bring about awareness of these efforts within the transportation and technology communities and to assure understanding of those communities' needs. Future progress will depend on the continued encouragement of coordinated efforts.

PLAN CONTENTS AND SCOPE

The *National Transportation Technology Plan* differs from the 1998 plan in four ways:

It includes new technology partnerships identified in the national Strategy on maritime safety and space transportation.

In keeping with the national Strategy, it renames and broadens the scope of the partnerships on next generation vehicles and transportation security.

It clarifies the links between the broader technology partnerships and specific Federal programs.

It increases the time span shown on the partnerships' technology roadmaps from eight years to ten.

[2] Formerly Next Generation Surface and Marine Transportation Vehicles.
[3] Formerly Total Terminal Security.
[4] New technology partnership.
[5] New technology partnership. Named "Space Transportation Technologies" in the NSTC *National Transportation Science and Technology Strategy.*

Chapters 2 through 14 of this plan present the following details for each of the thirteen technology partnerships:

Vision: The broader societal objectives underpinning the partnership.

Goal(s): The specific transportation improvements that will result. These goals support the Administration's national goals for safety, security, the environment, economic growth, and mobility and access, and are in agreement with the Department of Transportation's *Strategic Plan 1997–2002*.

Near-term Outcomes: The measurable results of the partnership, taken from DOT's *FY 2001 Performance Plan* or other agency performance plans.

Magnitude of the Problem: The transportation problems that the partnership addresses.

Requirements: The need for the partnership in light of the stated transportation problems.

Investment Strategy: The partnership's participants, both within and outside the Federal Government; the management structure; the core research and technology activities; and the funding requirement.[6]

Technical Challenges and Implementation Issues: The key obstacles to the successful implementation of the partnership.

Acronyms: The abbreviations used.

Technology Roadmap: The critical technology elements, activities, and programs planned for 2000 through 2010.

Table 1 summarizes the vision, goal(s), near-term outcomes, technology elements, and related Federal programs for each of the technology partnerships. For those partnerships representing new activities, the Federal programs listed in the table refer to efforts with the same focus as the partnership and upon which a framework for the new effort may be built.

[6] Although the White House Office of Management and Budget requires that this plan specify only authorized funding, there remains a need to address the long-term funding needs of these technology partnerships.

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships

Aviation Safety Research Alliance	
Vision An even safer aviation system that accommodates continued growth in air traffic while experiencing fewer aircraft accidents and related fatalities.	
Goal Identify methods that, when implemented, would reduce the fatal aviation accident rate by 80 percent by 2007, as compared to the 1997 baseline.	
Near-Term Outcomes Reduce the fatal aviation accident rate for commercial air carriers from 0.040* fatal accidents per 100,000 flight hours in 1999 to 0.031 per 100,000 flight hours in 2001. By 2001, reduce runway incursions from 322 in 1999 to 241 incursions.	
Technology Elements Synthetic and enhanced vision displays. Improved terrain avoidance and navigation systems. Improved materials in aircraft structures, airframes, and engines. Advanced fire prevention, detection, and suppression. Real-time weather information processors and displays.	
Related Federal Programs	
Accident Mitigation (NASA). Advanced General Aviation Transport Experiments Consortium (NASA). Aeromedical Research (FAA). Aging Aircraft (FAA, NASA, DOD). Aircraft Catastrophic Failure Prevention Research (FAA). Aircraft Health Management Technologies (NASA). Airport Safety Technology (FAA). Airport Systems (FAA). Aviation Performance Measuring System (FAA, NASA). Aviation Safety and Risk Analysis (FAA). Aviation Safety Reporting System (FAA, NASA). Aviation Systems Monitoring and Modeling (NASA). Aviation Weather Research Program (FAA). Engine Failure Containment (NASA). Fire Safety (FAA, NASA). Flight Deck Human Factors (FAA, NASA, DOD). Flight Safety and Atmospheric Hazards (FAA, NASA).	Global Analysis Information System (FAA, NASA). Human Factors (NASA). Icing Research (NASA). Inherently Reliable Systems (NASA). Integrity and Security (NASA). Loss of Control (Upset) Management Technologies (NASA). Methods of Analysis for System Stability and Safety (NASA). Post-Crash Response (FAA, NASA). Propulsion and Fuel Systems (FAA). Safe All-Weather Flight Operations for Rotorcraft (NASA). Safer Skies (FAA, NASA, DOD). Single Aircraft Accident Prevention (NASA). Software (NASA). Structural Crashworthiness (FAA, NASA). Synthetic Vision Technology Development (NASA). Systemwide Accident Prevention (NASA). Weather Accident Prevention (NASA).

* 1999 preliminary data.

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Next Generation Global Air Transportation
Vision A safer, more efficient, environmentally compatible, and sustainable airspace system that meets future needs for global air transportation.
Goal Achieve a global air transportation system that supports "free flight" and similar concepts and that (1) assures the most effective use of present and future air system capacity, and (2) assures that system capacity is devoted to meeting the highest priority needs for it.
Near-Term Outcomes Reduce the rate of air travel delays from 220 delays per 100,000 activities in 1999 to 171 per 100,000 activities in 2001. Increase the percentage of flights that aircraft are able to fly off ATC-preferred routes from 77.4 percent in 1999 to 80 percent in 2001. By 2001, reduce runway incursions from 322 in 1999 to 241 incursions.
Technology Elements User request evaluation tools. Surface movement advisor. Traffic sequencing and metering tools. Collaborative decision-making tools. Global Positioning System and augmentation. Enhanced weather and situational information. Airport planning and design technology.
Related Federal Programs Advanced Air Transportation Technology (NASA). Advanced General Aviation Transport Experiments Consortium (NASA). Aviation Safety Research (NASA). Aviation Weather Research Program (FAA). Center for Advanced Aviation System Development (FAA). Civil Tiltrotor Research (NASA). Free Flight Phase 1 (FAA, NASA). Integration of Intelligent Aviation Systems (NASA). NAS Architecture (FAA). Safe Flight 21 (FAA). Technology for Advanced Operational Concepts (NASA). Terminal Area Productivity (NASA).

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Next Generation Transportation Vehicles
Vision A far more sustainable transportation system with fewer harmful environmental impacts and reduced dependence on fossil fuels.
Goal Develop internationally competitive, domestically produced transportation vehicles that achieve unprecedented gains in fuel efficiency and in both environmental and operational performance, including reduced greenhouse gas emissions.
Near-Term Outcomes By 2001, reduce on-road mobile source emissions to a target level of 62.2 million tons as compared to the 1998 level of 63.7 million tons. Reduce carbon-equivalent emissions from transportation sources. By 2001, reduce transportation-related petroleum consumption (in quadrillion BTUs) to 3.09 per trillion dollars of Real Gross Domestic Product.
Technology Elements Lightweight structural materials. Occupant protection systems. Fuel cells and other energy conversion/storage technologies. Improved internal combustion technologies. Advanced manufacturing processes. High-speed rail technology.
Related Federal Programs Advanced Bus Propulsion Systems (FTA). Advanced Combustion Engine R&D (DOE). Advanced Vehicle Technologies Program (RSPA, FHWA). Aging Aircraft (NASA). Airframe Materials and Structures (NASA). Airframe Methods and Design Environment Integration (NASA). Automotive Alternative Fuels R&D (DOE). Automotive Materials Technology Program (DOE). Electric Vehicle R&D (DOE, FTA). Fuel Cell R&D (DOE, FTA). General Aviation (NASA). Heavy Vehicle Alternative Fuels and Heavy Vehicle Systems R&D (DOE). Heavy Vehicle Materials Technology (DOE). Heavy Vehicles (NHTSA). Infrastructure, Systems, and Safety (DOE). Motor Carrier Research and Technology (FMCSA). New Bus Vehicles and Infrastructure (FTA). Next Generation High-Speed Rail (FRA). Noise Reduction (FAA, NASA). Partnership for a New Generation of Vehicles (DOC, DOE, DOT). Propulsion Emissions Reduction and Propulsion Engine Systems (FAA, NASA). Safety of High-Speed Ground Transportation (FRA). Safety Systems (NHTSA). Shipyard Revitalization (MARAD). Vehicle Systems R&D (DOE).

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

National Intelligent Transportation Infrastructure
Vision A truly seamless intermodal surface transportation system that accommodates private, public, and commercial vehicles; permits increasing communication and cooperation between infrastructure and vehicles; and utilizes relevant communication and information technologies to promote access and commerce.
Goals Make the most effective use of the existing transportation system; reduce the costs of operating and using the surface transportation system; reduce travel time for all system users; increase productivity and improve customer service for highway and transit users; provide accurate system information to enable more effective transportation planning, operating policies, and pricing/control strategies; reduce traffic crashes and fatalities; and permit experimentation with, and demonstration of, policy-sensitive traffic control strategies.
Near-Term Outcomes By 2001, reduce delays on Federal-aid highways to 7.9 hours of delay per 1,000 vehicle-miles traveled, from the 1998 level of 8.1 hours. Integrate intelligent transportation systems in 56 metropolitan areas by 2001, compared to 48 areas in 1999.
Technology Elements Traffic surveillance and control systems. Electronic toll collection. Traveler information systems. Commercial Vehicle Operations components. Advanced Public Transit System components. Incident management. Weather information systems.
Related Federal Programs ITS Architecture and Standards (FHWA, FTA). ITS Deployment Incentive Program (FHWA). ITS Mainstreaming (FHWA, FTA). ITS Program Support (FHWA). Nationwide Differential Global Positioning System (FRA, FHWA, USCG).

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Intelligent Vehicle Initiative
Vision A roadway system where Americans operate in a significantly safer environment and enjoy greater mobility and efficiency, while enhancing and preserving the environment and character of the communities it serves.
Goals Reduce the number of highway crashes and pedestrian casualties and the resulting injuries and fatalities; improve the effectiveness of intelligent systems to assure safe vehicle operation.
Near-Term Outcomes By 2001, reduce the rate of highway-related fatalities to 1.5 per 100 million vehicle-miles traveled.* Reduce the rate for injuries from 119** in 1999 to 113 per 100 million vehicle-miles traveled in 2001.
Technology Elements Adaptive cruise control. Vehicle-located collision-avoidance systems. Vision enhancement. Location-specific alerts and warnings. Automatic collision and emergency notification. Smart restraints. Traveler information systems. Transit passenger monitoring. Vehicle stability warning and diagnostics. Automated transactions and cargo ID. Obstacle/pedestrian detection. Precision docking.
Related Federal Programs Advanced Public Transit Systems (FTA). Advanced Vehicle Control and Safety Systems (NHTSA). Automated Vehicle Control and Information Systems (FHWA). Crash Avoidance (NHTSA). Driver Alertness and Fatigue (FMCSA).

* Preliminary estimates show that this rate was achieved in 1999. If the final 1999 data confirms the preliminary data, the outcome goal may be revised downward.
** 1999 preliminary estimate.

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Transportation and Sustainable Communities
Vision A transportation system that meets the needs for mobility and accessibility while balancing the current and long-term goals of economic growth, environmental quality, and social equity.
Goals Integrate and coordinate existing research agendas to minimize duplication and research gaps while optimizing support for a sustainable transportation system; develop improved technical tools and models to analyze the impacts of transportation activities on both the natural and the social environment.
Near-Term Outcomes By 2001, reduce on-road mobile source emissions to a target level of 62.2 million tons as compared to the 1998 level of 63.7 million tons. Reduce carbon-equivalent emissions from transportation sources. By 2001, increase to 11.78 percent the percentage of urban population living within a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour) from a 1999 level of 11.24 percent. Minimize the adverse impacts of transportation projects on wetlands and replace at least 1.5 acres of wetlands for every 1 acre affected where impacts are unavoidable.
Technology Elements Travel-demand (e.g., TRANSIMS), air quality, and other models. Alternative fuels and vehicles. Technologies that replace transportation or reduce its adverse impacts (i.e., ITS).
Related Federal Programs Alternative Fuels Evaluation (National Park Service). Biofuels Feedstock/System Technology Development Programs (DOE). Clean Cities Program (DOE). Communities 2020 (HUD). Community Development Patterns and Water Quality (EPA). Ecosystem Linkages (U.S. Fish and Wildlife Service, U.S. Forest Service). Environmental Impact and Ecosystem Management & Restoration (USACE). Environmental Justice (FHWA, FRA, FTA). Environmental/Transportation Planning Research (FHWA). Environmentally Sensitive Low-Impact Development (EPA). Evaluation of MOBILE Emissions Factor Model (FHWA, EPA). Hydrogeomorphic Wetlands Assessment (EPA, USACE). Institutional Aspects of Urban Runoff Management (EPA). Livable Communities (FTA). Metropolitan and Rural Policy Development (FTA). Model Solutions to Recycling Brownfield Areas (HUD). Planning Methodologies and Watershed Management (USACE). Policy Research (FHWA, FTA). Projects Related to Healthy People Goals and Objectives (CDC). Regional Biomass Energy Program (DOE). Right-of-Way Research (FHWA). Smart Growth Network (EPA). TEA-21 Metropolitan and Statewide Planning (FHWA). Transportation and Community and System Preservation Pilot Program (FHWA). Travel Demand Forecasting (FHWA, FTA, EPA). Travel Model Improvement Program (FHWA, FTA, EPA).

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Transportation Infrastructure Assurance
Vision A transportation infrastructure that is secure from acts of terrorism and crime and that adapts rapidly to natural or intentional disruptions.
Goal Develop a comprehensive approach to assessing threats to the security of transportation's physical and information infrastructure and to implementing integrated security technologies and procedures tailored to these threats.
Near-Term Outcomes Increase the detection of explosive devices and weapons that may be brought aboard aircraft. Get threat information to those who need to act within 24 hours, at least 90 percent of the time.
Technology Elements Advanced sensor technologies. CAT scan and "sniffer" technologies. Motion detectors. High-confidence systems and software. Real-time passenger profiling and cargo information systems. Integration of transportation control systems.
Related Federal Programs Aircraft Hardening (FAA). Airport Security Technology Integration (FAA). Aviation Security Human Factors (FAA). Domestic Counterterrorism Program (DOJ/NIJ). Explosives and Weapons Detection (FAA). Force Protection (Air Mobility Command/DOD). Safety and Security (FTA).

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Enhanced Goods and Freight Movement at Domestic and International Gateways
Vision A more productive national economy afforded by a more flexible, efficient, and seamless freight transportation system.
Goals Improve freight mobility at the Nation's land borders and ports; ensure diffusion of existing freight information technologies and networks; expedite the global flow of goods.
Near-Term Outcome Reduce the percentage of ports reporting landside impediments to the flow of commerce from 40 percent in 1999 to 37 percent in 2001.
Technology Elements Expanded Differential GPS. Electronic toll collection. Dedicated short-range communications. Electronic data interchange, e.g., smart tags and cards. Sensors and displays. Vehicle-located technologies.
Related Federal Programs Industry Competitiveness (MARAD). Intermodal Development (MARAD).

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure
Vision A self-sustaining, environmentally compatible transportation infrastructure that is durable and efficient and that requires fewer human, economic, and environmental resources to produce, operate, and maintain.
Goals Accelerate the comprehensive repair, renewal, and advancement of the Nation's aging transportation infrastructure using stronger, cheaper, and environmentally superior materials and more cost-effective program delivery and management systems; reduce waste, pollution, and emissions generated in the production of infrastructure materials.
Near-Term Outcomes Increase the percentage of miles on the National Highway System that meet pavement performance standards for acceptable ride quality from 91.8 percent in 1998 to 91.9 percent in 2001. Reduce the percentage of bridges on the National Highway System that are deficient from 22.7 percent* in 1999 to 22.3 percent in 2001. Maintain in good or fair condition at least 93 percent of runways at all commercial service airports and reliever airports, as well as selected general aviation airports.
Technology Elements Mobile nondestructive testing and evaluation. Superpave and other new materials. Environmentally superior materials. Advanced computer-aided design and development tools. Improved models of condition & performance. Risk management. Tunneling. Construction safety technologies. Spread-spectrum radio-based systems.
Related Federal Programs Airport Pavement Technology (FAA). Applied Research and Technology (FHWA). Communication-based Train Control (FTA). Local Technical Assistance Program (FHWA). Pavement Research (FHWA). Seismic Research and Development Program (FHWA). State Planning and Research Program (FHWA). Strategic Highway Research Program (FHWA). Structures Research Program (FHWA). Technology Assessment and Deployment (FHWA). Track, Structures, and Train Control (FRA). Transit Cooperative Research Program (FTA). Turnkey Demonstration Program (FTA).

* Preliminary 1999 data.

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Maritime Safety Research Alliance
Vision A maritime transportation system that is the world's safest and most cost-effective.
Goals Reduce collisions; deaths and injuries from maritime casualties; and the risk of passenger vessel casualties with major loss of life.
Near-Term Outcomes Reduce the number of high-risk passenger vessel casualties to 52 per 1,000 vessels in 2001; the overall target is a 10 percent reduction over the period 1999–2003. Reduce the number of collisions, allisions, and groundings from 1,377* in 1999 to 1,199 in 2001. Reduce recreational boating fatalities from 773** fatalities in 1999 to 749 in 2001.
Technology Elements Advanced training technologies. Improved small vessel designs and structures. GPS navigation. Integration of sea- and land-based intelligent systems. Real-time weather systems.
Related Federal Programs Intermodal Development (MARAD). Marine Safety (USCG). Marine Transportation System (MARAD, OST, USCG). Maritime Safety (MARAD). Prevention Through People (USCG). Servicewide Safety and Environmental Compliance (USCG). Ship Structures Cooperative Research Program (MARAD, USCG, Navy). Shipyard Revitalization (MARAD). Waterways Safety and Management (USCG).

* 1999 preliminary data.
** Estimate based on 1999 preliminary data.

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Next Generation Space Transportation Technology
Vision Realization of the full potential for commerce, technology, and exploration in space.
Goal Research, develop, verify, and transfer advanced aeronautics, space, and related technologies to support revolutionary space vehicles, launch systems, and operations.
Near-Term Outcomes Continue vehicle assembly of the X-33, a half-scale technology demonstrator of a full-scale, commercially developed reusable launch vehicle (RLV), in preparation for flight-testing. Complete vehicle assembly and begin flight-testing of the X-34, which will demonstrate technologies necessary for an RLV but will not be a commercially viable vehicle itself. Proceed with assembly and flight test plans for the X-37, the first-ever orbital experimental space transportation demonstrator, which will play a major role in developing systems for a second generation RLV.
Technology Elements Reusable launch vehicles and related spaceport architecture. Advanced sensors and testing technologies. Integration of air-breathing propulsion, cryogenics, advanced structures, and other technologies.
Related Federal Programs 2nd Generation RLV Focus (NASA). Advanced Space Transportation (NASA). Airframe Technology (NASA). Atmospheric Space Systems (NASA). Future X/Pathfinder (NASA). Future X/X-34 Technology Demonstration (NASA). Hybrid Hyperspeed Propulsion (NASA). Hyper-X (NASA). Intelligent Health and Safety Monitoring (NASA). Pulse Detonation Engine Technology (NASA). Space Transfer and Launch Technologies (NASA). Super Lightweight Multi-Functional Systems Technology (NASA). X-33 Advanced Technology Demonstrator (NASA).

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Accessibility for Aging and Transportation-Disadvantaged Populations
Vision A transportation system that meets the mobility and accessibility needs of the elderly, the poor, persons with disabilities, and all other Americans without access to a private automobile.
Goals Create model alternative transportation systems that serve the needs of the elderly and transportation-disadvantaged people while taking full advantage of existing services, resources, and development patterns; promote development of transit-compatible communities that integrate transit and pedestrian services for all users; provide opportunities for employing welfare recipients by preserving communities and enhancing transit.
Near-Term Outcomes By 2001, increase to 11.78 percent the percentage of urban population living within a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour) from a 1999 level of 11.24 percent. Increase the percentage of key rail stations that are in compliance with the Americans With Disabilities Act (ADA) from 49 percent in 1999 to 58 percent in 2001. Increase the percentage of bus fleets that are ADA-compliant from 77 percent in 1999 to 83 percent in 2001. Increase the number of employment sites that are made accessible by Job Access and Reverse Commute transportation services; the goal for 2001 is 8,050 sites compared to 1,692 sites* in 1999. Increase transit ridership from 43.10 billion passenger-miles in 1999 to 43.97 billion in 2001.
Technology Elements Advanced Public Transit System elements, such as computer-aided dispatch, automatic vehicle location, and electronic fare collection. Next generation paratransit services.
Related Federal Programs Access to Jobs and Reverse Commute Program (FTA). Advanced Public Transit Systems (FTA). Advanced Rural Transportation Systems (FHWA, FTA). Autonomous Dial-a-Ride Transit (FTA). Bridges to Work (HUD). Bus Rapid Transit (FTA). Jobs Plus (HUD). Metropolitan and Rural Policy Development (FTA). National Agenda for the Transportation Needs of an Aging Society (CDC, NHTSA, NIH, OST). Project Action (FTA). Rural Transit Assistance Program (FTA). Safe Mobility for Life (NHTSA). Smart Growth Network (EPA). Transit Cooperative Research Program (FTA). Transportation and Community and System Preservation Pilot Program (FHWA).

* 1999 preliminary estimate.

Table 1. Vision, Goal(s), Near-Term Outcomes, Technology Elements, and Related Federal Programs for Technology Partnerships (cont.)

Enhanced Transportation Weather Services
Vision A transportation system that is significantly safer, with far greater capacity and efficiency, by reducing the impacts of adverse weather.
Goal Develop seamless, cost-effective transportation weather information systems.
Near-Term Outcomes By 2001, reduce the rate of highway-related fatalities to 1.5 per 100 million vehicle-miles traveled.* Reduce the rate of highway-related injuries from 119** in 1999 to 113 per 100 million vehicle-miles traveled in 2001. Reduce the fatal aviation accident rate for commercial air carriers from 0.040*** fatal accidents per 100,000 flight hours in 1999 to 0.031 per 100,000 flight hours in 2001. Increase the number of runways that are accessible in low-visibility conditions from 1,084 runways in 1999 to 1,191 in 2001.
Technology Elements Weather satellites, radars, wind profilers, surface weather information systems. Meso- and microscale atmospheric models/heat balance models. ITS Service Centers. Traveler information systems. Aviation Gridded Forecast System. Integrated Terminal Weather System. Advanced Weather Interactive Processing System. Decision support systems.
Related Federal Programs Advanced Air Transportation Technology (NASA). Aviation Safety Program (NASA). Aviation Weather Research Program (FAA). Civil Tilt Rotor (NASA). Icing Research (NASA). Inherently Reliable Systems (NASA). National Weather Service Modernization Program (NWS). Revolutionary Concepts (NASA). Safe All-Weather Flight Operations for Rotorcraft (NASA). Single Aircraft Accident Prevention (NASA). Small Aircraft Transportation Systems (NASA). Strategic Highway Research Program (FHWA). Synthetic Vision (NASA). System-wide Accident Prevention (NASA). Weather Accident Prevention (NASA). Weather and Winter Mobility (FHWA).

* Preliminary estimates show that this rate was achieved in 1999. If the final 1999 data confirms the preliminary data, the outcome goal may be revised downward.
** 1999 preliminary estimate.
*** 1999 preliminary data.

2. AVIATION SAFETY RESEARCH ALLIANCE

VISION

An even safer aviation system that accommodates continued growth in air traffic while experiencing fewer aircraft accidents and related fatalities.

GOAL

Identify methods that, when implemented, would reduce the fatal aviation accident rate by 80 percent by 2007, as compared to the 1997 baseline.

NEAR-TERM OUTCOMES

Reduce the fatal aviation accident rate for commercial air carriers from 0.040[7] fatal accidents per 100,000 flight hours in 1999 to 0.031 per 100,000 flight hours in 2001.

By 2001, reduce runway incursions from 322 in 1999 to 241 incursions.

MAGNITUDE OF THE PROBLEM

Commercial aviation has established an impressive safety record. That accomplishment has been based largely on advances in the technology, including cockpit automation, simulator training, and air traffic control. The steady long-term improvement has been particularly remarkable in an industry that must adapt continually to a high rate of technological change. However, while the accident rate for scheduled airlines over the last two decades has been very low, it has been relatively constant. The absence of continuing accident rate reductions is a cause of serious concern. Even with today's very low accident rate, projected growth in air travel will inevitably produce a higher and continually increasing number of accidents as years pass, unless the rate can be decreased. If left unchecked there could be a fatal airline accident somewhere in the world each week in less than two decades. This provides a particularly strong motivation for aggressive efforts to lower the accident rate.

The importance of research and technology in this endeavor was noted in a study by the FAA's Research, Engineering, and Development Advisory Committee. After identifying several important new technologies, their report said "the synergy and steady advance associated with all of the above technology areas are creating rapidly succeeding vistas of

[7] 1999 preliminary data.

rich new capabilities. As they combine and specific new applications are developed, we have a critical family of technologies that imply major...opportunities for safety enhancement."[8]

At the same time, technological change can be a two-edged sword. In addition to research to exploit potential avenues to increase safety, continuing work is necessary to assure that new systems and procedures do not inadvertently introduce new hazards. As a 1996 NASA report noted, "The history of aviation is characterized by periods of major quantum jumps in safety brought about by advances in technology, followed by years of marginal improvements. Today we already can see the new technology that may drive the next quantum leap in safety. The challenge is to ensure that our leap in technology to solve past problems does not induce new problems that pose a greater threat. Our next leap must be a leap based on sound research."[9]

REQUIREMENTS

On February 12, 1997, the White House Commission on Aviation Safety and Security issued its final report to President Clinton. The report emphasized the need to reduce dramatically the aviation accident rate as air traffic doubles over the next decade. As stated by the President, "We will achieve a national goal of reducing the fatal aircraft accident rate by 80 percent within 10 years."

Historically, research and technology have driven advances in aviation safety. Programs under way for years within government and industry have been successful at holding the accident rate constant and countering potential problems associated with the introduction of new technologies. However, reducing the accident rate by 80 percent requires a truly integrated partnership between Federal agencies and the aviation industry. The Aviation Safety Research Alliance is a coordinated effort among the FAA, NASA, DOD, and industry to (1) further define the safety goal; (2) identify focus areas; (3) agree on intervention strategies; and (4) commit to mutual action plans.

Among Federal agencies the FAA has the lead role, focusing on regulation and certification, National Airspace System (NAS) infrastructure, and system surveillance. NASA's role is developing enabling tools and technologies to be incorporated into the FAA's operational programs and implemented voluntarily by industry. DOD is concerned primarily with the safety of military operations and the transfer of defense technologies to the civil sector. Finally, the aviation industry works closely with its Federal partners on identifying safety issues, in addition to having the dominant role in technology implementation.

[8] *Challenge 2000: Impact of Future Technologies.* March 6, 1996.
[9] *Toward a Safer 21st Century: Aviation Safety Research Baseline and Future Challenges.* December 1996.

INVESTMENT STRATEGY

Participants

Federal: FAA, NASA, DOD (lead agencies); DOE; NIST; NSF; NWS; U.S. Bureau of Mines.

Other: United Nations/International Civil Aviation Organization, aircraft and avionics manufacturers, airlines, aviation organizations, universities.

Management

This partnership is managed jointly by the FAA, NASA, and DOD under a Commercial Aviation Safety Team and in close cooperation with industry.

Critical Technology Elements and Activities

As shown in the accompanying roadmap, this partnership has three thrusts: accident precursor identification and safety risk management, accident prevention, and accident mitigation. These activities, which include both operational and R&D elements, are discussed in greater detail in the NSTC *National Research and Development Plan for Aviation Safety, Security, Efficiency and Environmental Compatibility.*

Accident Precursor Identification and Safety Risk Management: This research seeks to identify latent and potential operational safety issues and correct them before they become accidents through (1) comprehensive monitoring, sharing, and use of operational safety information and a consequent growth in the understanding of current and emerging accident precursors and direct causes, and (2) immediate operational and technical interventions at the local, national, and international levels.

Accident Prevention: Research will identify and implement interventions that eliminate the leading categories of accidents: controlled flight into terrain, runway incursions, weather, and loss of control. This will be achieved primarily through (1) the elimination of recurring accident causes, and (2) the early detection and prevention of accidents due to new causes, such as the introduction of insufficiently validated technologies or operations. This effort is closely related to the Safer Skies initiative, a focused safety agenda and partnership among the FAA, NASA, DOD, and industry.

Mitigation of Consequences: These efforts aim to reduce the risk of injury in the unlikely event of an accident through improvements in aircraft crashworthiness, occupant protection, fire safety, passenger evacuation, and airport emergency services.

These activities are coordinated with and closely related to those conducted as part of the Next Generation Global Air Transportation partnership.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

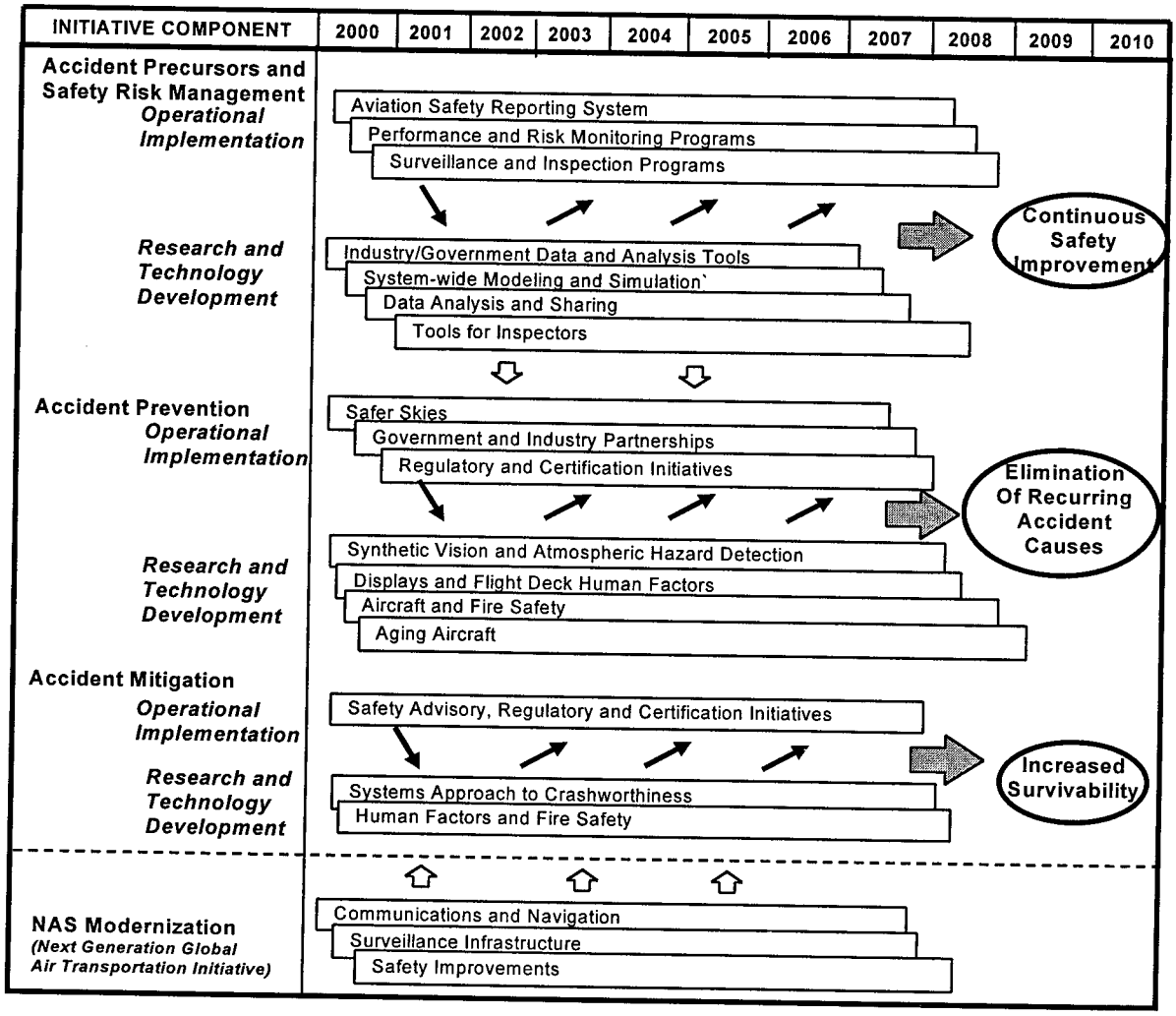
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

The primary issue for this partnership is deploying the new safety technologies within a time frame that permits partners to meet the ambitious safety goal that has been established.

ACRONYMS

DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
FAA	Federal Aviation Administration
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NSTC	National Science and Technology Council
NWS	National Weather Service
R&D	Research and Development

Technology Roadmap for the Aviation Safety Research Alliance



3. NEXT GENERATION GLOBAL AIR TRANSPORTATION

VISION

A safer, more efficient, environmentally compatible, and sustainable airspace system that meets future needs for global air transportation.

GOAL

Achieve a global air transportation system that supports "free flight" and similar concepts and that (1) assures the most effective use of present and future air system capacity, and (2) assures that system capacity is devoted to meeting the highest priority needs for it.

NEAR-TERM OUTCOMES

Reduce the rate of air travel delays from 220 delays per 100,000 activities in 1999 to 171 per 100,000 activities in 2001.

Increase the percentage of flights that aircraft are able to fly off ATC-preferred routes from 77.4 percent in 1999 to 80 percent in 2001.

By 2001, reduce runway incursions from 322 in 1999 to 241 incursions.

MAGNITUDE OF THE PROBLEM

Many factors will challenge our ability to operate the National Airspace System (NAS) safely and efficiently. For one, the FAA expects that world revenue passenger miles will increase by 64 percent between 1997 and 2008. To meet this demand, airlines will increase the hours flown by their large aircraft, by as much as 52 percent. In fact, the use of larger and heavier aircraft to accommodate demand will help to increase airlines' inventories of aircraft by 50 percent.

REQUIREMENTS

Air transportation is essential to the Nation's economic well-being. Since 1960, the U.S. gross domestic product has grown 14-fold and U.S. exports 30-fold. Today, American exports total more than $580 billion a year. Such growth is made possible largely by safe, reliable, and consistent air transportation. In this era of global economies, air transportation helps make it possible to move quickly millions of people and billions of dollars of goods to markets around the world. The challenge today is to keep ahead of

this growth in globalization by getting people and freight anywhere in the world safely, efficiently, and at a reasonable cost.

Anticipating the future growth in air traffic, this partnership addresses the near- and long-term modernization and evolution of the NAS to assure that it continues to meet users' needs. Including both the enabling technology and associated operational practices, modernization will (1) provide new systems to enhance capabilities and services, and (2) make the critical infrastructure for ATC services far easier and more cost-effective to operate and maintain. While the White House Commission on Aviation Safety and Security recommended that the basic infrastructure be in place by 2005, continuing system evolution will depend on longer term breakthroughs—such as powerful automation aids and new operational concepts—now being pursued by the FAA, NASA, DOD, and industry.

The basic NAS infrastructure, with respect to both near-term implementation and longer term research, can be described in terms of seven elements:

Communications: Integration of aviation communications systems into a seamless network using digital technology for voice and data, with electronic data exchange between controllers and cockpit.

Navigation: Satellite-based navigation supporting direct routes and more predictable schedules for users, with declining reliance on ground-based navigation aids. The Global Positioning System (GPS), in conjunction with the Wide-Area and Local-Area Augmentation Systems (WAAS and LAAS), will become the primary means for en route navigation and instrument approaches.

Surveillance: Gradual transition from current radar systems to digital radar and Automatic Dependent Surveillance (ADS), which, when coupled with broadcast capabilities (ADS-B), will greatly enhance pilot awareness of the surrounding environment and eventually provide similar information for controllers.[10]

Aviation weather: Improved ways to collect, process, transmit, and display weather information, during planning and in flight, based on real-time data from multiple sources. This includes development of improved forecasting and aviation-specific weather products, such as near-term (0- to 30-minute) predictions of significant terminal-area weather.

[10] ADS is a technique in which aircraft position is determined using an on-board global navigation satellite system receiver. ADS-B is an extension of this concept, in which each aircraft continually broadcasts its identity, altitude, and position directly to ground stations and nearby aircraft.

Avionics: Aircraft systems that link GPS receivers to digital terrain maps; multi-mode digital communications technology for a wide range of uses; ADS-B to transmit position, velocity, and intent to ground stations and other aircraft; multi-functional displays; and an enhanced collision avoidance system.

Free flight operational tools: Tools that give controllers, planners, and service operators more complete information about air traffic control and flight operations, including data-link communications using predefined messages, support for collaborative decision-making with airlines, and improved sequencing into terminal areas and on the airport surface.

Automation infrastructure: Infrastructure elements including improved air traffic controller displays and computers capable of supporting and exploiting new sequencing and spacing tools, and advanced communications, navigation, surveillance, and weather systems. This also includes a system-wide information network that enables users and providers to receive and share common data and make joint operational planning decisions.

INVESTMENT STRATEGY

Participants

Federal: FAA, NASA (lead agencies); DOD; NSF; NWS; USCG.

Other: Airlines, aircraft and avionics industries, airport authorities, academia, International Civil Aviation Organization.

Management

The activities in this partnership are managed and coordinated by the FAA and NASA, in cooperation with DOD, other Federal agencies, and the aviation industry.

Critical Technology Elements and Activities

NAS modernization is a large, complex, and lengthy effort. As illustrated in the roadmap below, there are four major components of this partnership: architecture definition, architecture implementation, support for air traffic operations, and breakthrough technologies. The *National Research and Development Plan for Aviation Safety, Security, Efficiency and Environmental Compatibility* discusses these elements in greater detail.

Architecture Definition: Released by the FAA in January 1999, the NAS Architecture lays out the integration of equipment, personnel, facilities, and procedures to support the joint Government/Industry Operational Concept for the Evolution of Free Flight, and addresses the key policy and program decisions needed to accomplish modernization through 2015. Beyond 2015, the architecture will continue to evolve as new technologies and concepts are developed.

Architecture Implementation: Partners will implement the architecture components in phases from now through 2015. This will involve two major initiatives: Free Flight Phase 1 and Safe Flight 21. Taken together, they will effectively develop, demonstrate, and field an integrated set of next generation air traffic management procedures and tools. The first step in implementation, Free Flight Phase 1, will deploy selected low-risk technologies that provide the core capabilities for free flight. In parallel with this effort, Safe Flight 21 will demonstrate the safety and technical feasibility of improved operational procedures; advanced communication, navigation, and surveillance tools; and streamlined certification processes.

Support for Air Traffic Operations: This effort supports the FAA's Air Traffic Operations in the areas of human factors, facility maintenance, and improved weather information. There are two emphases: providing improved weather data, services, and products to controllers, and making all support services more efficient and cost-effective through high-reliability systems, remote monitoring and maintenance, and software upgrading.

Breakthrough Technologies: To meet the need for continuing NAS evolution, the FAA and NASA will work with other partners to make the fullest possible use of emerging technologies. Currently, the FAA is exploring a wide range of future technologies at its Center for Advanced Aviation System Development. Among the research areas being pursued or planned by NASA are the development of automated air traffic management decision aids, technologies that permit terminal-area operations at today's clear weather rates under instrument conditions, and a foundation for the integration of the intelligent aviation systems of the future.

These activities are coordinated with and closely related to those conducted as part of the Aviation Safety Research Alliance.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

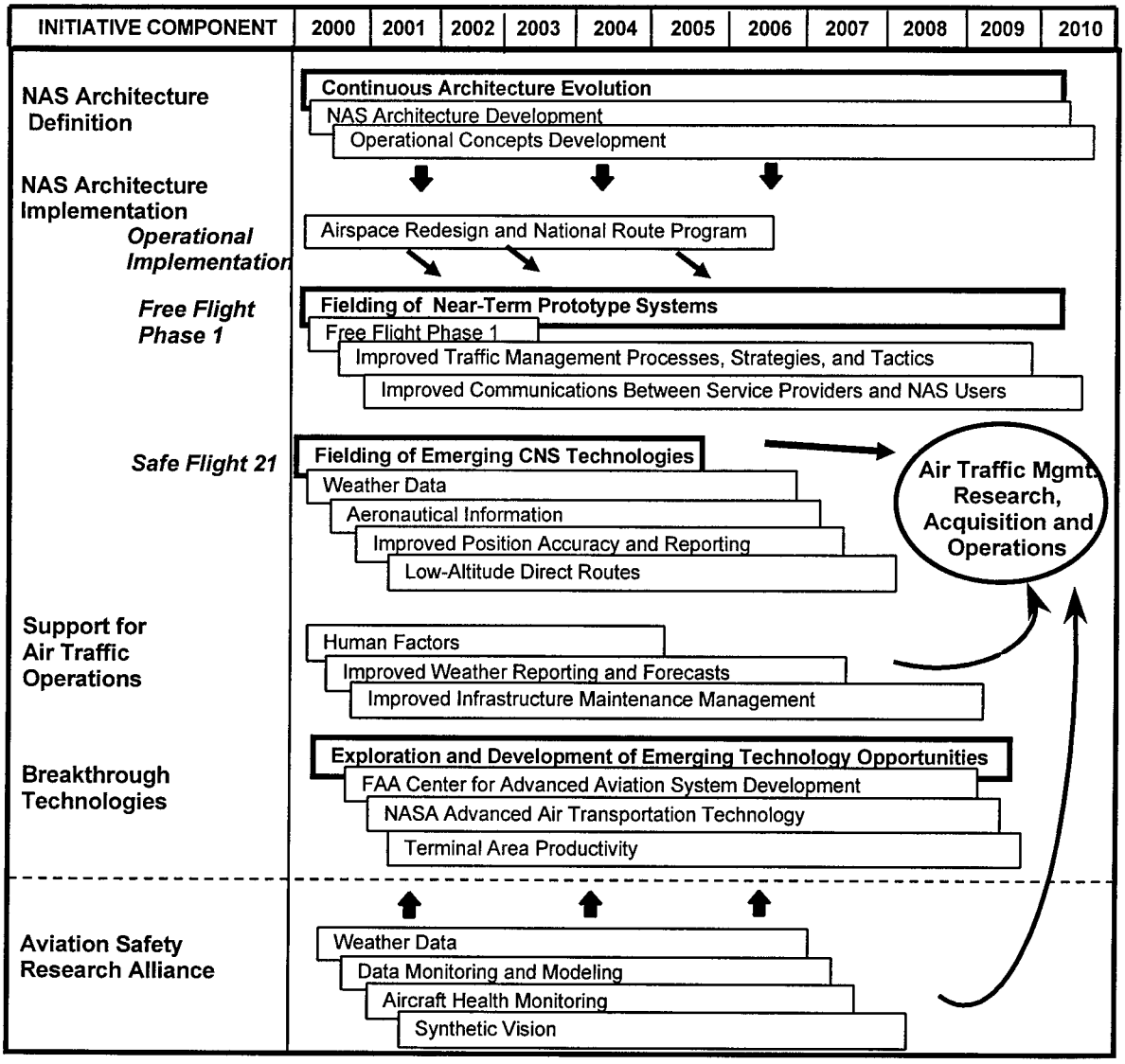
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

For this partnership, the principal technical challenge is coordinating implementation and deployment schedules for NASA's programs with the FAA's overall NAS Architecture.

ACRONYMS

ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance-Broadcast
ATC	Air Traffic Control
CNS	Communications, Navigation, and Surveillance
DOD	U.S. Department of Defense
FAA	Federal Aviation Administration
GPS	Global Positioning System
LAAS	Local-Area Augmentation System
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
NWS	National Weather Service
USCG	United States Coast Guard
WAAS	Wide-Area Augmentation System

Technology Roadmap for Next Generation Global Air Transportation



4. NEXT GENERATION TRANSPORTATION VEHICLES

VISION

A far more sustainable transportation system with fewer harmful environmental impacts and reduced dependence on fossil fuels.

GOAL

Develop internationally competitive, domestically produced transportation vehicles that achieve unprecedented gains in fuel efficiency and in both environmental and operational performance, including reduced greenhouse gas emissions.

NEAR-TERM OUTCOMES

By 2001, reduce on-road mobile source emissions to a target level of 62.2 million tons as compared to the 1998 level of 63.7 million tons.

Reduce carbon-equivalent emissions from transportation sources.

By 2001, reduce transportation-related petroleum consumption (in quadrillion BTUs) to 3.09 per trillion dollars of Real Gross Domestic Product.

MAGNITUDE OF THE PROBLEM

As the world's reliance on transportation vehicles has grown, so have concerns about concomitant increases in petroleum consumption, carbon emissions, and air pollution. Here in the United States, transportation consumes two-thirds of all petroleum used and produces one-third of greenhouse gases. The U.S. relies on petroleum to provide more than 95 percent of the energy required for transportation. Some researchers estimate that even a brief supply curtailment (i.e., two years) could drain as much as $500 billion from the economy. Yet another problem is urban air quality. Although many U.S. cities have seen recent air-quality improvements, transportation-related emissions of ozone precursors and fine particles continue to create health problems. Today, as many as 120 million U.S. residents live in areas with unhealthy air.

REQUIREMENTS

Addressing the problems of petroleum dependence, global warming, and air pollution requires significant advances in transportation vehicle technology. This partnership responds to this need through research leading to the development of highway vehicles, locomotives, ships, and aircraft that are better designed, more efficient, and less polluting.

Highway Vehicles: This effort will continue the Partnership for a New Generation of Vehicles (PNGV) and Advanced Technology Transit Bus (ATTB) activities and supplement them by also focusing on dramatic improvements in medium- and heavy-duty-vehicle fuel efficiency.

In 1993, the Clinton Administration joined in a historic partnership with the automobile industry, the PNGV, to establish global technical leadership in the development and production of affordable, fuel-efficient, and low-emission automobiles that meet today's safety and performance standards. However, while automobiles account for 40 percent of the Nation's highway transportation energy demand, trucks of all classes account for the rest. Since the oil embargo in 1973, essentially all of the increase in highway transportation energy use has been due to trucks, for two reasons: (1) the increase in demand for freight transport (provided by medium- and heavy-duty trucks) as the Nation's economy has grown, and (2) the increase in popularity for personal transport of light-duty trucks such as pickups, vans, and sport utility vehicles, which weigh more than a comparable automobile and need bigger engines (200–250 horsepower).

DOE's work in clean diesel technologies is designed to slow the tremendous increase in fuel demand associated with the Nation's growing reliance on all types of trucks. For heavy- and medium-duty trucks, these efforts aim to make diesel engines more fuel-efficient, less polluting, and able to use other suitable fuels. DOE research for light-duty trucks, conducted under 50 percent cost-shared cooperative agreements with U.S. diesel engine manufacturers and automakers, focuses on development of technologies for low-emission diesel engines that can replace gasoline engines in these vehicles. This approach would result in reduced greenhouse gas emissions without adverse economic impacts, given that the infrastructure for manufacturing and servicing the engine, as well as for refueling, is already in place.

In recent years, the FTA has worked in collaboration with the transit industry, DARPA, and DOE to develop a prototype ATTB. This bus uses lightweight composite materials and an electric drivetrain to achieve a four- to five-ton reduction in curb weight, low emissions, and reduced fuel consumption. Moreover, the Advanced Vehicle Technologies Program, or AVP, will develop and demonstrate a range of technologies for medium- and heavy-duty vehicles to reduce energy intensity and emissions and to improve industry competitiveness.

Locomotives: Applications in the U.S. for high-speed trains require a non-electric high-acceleration locomotive. Although most high-speed technology uses electric propulsion, virtually the only portion of the U.S. rail system currently electrified is the Northeast Corridor—and the cost of electrification is daunting. This initiative will support the development, test, and demonstration of non-electric high-speed rail (HSR) technology to establish a technological context in which State and local governments and private industry can proceed to implement new rail services.

Ships: The President's shipbuilding revitalization program includes an R&D element, MARITECH, which focuses on advanced ship designs and shipyard modernization. Additional research needs to address not only ship structure, but ship systems. This initiative will demonstrate a commitment to improved fuel efficiency and environmental performance through reduced fuel consumption, pollutant emissions, volume and toxicity of waste, and life-cycle cost. An aggressive program to demonstrate and develop the marine application of fuel cells has led to a partnership among the Departments of Transportation, Defense, Commerce, and Energy. The program's purpose is to develop fuel-cell technology for wider use in the government fleet and to transfer this technology to the private sector. Addressing the unique challenges of the marine environment, this initiative builds on existing efforts of DOE, DOD, and industry to develop fuel-cell technology for stationary shore-side power and land-vehicle propulsion.

Aircraft: Between now and 2015, world air travel is expected to grow 5 percent a year, creating a potential market for aircraft in excess of $1.1 trillion. U.S. leadership in this global competition will require advances in all aspects of aeronautics technology: safety, environmental compatibility, and cost. In the area of safety, advances in airframe inspection and structural life prediction will be essential to the safe and economical operation of an aging aircraft fleet. Concerns about environmental compatibility will require new noise- and emission-reduction technologies to accommodate growth in the number and size of aircraft. Finally, reductions in the time and cost required to develop, produce, and certify new aircraft will be key to cutting aircraft costs—and thus to making air travel more affordable. This joint effort among NASA, the FAA, and industry will develop advanced subsonic aircraft technology that will (1) ensure that U.S. commercial and general aviation aircraft continue to provide safe transportation; (2) significantly reduce the impacts of aircraft on the environment; and (3) decrease the cost of air travel.

INVESTMENT STRATEGY

Participants

Federal: DOT (FAA, FHWA, FMCSA, FRA, FTA, MARAD, NHTSA, RSPA, USCG); DOD (Army, Navy, DARPA); DOC; DOE; and NASA—all lead agencies; also EPA and NSF.

Other: Vehicle, engine, and fuel-cell manufacturers; aircraft manufacturers; fuel producers; component suppliers; developers of fuel cells and other new energy-conversion technologies; shipyards; State and local authorities; universities.

Management

The management structure for this partnership remains to be determined.

Critical Technology Elements and Activities

This partnership comprises vehicle research and technology in the following areas:

PNGV/Light Truck Clean Diesel Program/AVP/21st Century Trucks: This research will apply the technologies and concepts developed under the PNGV, Light Truck Clean Diesel Program, and AVP to improve the fuel efficiency of automobiles and light-, medium-, and heavy-duty trucks while maintaining safety and performance. It also will advance the 21st Century Trucks initiative, a public–private effort to develop and demonstrate commercially viable truck and propulsion systems technology that dramatically cuts the fuel use and emissions of medium and heavy trucks and buses.

Advanced Buses: This related effort is developing and fostering the commercialization of low- and zero-emission transit buses. Work includes completing development of a fuel-cell bus propulsion system, developing a 40-foot fuel-cell bus, research on the safe handling of fuel for fuel cells, and accelerated demonstration of all-electric and hybrid-electric transit bus technologies.

Next Generation High-Speed Rail: This program is developing and validating cost-effective high-speed (125–150 miles per hour) passenger rail technology that operates on existing infrastructure. Specific activities include demonstrating the operating and maintenance characteristics of non-electric locomotive designs, demonstrating the operability of flywheel energy storage, and testing active locomotive noise control.

Ship Building and Ship Structure: This activity, part of the MARITECH program, is developing improvements in commercial ship design and in shipyard facilities, processes, and procedures. A related effort, the Ship Structure Cooperative Research Program, investigates ship structural problems, pursues new technology, and develops innovative structural design, analysis, and fabrication techniques.

Marine Application of Fuel Cells: This effort will develop, test, and install affordable, highly efficient, low- or zero-emission shipboard fuel-cell power and propulsion systems. The first phase will develop and test a conceptual design and components for a fuel-cell power plant capable of operating on naval distillate (diesel) fuel. Phase 2 will design and build a reduced-scale fuel-cell power plant and perform land-based tests. The final phase will demonstrate the technology in a marine environment.

Advanced Subsonic Technology: This program seeks to develop high-payoff technologies leading to a new generation of environmentally compatible and operationally efficient U.S. subsonic aircraft. Specific research activities are addressing technology to safely and economically extend the life of older aircraft; new noise-reduction technologies; environmental-impact assessment; propulsion emissions reduction and new propulsion engine systems; technology transfer to general aviation aircraft; fabrication methods and tools for advanced airframe materials and structures; and new airframe design methodologies.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

For the PNGV, the most formidable goal is to develop a new class of automobiles that achieves a tripling in fuel economy without a penalty in emissions, performance, utility, or life-cycle cost. Technical challenges to achieving this goal could affect nearly every aspect of automobile design and construction. Although these challenges can be traded off against one another through a balanced approach that also addresses fuel and fuel quality, three broad issues appear prominent at this time: (1) dramatic reduction in body and chassis mass, while meeting safety standards; (2) dramatic increase in energy-conversion efficiency, while meeting emissions standards; and (3) recovery of kinetic energy normally lost during braking, while meeting cost targets.

The most critical challenge for diesel engine technologies for all types of trucks and automobiles is meeting increasingly stringent emission standards. Results from single-cylinder diesel engine tests indicate that, indeed, very low emissions are technically feasible. Arriving at the most cost-effective and workable emissions-control strategy, however, requires a three-pronged systems approach: (1) understanding the effects of fuel composition and properties on engine performance and emissions; (2) improved understanding of the combustion process to better control emissions formation inside the cylinder; and (3) innovative exhaust after-treatment techniques to further clean up what comes out of the engine.

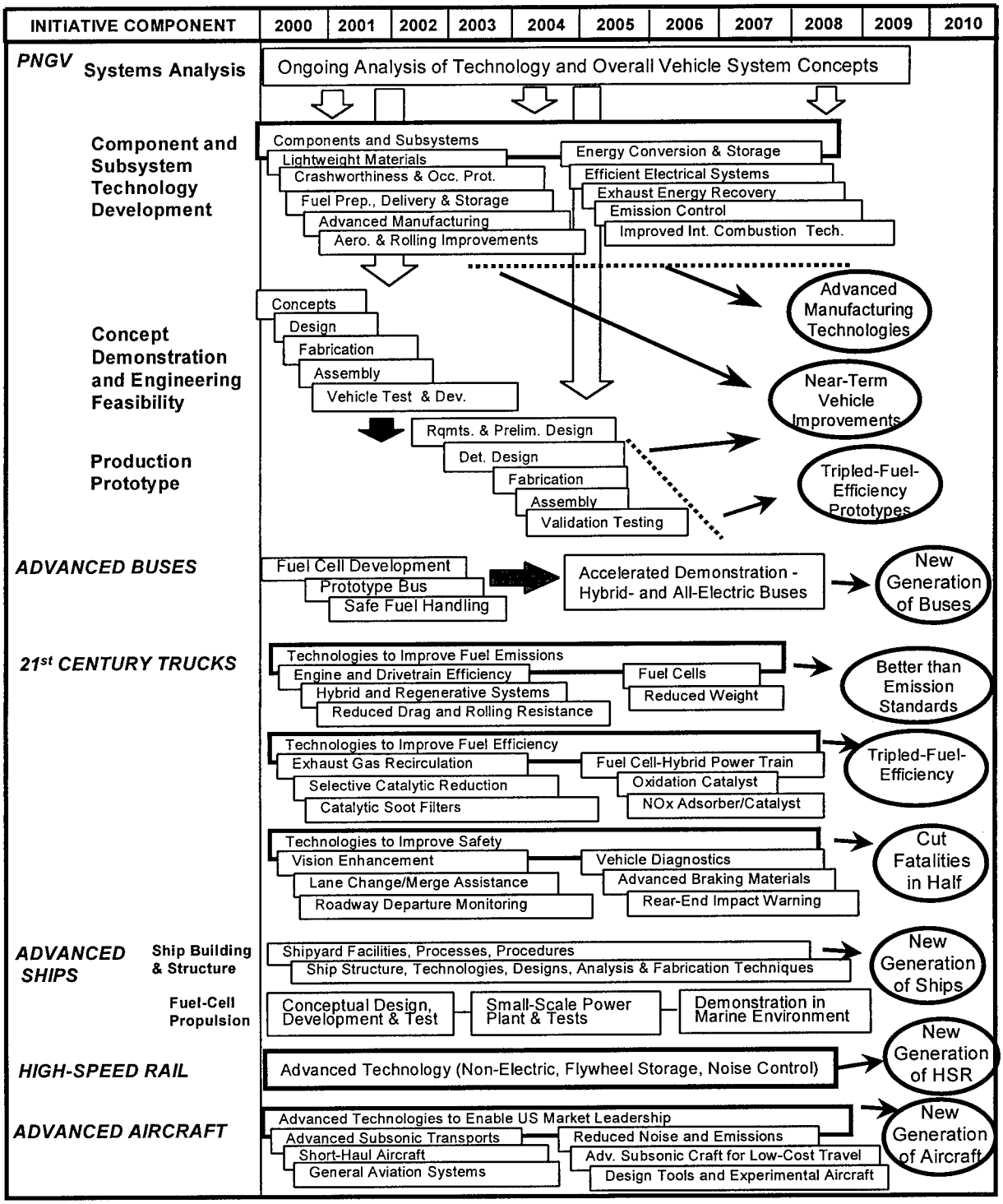
Beyond the technical challenges, there are many other issues that may ultimately be important as next generation automobiles, trucks, and buses are deployed. In all cases, the consideration of options for the use of accumulated investments in both physical infrastructure and trained workers and vehicle users will be important. Among the specific challenges are (1) the supply of alternative raw materials and the infrastructure needed to produce finished materials at commercially viable costs; (2) the motor vehicle industry structure and the capital, labor, and energy required to manufacture components and assemble vehicles; and (3) consumer acceptance of the new vehicles.

For next generation rail, ships, and aircraft, affordability is a primary issue. A key goal of high-speed locomotive research is to reduce the per-mile infrastructure upgrade costs from about $10 million to $2 to $3 million. In the marine fuel-cell program, affordability is stressed by addressing the costs associated with ship design, fabrication, outfitting, maintenance, and operation, and by using commercial technology wherever possible. Finally, partners in the effort to develop advanced subsonic aircraft aim to cut costs through integrated design methodologies, new aerodynamic concepts, and faster design cycles; these concepts and tools will provide superior aircraft while reducing operating costs, environmental impacts, and development risks.

ACRONYMS

ATTB	Advanced Technology Transit Bus
AVP	Advanced Vehicle Technologies Program
DARPA	Defense Advanced Research Projects Agency
DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. 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
HSR	High-Speed Rail
MARAD	Maritime Administration
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
PNGV	Partnership for a New Generation of Vehicles
R&D	Research and Development
RSPA	Research and Special Programs Administration
USCG	United States Coast Guard

Technology Roadmap for Next Generation Transportation Vehicles



5. NATIONAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE

VISION

A truly seamless intermodal surface transportation system that accommodates private, public, and commercial vehicles; permits increasing communication and cooperation between infrastructure and vehicles; and utilizes relevant communication and information technologies to promote access and commerce.

GOALS

Make the most effective use of the existing transportation system; reduce the costs of operating and using the surface transportation system; reduce travel time for all system users; increase productivity and improve customer service for highway and transit users; provide accurate system information to enable more effective transportation planning, operating policies, and pricing/control strategies; reduce traffic crashes and fatalities; and permit experimentation with, and demonstration of, policy-sensitive traffic control strategies.

NEAR-TERM OUTCOMES

By 2001, reduce delays on Federal-aid highways to 7.9 hours of delay per 1,000 vehicle-miles traveled, from the 1998 level of 8.1 hours.

Integrate intelligent transportation systems in 56 metropolitan areas by 2001, compared to 48 areas in 1999.

MAGNITUDE OF THE PROBLEM

Surface transportation in the United States faces a number of challenges. Despite the fact that we have one of the best transportation systems in the world, congestion costs an estimated $40 billion a year. Moreover, safety remains a serious problem: traffic crashes result in the loss of 40,000 lives each year and represent a $150 billion financial burden to the economy. Finally, surface transportation safety and efficiency have direct impacts on economic growth, land use, and accessibility to jobs and critical services. The inefficient movement of vehicles, whether private, commercial, or transit, reduces productivity, wastes energy, increases emissions, and threatens the quality of life that we enjoy.

REQUIREMENTS

Intelligent transportation systems (ITS) offer promising solutions to the problems of congestion, highway crashes, and environmental impacts. At their most basic level, ITS apply information technologies to make surface transportation safer and more efficient. However, no single technology "fix" can meet America's growing demand for travel. Although individual ITS products and services have their unique merits, it is important that they be seamlessly integrated to support multimodalism and intermodalism in metropolitan and rural areas and on interstate corridors.

This partnership seeks to deploy an integrated National Intelligent Transportation Infrastructure (NITI) across the United States within the next decade. A communication and information "backbone," the NITI refers to the integrated electronics, communications, and hardware and software elements that will enable ITS products and services to work together to save time and lives, including DOT's Nationwide Differential Global Positioning System. Analogous to the local- and wide-area networks used in many workplaces, the NITI will allow the surface transportation system to be managed as a seamless entity by integrating transportation and management information systems across both modal and jurisdictional lines within a region and, where appropriate, across the country. The NITI also will be a rich source of data for use in transportation planning and demand-management strategies. Partners have configured the initiative to address the needs of three specific types of users:

The *Metropolitan Intelligent Transportation Infrastructure* will integrate the various NITI components in metropolitan areas of the country.

The *Commercial Vehicle Operations Infrastructure* will integrate existing information databases to promote safe and efficient freight operations and enable electronic business transactions.

The *rural initiative* has identified clusters of related technologies to enhance the safety of rural highways and upgrade transportation services in rural communities.

Key NITI components focus on improvements in public transportation. Known collectively as Advanced Public Transit Systems, these elements include Traffic Management, for example, through automated dispatching or automatic vehicle location; Electronic Fare Payment, through use of "smart cards" or other media; and Traveler Information Systems, such as automated kiosks. Another important component, Positive Train Control, will communicate with other NITI elements to ensure positive train separation, enforce speed restrictions, and detect hazards at highway–rail crossings.

Although today travelers across the country are using ITS, no area has all of the NITI components in place, and very few have integrated the components into a regional

communication and information platform. However, a number of existing Model Deployment Initiatives (MDIs) are leading examples.

INVESTMENT STRATEGY

Participants

Federal: DOT (ITS Joint Program Office—lead agency, FHWA, FRA, FTA, MARAD, USCG); DOD (USACE); DOJ (INS); Treasury (Customs); NSF; USDA.

Other: State DOTs, MPOs, emergency response and law enforcement agencies, railroads, trucking companies, information systems vendors and manufacturers, ITS Service Centers.

Management

DOT's ITS Joint Program Office (JPO) provides strategic leadership for ITS research and deployment support, guides and coordinates the development of ITS program policies, coordinates the ITS program with the various DOT modal administrations, and ensures resource accountability. The JPO receives policy guidance from the ITS Management Council, which is chaired by the DOT Deputy Secretary, and acts as a liaison among the modal administrations that actually carry out the research.

As with all other ITS research and technology programs, this program is coordinated by the JPO and implemented by the modal administrations responsible for its various components, in cooperation with industry and State and local agencies.

Critical Technology Elements and Activities

This partnership is pursuing several activities to support and eliminate barriers to the deployment of an integrated NITI across the country. Related work is being conducted as part of the Intelligent Vehicle Initiative. As shown below, there are six fundamental elements of this strategy:

Evaluate NITI Benefits: Among other activities, this will demonstrate the benefits of integrated regional travel management and travel information systems at four sites: Seattle, Phoenix, San Antonio, and New York City. Similarly, it will showcase seven commercial vehicle deployments initiated in 1996 in California, Colorado, Connecticut, Kentucky, Michigan, Minnesota, and Washington/Oregon.

Create Funding Incentives for NITI Technologies: TEA-21 includes an incentive funding program targeted at the integration of ITS functions in metropolitan areas, rural communities, and commercial vehicle operations. The program calls for a 50 percent match by the local authority or private partner.

Build Professional Capacity: Because there are not enough professionals with the skills necessary to support the effective delivery of ITS services, professional capacity building is crucial to establishing an NITI. Partners will accomplish this by developing and presenting a number of workshops and seminars across the country.

Provide Technical Assistance: Partners are supporting ITS implementation among State and local authorities through guidance and documentation on project planning, technology procurements, enabling technologies, and innovative financing.

Accelerate Standards Development: Completed in 1996, the National ITS Architecture defines those areas in which standards would promote ITS interoperability and integration. Based on these requirements, and working closely with users and manufacturers, DOT initiated a program to accelerate the setting of 80 ITS standards. As of September 1999, DOT had completed 24 of the standards, with 23 others nearing completion. The Department will complete the remaining 33 standards within the next two years.

Establish Conformity Criteria for Architecture and Standards: A key effort is to identify criteria that will enable localities to ensure that their regional frameworks conform to the National ITS Architecture and agreed-upon standards.

Funding Requirement

FY 1999 Federal funding is $122 million, and FY 2000 funding $119 million. Future funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

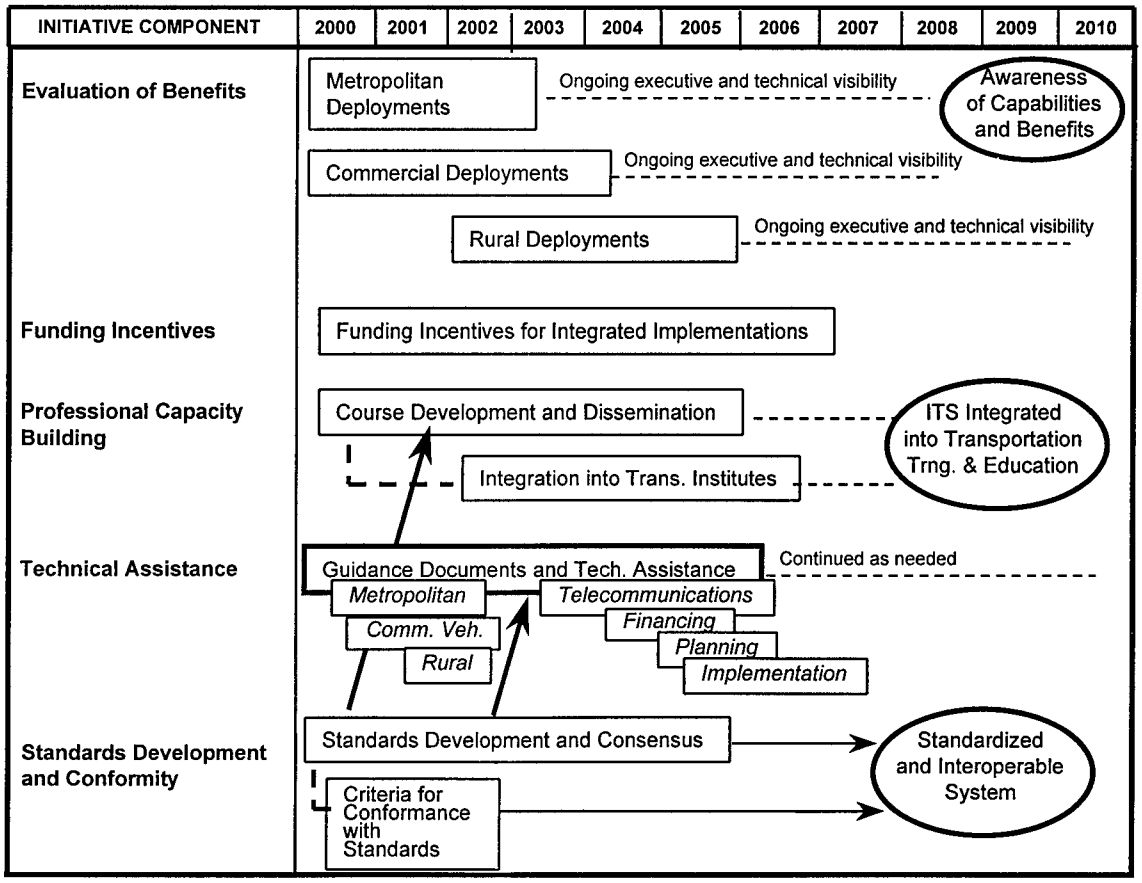
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

Achieving this partnership's goals requires that multiple decision makers and organizations, at multiple levels, coordinate and share a common vision. Yet, a number of different agencies build and operate highways, streets, and transit systems, and still others are responsible for emergency response, law enforcement, and other functions. In particular, each State government has multiple agencies that regulate various aspects of commercial vehicle operations, with little or no coordination among these agencies.

ACRONYMS

DOD	U.S. Department of Defense
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FY	Fiscal Year
INS	Immigration and Naturalization Service
ITS	Intelligent Transportation Systems
JPO	ITS Joint Program Office
MARAD	Maritime Administration
MDI	Model Deployment Initiative
MPO	Metropolitan Planning Organization
NITI	National Intelligent Transportation Infrastructure
NSF	National Science Foundation
TEA-21	Transportation Equity Act for the 21st Century
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture

Technology Roadmap for the National Intelligent Transportation Infrastructure



6. INTELLIGENT VEHICLE INITIATIVE

VISION

A roadway system where Americans operate in a significantly safer environment and enjoy greater mobility and efficiency, while enhancing and preserving the environment and character of the communities it serves.

GOALS

Reduce the number of highway crashes and pedestrian casualties and the resulting injuries and fatalities; improve the effectiveness of intelligent systems to assure safe vehicle operation.

NEAR-TERM OUTCOMES

By 2001, reduce the rate of highway-related fatalities to 1.5 per 100 million vehicle-miles traveled.[11]

Reduce the rate for injuries from 119[12] in 1999 to 113 per 100 million vehicle-miles traveled in 2001.

MAGNITUDE OF THE PROBLEM

The personal, social, and economic costs of motor vehicle crashes include pain and suffering; direct costs sustained by the injured persons and their insurers; indirect costs to taxpayers for health care and public assistance; and, for many crash victims, a lower standard of living and quality of life. During the past two decades, motor vehicle crashes accounted for over 90 percent of all transportation fatalities and an even larger percentage of accidents and injuries. More than 40,000 people die each year in highway crashes, with a total economic loss at over $150 billion annually. In addition, 30,000 bus crashes over the past 5 years resulted in 17,000 deaths and injuries. Driver error is cited as the primary cause in about 90 percent of all police-reported crashes involving cars, buses, and trucks. Pedestrian deaths and injuries pose yet another significant problem.

[11] Preliminary estimates show that this rate was achieved in 1999. If the final 1999 data confirms the preliminary data, the outcome goal may be revised downward.
[12] 1999 preliminary estimate.

REQUIREMENTS

Research indicates that collision-avoidance systems offer the potential for significantly reducing motor vehicle crashes. In particular, preliminary NHTSA estimates show that rear-end, lane-change, and roadway-departure crash-avoidance systems have the potential, collectively, to reduce crashes by one-sixth, or about 1.2 million crashes a year. Such systems may warn drivers, recommend control actions, or introduce temporary or partial automated control of the vehicle in hazardous situations.

The Intelligent Vehicle Initiative (IVI) is a government–industry program to accelerate the development and commercialization of these safety- and mobility-enhancing driver-assistance systems. The underlying proposition is that Federal involvement will move up the timetable for introducing such publicly beneficial innovations into common use and reduce the possibility of degraded safety from non-integrated after-market applications. At the same time, in recognition of the need for balance between public benefits and marketability, government and industry partners in the IVI will ensure that all safety benefits identified are reasonable, that the proposed systems are commercially viable, and that products can be implemented in the near term.

The overall emphasis of the IVI is on four areas: (1) research and evaluation of the costs and benefits of IVI products; (2) development of industry-wide standards; (3) system prototyping; and (4) field test evaluations of the most promising products.

INVESTMENT STRATEGY

Participants

Federal: DOT (ITS Joint Program Office—lead agency, FHWA, FMCSA, FTA, NHTSA, RSPA/Volpe Center); DOD (TARDEC); NSF.

Other: Motor vehicle and trucking industries, fleet operators, State and local transportation and law enforcement agencies, emergency response organizations, universities and other research organizations, professional societies.

Management

The FHWA, FTA, and NHTSA jointly manage the IVI. The ITS Joint Program Office is responsible for program coordination and budget oversight. In addition, guidance and direction is being sought from all interested parties.

Critical Technology Elements and Activities

Ongoing and recently completed work on crash avoidance, obstacle sensing, intelligent speed control, in-vehicle information systems, automated highway systems, and motor carrier safety provides a strong foundation for intelligent vehicle research. The IVI will continue and expand these efforts, particularly in areas such as human factors, sensor performance, modeling, and driver acceptance. This work is closely related to the National Intelligent Transportation Infrastructure partnership and has further applications for Transportation and Sustainable Communities.

The broad technology elements of the IVI, shown in the technology roadmap, include:

Crosscutting Technology Activities: Guiding and influencing all other program elements, these activities include architecture and standards development; research, development, and testing in human factors and technology; acquisition, expansion, and validation of simulation models and other evaluation tools; development and execution of an outreach plan to ensure the participation of industry and others; development and implementation of evaluation plans for field operation; and program planning and administration.

Development of Specific Technologies and Services: This covers the research, development, testing, and evaluation of individual crash-avoidance and efficiency-enhancing systems, including rear-end, road-departure, lane-change, merge, intersection, and railroad-crossing collision avoidance; vision enhancement; location-specific alerts and warnings; automatic collision notification; smart restraints; navigation and routing; real-time traffic and traveler information; vehicle stability warning; vehicle diagnostics; cargo identification; automated transactions; obstacle/pedestrian detection; precision docking; and transit passenger monitoring.

Selection of Technologies and Services for Integration: This represents the selection of specific intelligent vehicle technologies, and the mix of services, to be included in integrated packages. Selection involves extensive work on estimating benefits and costs and user acceptance.

System Design and Development: Two types of activities are included in this category: (1) research, development, and prototype testing to assess intelligent vehicle capabilities, and (2) developing system and subsystem specifications for the vehicle and infrastructure modifications necessary for operational tests.

Operational Tests and Technology Evaluation: Work in this area implements the plans for field tests on actual highways, evaluates the integrated intelligent vehicle services subject to the operational tests, develops deployment plans, establishes performance thresholds, and develops recommendations.

Technology Deployment: This refers to the actions by manufacturers and their suppliers to make and offer intelligent vehicle systems in production motor vehicles. It is anticipated that manufacturers will adopt the systems as part of their standard product lines. Product deployment also includes the installation of infrastructure-based components by regional, State, and local highway agencies. This activity is the final step and ultimate objective of the IVI.

Funding Requirement

FY 1999 Federal funding is $21 million, and FY 2000 funding $23 million. Future funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

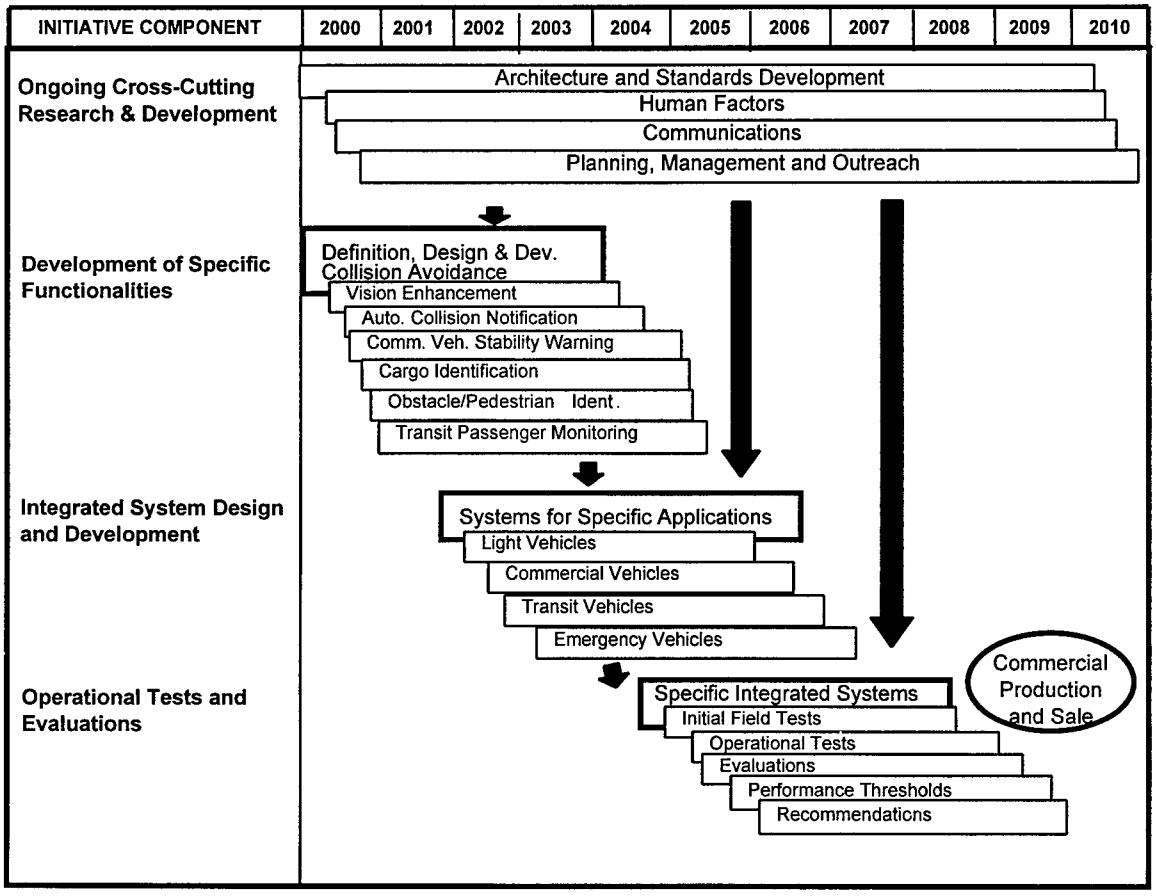
A primary technical hurdle is developing technologies that complement, and perhaps even accomplish on their own, the human visual and higher cognitive abilities by which collision avoidance occurs.

Among non-technical issues, the most critical is the need for the ongoing support of the automotive industry. The active role of automakers and their suppliers is important for achieving the program's strategic goals and outcomes.

ACRONYMS

DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FTA	Federal Transit Administration
FY	Fiscal Year
ITS	Intelligent Transportation Systems
IVI	Intelligent Vehicle Initiative
NHTSA	National Highway Traffic Safety Administration
NSF	National Science Foundation
RSPA	Research and Special Programs Administration
TARDEC	U.S. Army Tank-Automotive Research, Development, and Engineering Center

Technology Roadmap for the Intelligent Vehicle Initiative



7. TRANSPORTATION AND SUSTAINABLE COMMUNITIES

VISION

A transportation system that meets the needs for mobility and accessibility while balancing the current and long-term goals of economic growth, environmental quality, and social equity.

GOALS

Integrate and coordinate existing research agendas to minimize duplication and research gaps while optimizing support for a sustainable transportation system; develop improved technical tools and models to analyze the impacts of transportation activities on both the natural and the social environment.

NEAR-TERM OUTCOMES

By 2001, reduce on-road mobile source emissions to a target level of 62.2 million tons as compared to the 1998 level of 63.7 million tons.

Reduce carbon-equivalent emissions from transportation sources.

By 2001, increase to 11.78 percent the percentage of urban population living within a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour) from a 1999 level of 11.24 percent.

Minimize the adverse impacts of transportation projects on wetlands and replace at least 1.5 acres of wetlands for every 1 acre affected where impacts are unavoidable.

MAGNITUDE OF THE PROBLEM

Transportation is vital to our economy and our society. It supports economic development through the movement of goods and through access to jobs, services, and other activities. However, as we enter the 21st century, concerns are growing about how to meet increasing demands for access and mobility, safe and efficient operations, capacity of the current transportation infrastructure, environmental quality, and social equity.

The negative effects of transportation activities, and the development patterns they support, include contribution to greenhouse gases and global warming, congestion, air and water pollution, inefficient land use, unequal access to transportation, and ecosystem fragmentation. Specifically:

Transportation accounts for as much as a third of U.S. greenhouse gas emissions.

After bottoming out in 2010 at levels about 30 percent lower than in 1990, nitrogen oxide emissions in the Northeast Ozone Transport Region will reverse course and begin climbing through 2015 and beyond, unless new technologies can keep pace.

Congestion costs are $6.6 billion in New York City and $7.7 billion in Los Angeles, where it would require 665 new lane miles of highway annually just to maintain current mobility.

Welfare reform is helping individuals get and keep jobs across the country: caseloads have fallen by 7.2 million since 1993, but transportation remains one of the biggest barriers facing people who move from welfare to work. Few welfare recipients own cars. Existing mass transit does not provide adequate links to many suburban jobs at all, or within a reasonable commute time. In addition, in many urban and rural areas—where most recipients reside—transit does not reach most of the potential jobs or is nonexistent.

These and related concerns are of vital importance to regional, national, and international environmental policy.

REQUIREMENTS

Despite widespread recognition of the concerns listed above, there is a lack of understanding of how best to balance the often conflicting goals of economic growth, environmental quality, and sustainability. This partnership's key focus is exploring how sustainable transportation and land use can contribute to this balance.

As acknowledged above, transportation systems interact with other built, social, and natural systems, and thus have broad impacts on sustainability. This partnership looks at the interrelationships between transportation decisions—including policies, investments, and strategies—and development. These relationships produce environmental, social equity, and economic outcomes, sometimes characterized as the "Three E's." Transportation can be considered "sustainable" to the extent that it contributes to improved economic opportunity, social equity, public health, and environmental quality.

Federal agencies contribute to sustainable communities through several means, including:

Expanding understanding of both the positive and negative consequences of transportation choices.

Facilitating development of effective regional entities that can guide investment in transportation and other infrastructure.

Developing better forecasting, planning, and impact assessment tools for use by regional bodies and localities.

Continuing environmentally beneficial technology research.

Supporting development, demonstration, and evaluation of sustainable community and transportation initiatives.

This partnership furthers the efforts of Federal agencies to work with each other and with other levels of government and the private sector to contribute to sustainability.

INVESTMENT STRATEGY

Participants

Federal: DOD (USACE); DOE; DOT (Office of the Secretary, BTS, FAA, FHWA, FRA, FTA, RSPA); EPA; HHS (CDC); HUD; Interior (National Parks Service); OMB—all lead agencies.

Other: State and local transportation/environmental agencies and organizations; public health agencies; MPOs; mayoral offices; environmental advocates; environmental technology manufacturers and vendors; transportation system design, engineering, and construction firms; materials manufacturers; vehicle and fuel manufacturers; universities.

Management

The Federal partners in this initiative jointly manage its activities, with overall direction from the NSTC and guidance from the non-Federal participants.

Critical Technology Elements and Activities

This partnership encompasses a broad range of research and technology development activities, which are described in detail in the *National Research Agenda for Transportation and Sustainable Communities*. These efforts are summarized below and on the accompanying roadmap.

Improved Awareness and Understanding of Sustainable Transportation: This activity furthers dialog among Federal, State, and local agencies; the private sector; environmental and other advocacy groups; and, ultimately, the public, on the national policy implications and choices relating to transportation and sustainable communities.

Behavioral, Social, and Institutional Factors: This activity seeks to (1) explicate the complex relationships among transportation planning, land use, and social equity, and (2) develop model institutional approaches for cooperative decision making and regional transportation and land-use planning.

Implementation Issues for Next Generation Vehicles and Fuels: Addressing the critical role of alternative fuels and vehicles in making transportation more sustainable, this activity involves analysis of (1) the implications of new vehicles and fuels for the transportation infrastructure and the economy; (2) the different evolutionary pathways in moving toward an alternative vehicle/fuel system; and (3) the broader role of petroleum alternatives in achieving sustainability.

Information Technology and Sustainable Transportation: This looks at the implications of information technologies for sustainability, such as whether they result in major changes in travel demand and patterns. It also addresses how such technologies could promote sustainability, for example, by increasing the productivity of transit systems; facilitating congestion pricing; affording better methods for transportation and environmental planning; or enabling intelligent vehicle applications, such as electronic speed-control systems, that regulate vehicle speeds in residential areas and pedestrian activity centers.

Improved Analytical Tools and Indicators: This activity is developing better tools for understanding the complex relationships between transportation systems and land use/ development strategies—including improved data, performance measures, and a new generation of analytical models.

Aviation and Sustainability: Efforts in this area will examine the environmental impacts of continued growth in aviation, including the implications of introducing "free flight"; policy options for managing this growth; and competitive intermodal options for intercity transportation.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

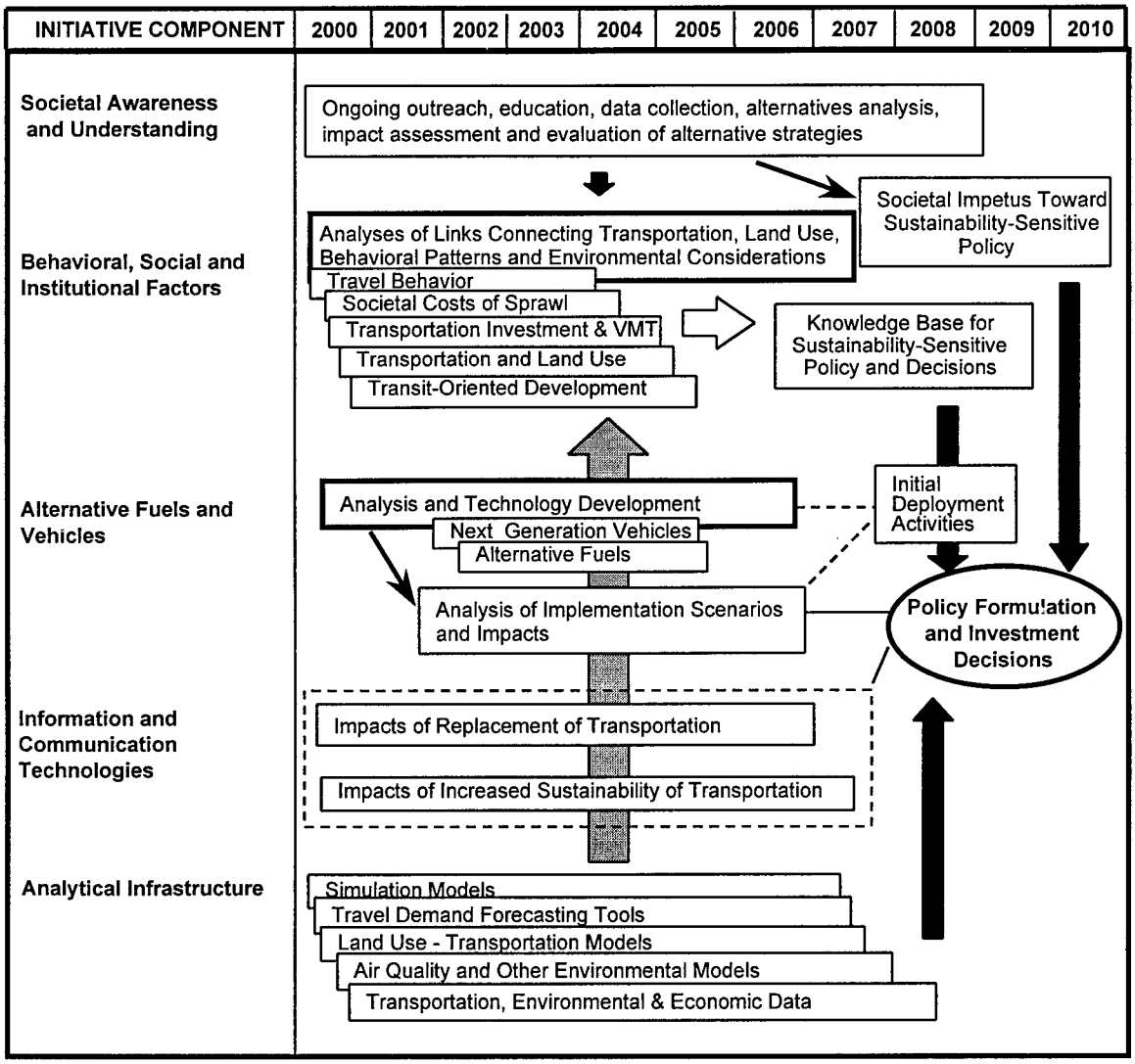
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

As discussed above, "sustainability" is a matter of degree, with progress measured by outcomes ranging from reduced greenhouse gases to better access to jobs. Thus, the greatest challenge for decision makers at all levels is to achieve a balance among preferred sustainability outcomes, some of which may be in competition. For this partnership, the choice of outcomes and measures will be evolutionary and will continue to be refined by participating agencies and key stakeholders.

ACRONYMS

BTS	Bureau of Transportation Statistics
CDC	Centers for Disease Control
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HHS	U.S. Department of Health and Human Services
HUD	U.S. Department of Housing and Urban Development
MPO	Metropolitan Planning Organization
NSTC	National Science and Technology Council
OMB	Office of Management and Budget
RSPA	Research and Special Programs Administration
USACE	U.S. Army Corps of Engineers
VMT	Vehicle-Miles Traveled

Technology Roadmap for Transportation and Sustainable Communities



8. TRANSPORTATION INFRASTRUCTURE ASSURANCE

VISION

A transportation infrastructure that is secure from acts of terrorism and crime and that adapts rapidly to natural or intentional disruptions.

GOAL

Develop a comprehensive approach to assessing threats to the security of transportation's physical and information infrastructure and to implementing integrated security technologies and procedures tailored to these threats.

NEAR-TERM OUTCOMES

Increase the detection of explosive devices and weapons that may be brought aboard aircraft.

Get threat information to those who need to act within 24 hours, at least 90 percent of the time.

MAGNITUDE OF THE PROBLEM

Recent events in the United States and in other parts of the world have focused considerable attention on the potential occurrence of major incidents of public terrorism. In our own country, such incidents have included the bombings of the World Trade Center in New York City, the Federal Building in Oklahoma City, and the Olympic Park in Atlanta. Throughout the rest of the world there have been bombings and chemical weapon attacks in Japan, Europe, the Middle East, South America, and Africa. The high level of concern about terrorism is reflected in the President's creation of a Presidential Commission on Critical Infrastructure Protection and a White House Commission on Aviation Safety and Security.

Historically, transportation is among the most visible and frequent targets of terrorist attacks, and recent terrorist incidents have reinforced that observation. Yet another security concern in transportation is cargo theft. Estimates place the losses resulting from such theft at over $13 billion a year.

REQUIREMENTS

Assessing the potential threat to transportation facilities and the range of measures that can be taken to guard against them requires the participation and assent of all organizations, both public and private, involved in transportation operations and oversight. This includes numerous Federal agencies with transportation, law enforcement, and threat-analysis responsibilities, as well as their State and local counterparts; transit and port authorities; and private transportation providers.

Among other topics, this partnership addresses the following:

Physical security of terminals.

Security of vital communication and information systems.

Development and dissemination of information about security incidents, as well as assessments of the potential threats to transportation facilities and operators.

In particular, this partnership supports the Transportation Subgroup of the NSTC Committee on Technology's Critical Infrastructure Protection R&D Interagency Working Group, by identifying current and new R&D activities that are necessary to (1) protect the nation's transportation infrastructure, operators, and users against future acts of terrorism and crime, and (2) enable the transportation system to adapt rapidly to natural or intentional disruptions.

INVESTMENT STRATEGY

Participants

Federal: DOT (FAA, FHWA, FRA, FTA, ITS Joint Program Office, MARAD, RSPA, USCG); DOD; DOJ (FBI, INS, NIJ); NSF; Treasury (U.S. Customs)—all lead agencies.

Other: State and local law enforcement agencies; port and airport authorities; transportation service providers (airlines, bus lines, transit agencies, trucking companies, ship lines, railroads, parcel and freight companies).

Management

Partners undertake this initiative under the overall guidance of the NSTC, with each providing resources and support as required. In the case of freight terminals, the executive staff of the National Cargo Security Council has offered to collaborate closely with the initiative's partners.

Critical Technology Elements and Activities

This partnership is undertaking the following activities, as illustrated in the accompanying technology roadmap:

Transportation Community Awareness and Understanding: This includes (1) outreach events on topics related to passenger and freight security, and (2) an ongoing program of system-level vulnerability assessments at major transportation terminals (air, rail, transit, port).

Identification of Best Practices: This activity is assessing a number of operational concepts and designs for an integrated security approach, documenting those that have proven to be the most effective, and identifying where further technological or procedural improvements are needed. Future efforts will build on the May 1999 report, *Intermodal Cargo Transportation: Industry Best Security Practices.*

Identify Key Technologies and Research Needs: This effort seeks to characterize the security technologies currently available, identify their potential application in an integrated security approach, and determine where further technology development is required.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

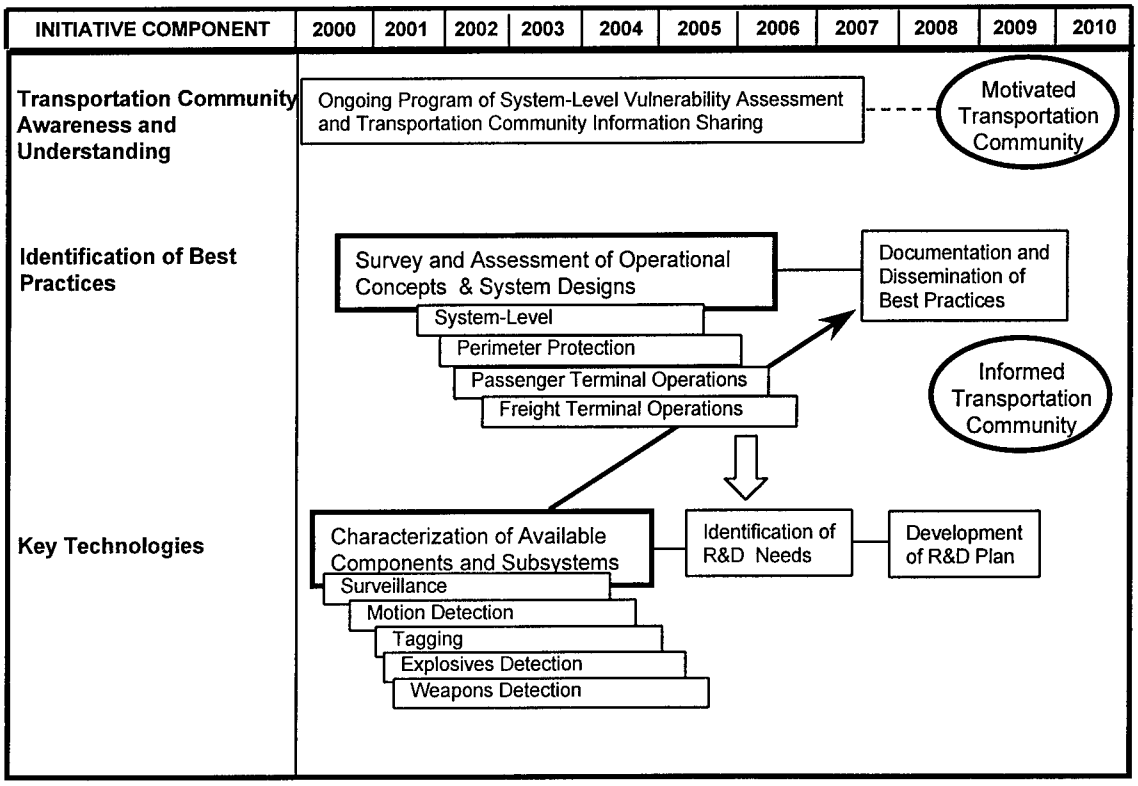
One of the most interesting technical challenges for this partnership is determining the best means of successfully implementing countermeasures originally developed for one mode or environment—for example, airports—in another mode or environment with different characteristics, operational procedures, and resource levels.

Moreover, a major non-technical issue is that transportation operations require the effective cooperation of a variety of institutions, some of which have differing or even conflicting perspectives and goals. Any major security feature must achieve at least the consent of these varying organizations to be implemented successfully.

ACRONYMS

DOD	U.S. Department of Defense
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
INS	Immigration and Naturalization Service
ITS	Intelligent Transportation Systems
MARAD	Maritime Administration
NIJ	National Institute of Justice
NSF	National Science Foundation
NSTC	National Science and Technology Council
R&D	Research and Development
RSPA	Research and Special Programs Administration
USCG	United States Coast Guard

Technology Roadmap for Transportation Infrastructure Assurance



9. ENHANCED GOODS AND FREIGHT MOVEMENT AT DOMESTIC AND INTERNATIONAL GATEWAYS

VISION

A more productive national economy afforded by a more flexible, efficient, and seamless freight transportation system.

GOALS

Improve freight mobility at the Nation's land borders and ports; ensure diffusion of existing freight information technologies and networks; expedite the global flow of goods.

NEAR-TERM OUTCOME

Reduce the percentage of ports reporting landside impediments to the flow of commerce from 40 percent in 1999 to 37 percent in 2001.

MAGNITUDE OF THE PROBLEM

Several trends in the past decade have transformed the way that goods are transported across the globe.

First and foremost is the unprecedented growth in the volume of international trade. NAFTA, in particular, has led to unprecedented growth in trade and land border traffic: U.S. exports to Mexico have grown by 37 percent and to Canada by 34 percent. Laredo, Texas, across the Rio Grande from Mexico, has become the Nation's largest inland port, handling more than 2,000 loaded tractor trailers a day and over 23,000 passenger cars and buses. The lines formed by vehicles at Laredo's border inspection gates are a mile long and take several hours to clear.

On highways, truck congestion has reduced freight mobility, with trucks on many key freight arteries accounting for as much as one-fourth of the average daily traffic. Delays due to congested highways are estimated at 2 billion hours per year.

Finally, congestion at container ports creates delays for shippers and increased costs for consumers. This congestion can result from bottlenecks on or near freight terminals or from city- or region-wide surface transportation congestion and inefficiencies.

While congestion is creating freight bottlenecks, the process of moving freight is becoming increasingly information-intensive. Already, information technologies have improved the logistics and management of freight movement and transformed the ability of trading partners to compete in global markets. Automation of terminal operations, for example, has afforded tremendous productivity improvements, while electronic scheduling and dispatch systems have increased both facility capacity and equipment utilization.

REQUIREMENTS

Spurred by ISTEA, TEA-21, and NAFTA, Federal, State, and local agencies are working with the private sector to enhance freight movement at international and domestic gateways. To date, an estimated $4.8 billion has been spent on freight gateway projects, with the Federal share totaling about 24 percent. Such efforts have included:

Gateway, Port Infrastructure, and Advanced Technology Investments: These projects include bridge and tunnel rehabilitation; highway access improvements; terminal structure and layout improvements; port access improvements; and tests of intelligent transportation system (ITS) technologies for electronic clearance of commercial vehicles at Canadian and Mexican land borders.

Investments at Advanced Freight Terminals: Mostly funded privately and by local and State agencies, these investments primarily support improvements at rail terminals, cargo consolidation hubs, and cargo airports.

Building on these efforts, this partnership seeks to facilitate information exchange and technology demonstrations to promote the deployment of innovative logistics practices and information technologies at freight gateways.

INVESTMENT STRATEGY

Participants

Federal: DOT (ITS Joint Program Office and Secretary's Office of Intermodalism—lead agencies, FAA, FHWA, FRA, MARAD, RSPA, USCG); DOC; DOD (MTMC); DOE; DOJ (INS); EPA; State; Treasury (U.S. Customs); USDA.

Other: National governments and international societies; State and local agencies; port and airport authorities; industry (air cargo companies, trucking companies, ship operators, railroads, parcel and freight companies, equipment manufacturers, vehicle manufacturers).

Management

Coordinated by the NSTC, Federal participants contribute resources and support as required, seeking ongoing guidance and participation from State, local, and private partners. DOT's ITS Joint Program Office provides overall leadership and management of this partnership.

Critical Technology Elements and Activities

This partnership involves the activities listed below, as illustrated in the technology roadmap.

Demonstrations and Pilot Programs: These demonstrations are assessing full-scale, integrated technology and logistics improvements at key freight gateways and freight interface points.

Tailored Technology Applications: Supporting the full-scale demonstrations, this activity seeks to apply advanced technologies and practices, such as electronic toll collection, electronic clearance, and smart cards, to specific improvements at freight terminals, ports, border crossings, and trade corridors.

Technology Assessments: The objective of this effort is to characterize the technologies and innovative practices currently available, determine their potential for improving freight mobility, and identify any new improvements that need to be developed.

System Architectures: This involves the development of detailed blueprints for automated freight gateways and trade corridors.

Standards: An integral part of each of the above activities, this work seeks to ensure interoperable and standardized U.S. freight transportation networks.

Information Exchange: An ongoing, crosscutting activity, this involves coordination and information exchange among Federal, State, local, and private partners.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

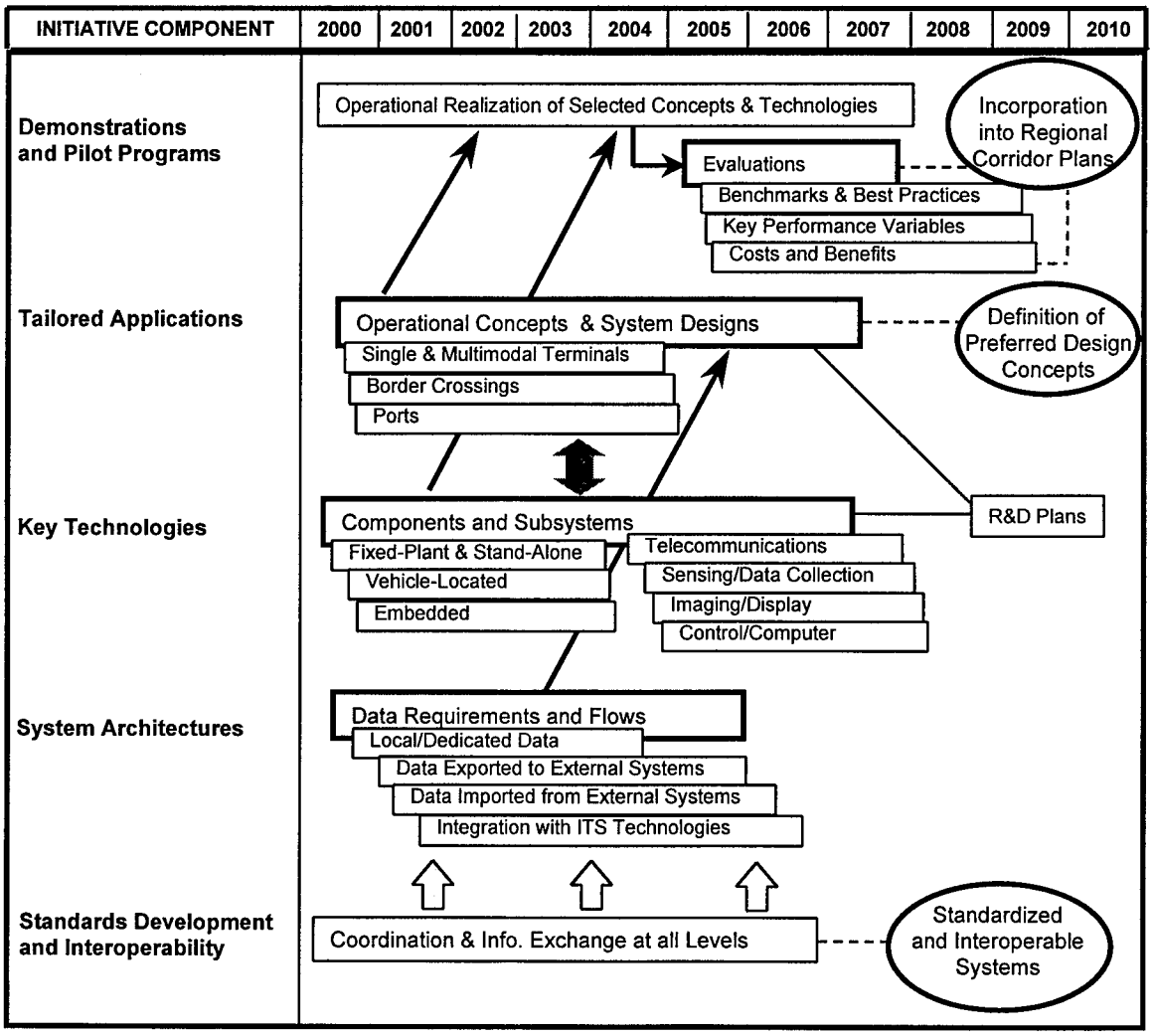
A major implementation issue for this partnership is the role of the Federal Government in diffusing new technologies and facilitating information exchange, and the willingness of the private sector to work with Federal partners.

In particular, the transfer of innovative technologies and practices developed in the past three or four decades is among this partnership's foremost opportunities. The Federal role in this process is significant, as new technology has little or no economic significance until there is "*innovation*," that is, until the technology is adopted and applied. Within the private sector, the decision to innovate is a function of the level of risk and the expected rate of return. Transfer of proven technologies and practices by Federal agencies reduces the risk to industry and generates net economic benefits to society.

ACRONYMS

DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
INS	Immigration and Naturalization Service
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
MARAD	Maritime Administration
MTMC	Military Traffic Management Command
NAFTA	North American Free Trade Agreement
NSTC	National Science and Technology Council
R&D	Research and Development
RSPA	Research and Special Programs Administration
TEA-21	Transportation Equity Act for the 21st Century
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture

Technology Roadmap for Enhanced Goods and Freight Movement at Domestic and International Gateways



10. MONITORING, MAINTENANCE, AND RAPID RENEWAL OF THE PHYSICAL INFRASTRUCTURE

VISION

A self-sustaining, environmentally compatible transportation infrastructure that is durable and efficient and that requires fewer human, economic, and environmental resources to produce, operate, and maintain.

GOALS

Accelerate the comprehensive repair, renewal, and advancement of the Nation's aging transportation infrastructure using stronger, cheaper, and environmentally superior materials and more cost-effective program delivery and management systems; reduce waste, pollution, and emissions generated in the production of infrastructure materials.

NEAR-TERM OUTCOMES

Increase the percentage of miles on the National Highway System that meet pavement performance standards for acceptable ride quality from 91.8 percent in 1998 to 91.9 percent in 2001.

Reduce the percentage of bridges on the National Highway System that are deficient from 22.7 percent[13] in 1999 to 22.3 percent in 2001.

Maintain in good or fair condition at least 93 percent of runways at all commercial service airports and reliever airports, as well as selected general aviation airports.

MAGNITUDE OF THE PROBLEM

The well-being and vitality of the transportation physical infrastructure are essential to the economic prosperity of the Nation. Transport infrastructure is the engine that powers the U.S. economy, employing 12 million people and attracting one of every 5 dollars in total household spending. In direct expenditures alone, transportation-related activities account for almost 20 percent of the U.S. Gross Domestic Product (GDP), with about 15 percent of that applied to construction, operation, and maintenance of transportation systems. Of these expenditures, more than 80 percent are for maintenance of our transportation infrastructure. Despite this fact, there is a need to update the technologies and practices used in infrastructure maintenance and construction if our transportation systems are to keep pace with growing demand.

[13] Preliminary 1999 data.

REQUIREMENTS

Recent advances in materials, technologies, and practices have the potential to improve infrastructure condition and performance without big increases in infrastructure spending. For example, engineers are beginning to use a variety of self-repairing, or "smart," materials in the repair and retrofit of bridges, docks, highways, and other elements of the transportation infrastructure; these materials use unique shape memory alloys to restore a structural component to its original shape, stiffness, or orientation. Structural monitoring and sensing devices promise to revolutionize the way we build, maintain, and operate built structures. And, as engineers take advantage of the enormous potential of high-performance concrete, fiber-reinforced polymers, and other advanced materials, the Nation will benefit from huge reductions in traffic delays, downtime, and other costs associated with infrastructure repair.

Yet, despite these advances, a number of factors combine to discourage innovation. These include the high cost of insurance for engineering and construction firms, antiquated contracting practices, the multitude of regulations, and industry fragmentation. There is a very real perception that innovation is risky: a recent survey by the American Consulting Engineers Council found that the threat of litigation caused 76 percent of respondents to avoid innovative methods and materials. Moreover, although the U.S. design and construction industry represents almost 13 percent of our GDP, it is highly fragmented, comprising over 1.2 million firms—85 percent of which have fewer than 10 employees.

This partnership represents the transportation component of the Partnership for the Advancement of Infrastructure and its Renewal (PAIR), an umbrella initiative for existing government, private sector, and university infrastructure, building, and construction programs. Called PAIR-T, the partnership seeks to create an environment that fosters an unprecedented level of collaboration and synergy on transportation research and development, demonstration, testing, evaluation, and technology transfer to State and local institutions. A major focus is the reduction of non-technical barriers that impede the introduction of innovative products and processes into the marketplace. The PAIR-T partners are collaborating on (1) identifying barriers to deploying innovative infrastructure renewal technologies; (2) removing these barriers; and (3) accelerating market acceptance of infrastructure products.

INVESTMENT STRATEGY

Participants

Federal: DOT (FHWA and RSPA—lead agencies, FAA, FRA, FTA, MARAD, USCG); DOD (USACE); DOC (NIST); NSF.

Other: CERF; AASHTO; TRB; CIRT; State DOTs and other State and local agencies; chemical, automotive, and material manufacturers; commercial freight, air transport, and insurance industries; infrastructure construction, planning, and management firms; communications, water, gas, and electric utilities; University Transportation Centers and other universities; industry and trade associations.

Management

PAIR-T is explicitly a cost-shared partnership between the private and public sectors. Representing the different participants from these sectors, a PAIR-T Executive Committee is responsible for developing and administrating operational policies, including all fiscal and administrative procedures. The Executive Committee provides guidance on all major PAIR-T initiatives and is responsible for maintaining and documenting project schedules, milestones, and human and capital resources. CERF serves as Secretariat to the PAIR-T Executive Committee.

Acting through the Transportation Research Board (TRB), the National Research Council (NRC) Committee for Review of the Federal Transportation Science and Technology Strategy issued a letter report in September 1999 reviewing the PAIR-T initiative. The PAIR-T partners will give strong consideration to the NRC's recommendations as the partnership's work progresses.

Critical Technology Elements and Activities

PAIR-T builds on earlier public–private efforts, including the NSTC Committee on Technological Innovation, Construction and Building Subcommittee; HUD's Partnership for Advancing Technologies in Housing; the CERF CONMAT effort, a proposed 10-year, $2 billion research and demonstration initiative; and the CERF Innovation Centers. In particular, partners will coordinate PAIR-T with the National R&T Partnership Forum, a joint effort involving the FHWA, AASHTO, and TRB, to ensure that development and demonstration of infrastructure technologies takes maximum advantage of collaborative opportunities. The "Infrastructure Renewal Working Group" of the National R&T Partnership will be the focal point for this coordination.

As shown on the accompanying roadmap, PAIR-T is undertaking the following specific activities:

Infrastructure and Technology Assessment: This includes assessing infrastructure repair and replacement needs; reviewing existing standards and procurement processes to permit fast-track approval of new technologies; prequalifying and preapproving innovation to reduce liability; evaluating the use of performance specifications, rather than design specifications, for infrastructure projects; and evaluating the use of life-cycle-cost planning methods and addressing key non-technical barriers.

Technology Education and Outreach: These efforts seek to identify the barriers to innovation in infrastructure renewal and options for overcoming them. This includes providing guidance on infrastructure performance evaluation and methods; publishing manuals and guidance to encourage the adoption of innovative technologies; and developing a national recognition program for State and local governments that use advanced infrastructure technologies, materials, and systems.

Consensus Building: This work seeks to establish industry goals and performance standards; leverage existing Federal, State, local, and private initiatives; develop coordinating mechanisms within agencies at all governmental levels; and establish and share databases on infrastructure technologies, performance, and assessment.

Demonstration Projects: These efforts will dramatize the impact that technology can make in revitalizing the nation's infrastructure. PAIR-T demonstration projects will be concerted partnerships between the private and public sectors, with both parties sharing risk and financing. PAIR-T will make particular efforts to involve State and local communities in identifying and implementing demonstration strategies.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

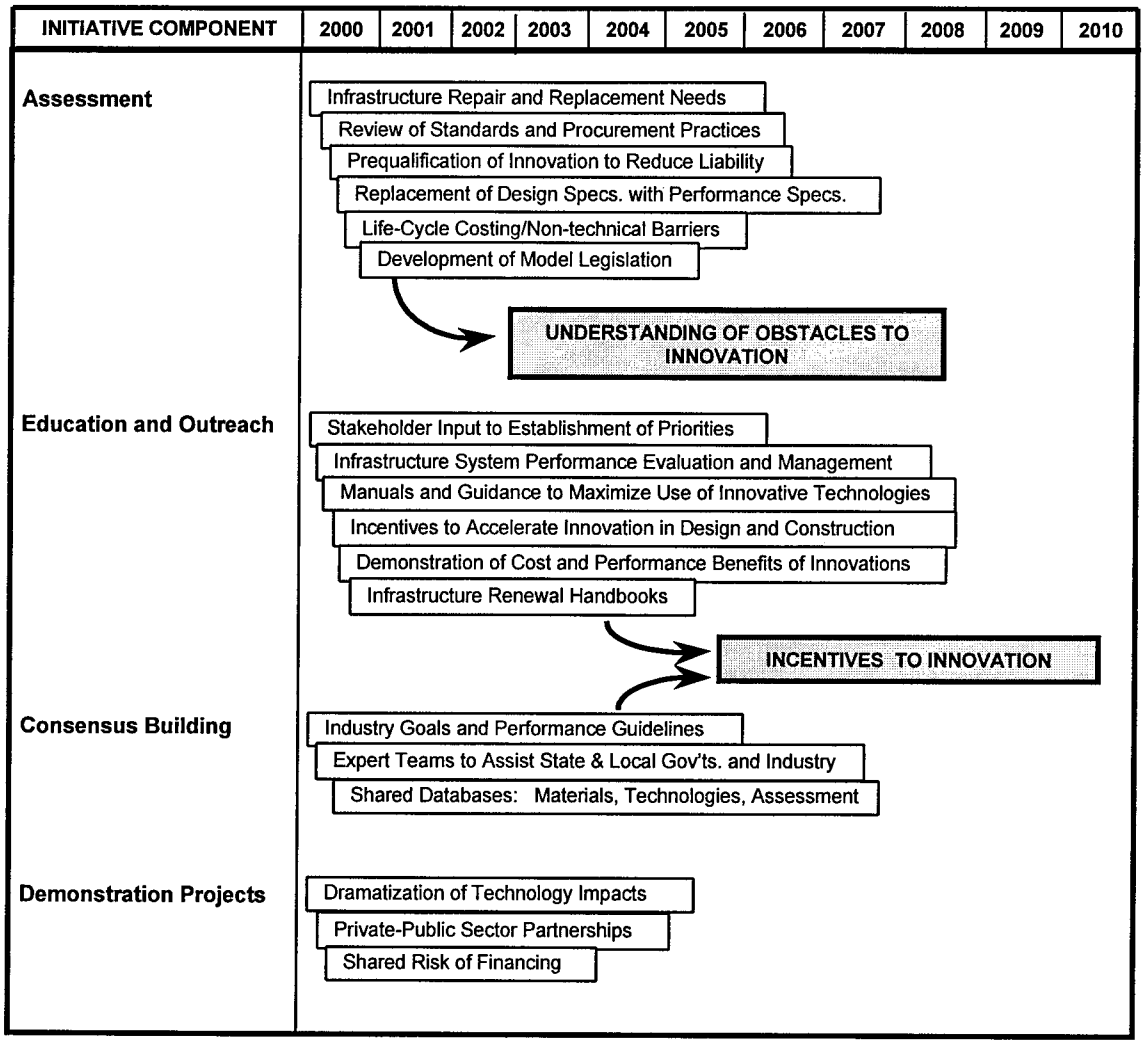
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

This partnership's key implementation issue is overcoming cultural and commitment barriers. As discussed above, the infrastructure sector is highly fragmented, making united action difficult. Moreover, the public works and civil infrastructure community is historically conservative and risk-averse. Only if "market pull" matches the "technology push" can innovations rapidly penetrate and develop market share in the infrastructure construction, materials, and equipment industries.

ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
CERF	Civil Engineering Research Foundation
CIRT	Construction Industry Round Table
CONMAT	High-Performance CONstruction MATerials and Systems Program
DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation (also State DOTs)
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GDP	Gross Domestic Product
HUD	U.S. Department of Housing and Urban Development
MARAD	Maritime Administration
NIST	National Institute of Standards and Technology
NRC	National Research Council
NSF	National Science Foundation
NSTC	National Science and Technology Council
PAIR	Partnership for the Advancement of Infrastructure and its Renewal
PAIR-T	Partnership for the Advancement of Infrastructure and its Renewal–Transportation
R&T	Research and Technology
RSPA	Research and Special Programs Administration
TRB	Transportation Research Board
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard

Technology Roadmap for Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure



11. MARITIME SAFETY RESEARCH ALLIANCE

VISION

A maritime transportation system that is the world's safest and most cost-effective.

GOALS

Reduce collisions; deaths and injuries from maritime casualties; and the risk of passenger vessel casualties with major loss of life.

NEAR-TERM OUTCOMES

Reduce the number of high-risk passenger vessel casualties to 52 per 1,000 vessels in 2001; the overall target is a 10 percent reduction over the period 1999–2003.

Reduce the number of collisions, allisions, and groundings from 1,377[14] in 1999 to 1,199 in 2001.

Reduce recreational boating fatalities from 773[15] fatalities in 1999 to 749 in 2001.

MAGNITUDE OF THE PROBLEM

The United States relies on a safe marine transportation system (MTS) to maintain its role as the world's leading maritime nation.

Safety is one of the primary goals of the MTS, a network of public and privately owned waterways, ports and their intermodal connections, vessels, vehicles, shipyards, and repair facilities. However, the expansion of trade and recreational use will stretch the system's ability to maintain safety while meeting demand. For example, over the next 20 years:

The total volume of domestic and international maritime trade will double.

The number of recreational users will increase up to 130 million annually.

Rapid growth will occur in high-speed ferry transportation, commercial fishing, and the military's use of the system for force projection and sustainment.

[14] 1999 preliminary data.
[15] Estimate based on 1999 preliminary data.

REQUIREMENTS

In November 1998, a national conference of private and public stakeholders agreed on a vision for the marine transportation system of 2020:

> *The U.S. Marine Transportation System will be the world's most technologically advanced, safe, secure, efficient, effective, accessible, globally competitive, dynamic and environmentally responsible system for moving goods and people.*[16]

This partnership supports this vision through a broad safety research alliance among Federal agencies, State and local authorities, and private interests. The alliance addresses three critical safety areas: human factors, vessel technology, and information systems. Efforts build on existing safety research partnerships, including DOT's MTS initiative, the Coast Guard's Prevention Through People Program, and the work of the United States Ship Structures Committee. This partnership is also part of a broader alliance that includes the Aviation Safety Research Alliance and the Intelligent Vehicle Initiative.

INVESTMENT STRATEGY

Participants

Federal: DOT (MARAD, USCG) and DOD (MTMC, Navy, USACE)—all lead agencies.

Other: Port authorities and other State and local authorities, the maritime industry, the intermodal industry, vessel manufacturers, shipyards and repair facilities, universities.

Management

The management structure for this partnership remains to be determined.

Critical Technology Elements and Activities

The specific activity areas comprising this partnership are described below and on the technology roadmap.

[16] U.S. Department of Transportation. *An Assessment of the U.S. Marine Transportation System: A Report to Congress*. September 1999.

Human Factors: It is by now well accepted that 70 to 90 percent of all accidents are caused by human error. This research activity thus addresses the human element in maritime operations, ranging from vessel operation and navigation to recreational boating and the accidental discharge of hazardous materials. Among the topics addressed are (1) development of training technologies that teach mariners how to deal with contingencies such as severe weather and equipment failure; (2) measurement and assessment of crew endurance and alertness; (3) analysis of shipboard fatigue countermeasures; and (4) the human factors in marine casualty investigations.

Vessel Design and Engineering: These efforts will improve safety through the development and application of (1) designs and structures for small vessels, such as recreational boats and fishing vessels, that reduce their vulnerability to damage or loss; (2) computer-based design tools; and (3) integrated safety design methodologies that incorporate structural safety, seaworthiness, survivability, and fire safety design components.

Information Systems: Navigation, communication, and information systems will be critical to meeting the growing demand for marine transportation while maintaining or improving safety. Among other research and technology activities, partners in the alliance will (1) develop real-time weather information systems that let mariners prepare for and avoid storms; (2) provide timely, accurate, and reliable navigation information through use of the Global Positioning System and augmentations; (3) integrate sea- and land-based information systems to permit rapid response to emergency situations; (4) test the effectiveness of an Automatic Identification System for improving waterways traffic management; and (5) develop a national "near-miss" reporting system to track incidents that almost result in vessel collisions.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

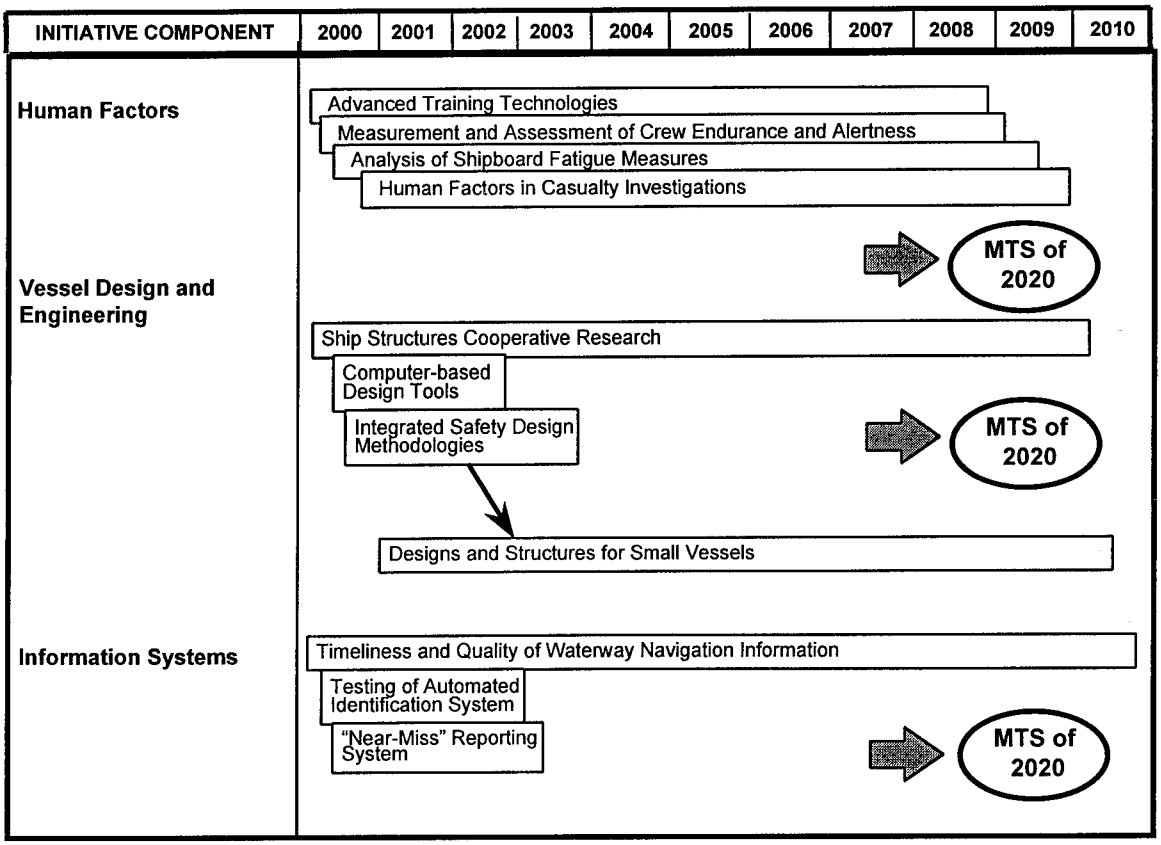
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

For this partnership, a foremost implementation issue is the need to greatly improve coordination among all public and private system users and stakeholders—at the local, State, regional, national, and even international levels. A key Federal role will be to foster coordination to better inform decision makers about research and technology advances, investment strategies, and resource allocations without duplicating or overlapping non-Federal efforts.

ACRONYMS

DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation
MARAD	Maritime Administration
MTMC	Military Traffic Management Command
MTS	Marine Transportation System
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard

Technology Roadmap for the Maritime Safety Research Alliance



12. NEXT GENERATION SPACE TRANSPORTATION TECHNOLOGY

VISION

Realization of the full potential for commerce, technology, and exploration in space.

GOAL

Research, develop, verify, and transfer advanced aeronautics, space, and related technologies to support revolutionary space vehicles, launch systems, and operations.

NEAR-TERM OUTCOMES

Continue vehicle assembly of the X-33, a half-scale technology demonstrator of a full-scale, commercially developed reusable launch vehicle (RLV), in preparation for flight-testing.

Complete vehicle assembly and begin flight-testing of the X-34, which will demonstrate technologies necessary for an RLV but will not be a commercially viable vehicle itself.

Proceed with assembly and flight test plans for the X-37, the first-ever orbital experimental space transportation demonstrator, which will play a major role in developing systems for a second generation RLV.

MAGNITUDE OF THE PROBLEM

Space launch is important to U.S. national security and economic well-being. Administration policy fosters a strong, internationally competitive commercial launch industry and cooperation between Federal agencies and the commercial space sector. Progress has been made toward these goals, for example, through the Air Force's public–private Evolved Expendable Launch Vehicle program and the ongoing Range Standardization and Automation upgrades.

Until recently, the bulk of space launches were related to the Government's civil and national security missions. Since the mid-1990s, however, commercial launch activities have more than tripled, as U.S. companies responded to the increase in world demand for commercial satellite launch services. The commercial sector's launch rate outpaced the Government launch rate in 1998.

Responding to the growth in commercial launch activities—and Government agencies' increasing reliance on commercial launch services—the White House in 1999 created an Interagency Working Group to review the future management and use of the primary U.S. space launch bases and ranges. Released in February 2000, the working group's report outlines several possible paths along which U.S. space launch capabilities could develop over the next two decades. It offers recommendations for appropriate next steps in the Nation's evolving management of its space launch bases and ranges, including the need to "examine, explore, and proceed with next-generation range technology development and demonstration."

REQUIREMENTS

Involving NASA, DOD, FAA, State governments, and industry, this partnership will address the needs of the Federal Government and the U.S. commercial space sector by developing and demonstrating technology that enables the operation of full-scale, highly competitive reusable space vehicles and related infrastructure.

NASA's Space Launch Initiative and Advanced Space Transportation Program include focused efforts to enhance launch competitiveness by working with the private sector to develop and demonstrate technologies applicable to low-cost RLVs. Assisted by FAA and DOD, these programs promise to bring a new paradigm to space launches—that of high-flight-rate, operational RLVs more akin to aviation than to today's space launches.

The Space Launch Initiative is intended to enable a competition by 2005 to develop competing RLVs that can be operational by 2010. Announced in February 2000, the initiative aims to develop a second generation of RLVs that would meet both NASA's space flight needs and commercial interests. It will leverage the success of the X-33, X-34, X-37, and other ongoing programs (see below) to reduce the remaining technical risks and create an environment for greater competition.

In addition, partners are jointly addressing the need to upgrade the Nation's spaceport and range infrastructure. While low-cost RLVs may not be realized until the end of the decade, the development of test and early operational vehicles will require new technologies for spaceports and ranges for operations, safety, and efficiency. NASA's Spaceport Technology Center (STC) will develop next-generation RLV spaceport and range technologies. This center will increase space launch safety, reduce costs, and foster commercialization by developing technology for integrated systems for launch and landing, vehicle ground processing, and payload processing.

INVESTMENT STRATEGY

Participants

Federal: NASA, FAA, DOD (all lead agencies).

Other: State spaceport authorities, U.S. commercial space launch providers, launch site operators, and satellite manufacturers and owners.

Management

This partnership considers the future needs of NASA, FAA, and DOD, with ongoing input from States and industry.

Critical Technology Elements and Activities

As shown in the roadmap below, this partnership encompasses the following major technical activities:

X-33: NASA's X-33, X-34, and X-37 (see below) are subscale technology demonstration RLVs that could pave the way to full-scale, commercially developed vehicles. The X-33 is the flagship demonstration vehicle for technologies that would dramatically lower the cost of access to space. This unpiloted vehicle takes off vertically like a rocket, reaching an altitude of up to 60 miles and speeds 13 to 15 times that of sound. The X-33 will demonstrate key Single Stage to Orbit (SSTO) technologies, delivering advancements in (1) ground and flight operations techniques that will substantially reduce operations costs for an RLV; (2) lighter, reusable cryogenic tanks; (3) lightweight, low-cost composite structures; (4) advanced Thermal Protection Systems to reduce maintenance; (5) propulsion and vehicle integration; and (6) application of New Millennium microelectronics for vastly improved reliability and vehicle health management.

X-34: The X-34 is a reusable, suborbital, air-launched vehicle that will fly at speeds approaching eight times the speed of sound and at altitudes up to 50 miles. It will demonstrate technologies and capabilities necessary for an RLV but will not be a commercially viable vehicle itself. Among these technologies and capabilities are (1) a high flight rate (25 flight tests in a year); (2) autonomous flight operations; (3) safe abort capability; and (4) a recurring flight cost of $500,000 or less.

X-37: The X-37 is a reusable, *orbital* testbed that will be the first X-vehicle flown from orbital speeds. It will be flown to low-Earth orbit in the Space Shuttle, and will conduct in-space operations and demonstrate technologies through reentry environments.

Launch Infrastructure: This activity will bring together Federal agencies, State authorities, and the launch industry to (1) determine the requirements for a launch infrastructure that is more competitive and flexible and that has expanded capacity; (2) conduct the research and develop the technology needed for timely infrastructure upgrades; and (3) address the requirements for a commercial space transportation system based on RLVs. NASA's STC will develop spaceport and range technologies for these and future vehicles. Another critical element will be to integrate space traffic control with air traffic management, allowing commercial RLV operators to use air traffic corridors for their ascent to and re-entry from space.

Launch Safety: The X-33, X-34, and X-37 programs are expected to conduct multiple flight tests over the Atlantic Ocean and over land in the western United States. Moreover, the successful development and testing of even one of the dozen or more RLVs currently being considered by entrepreneurs will require additional launch and landing sites, possibly near airports or National Ranges, to safely accomplish these activities. Once one or more of these systems becomes truly operational, the number of launches in the United States each year will increase dramatically, from the tens to the hundreds, as launch costs are drastically reduced. This partnership will facilitate the FAA's space launch oversight and innovative licensing requirements needed to safeguard the public safety.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

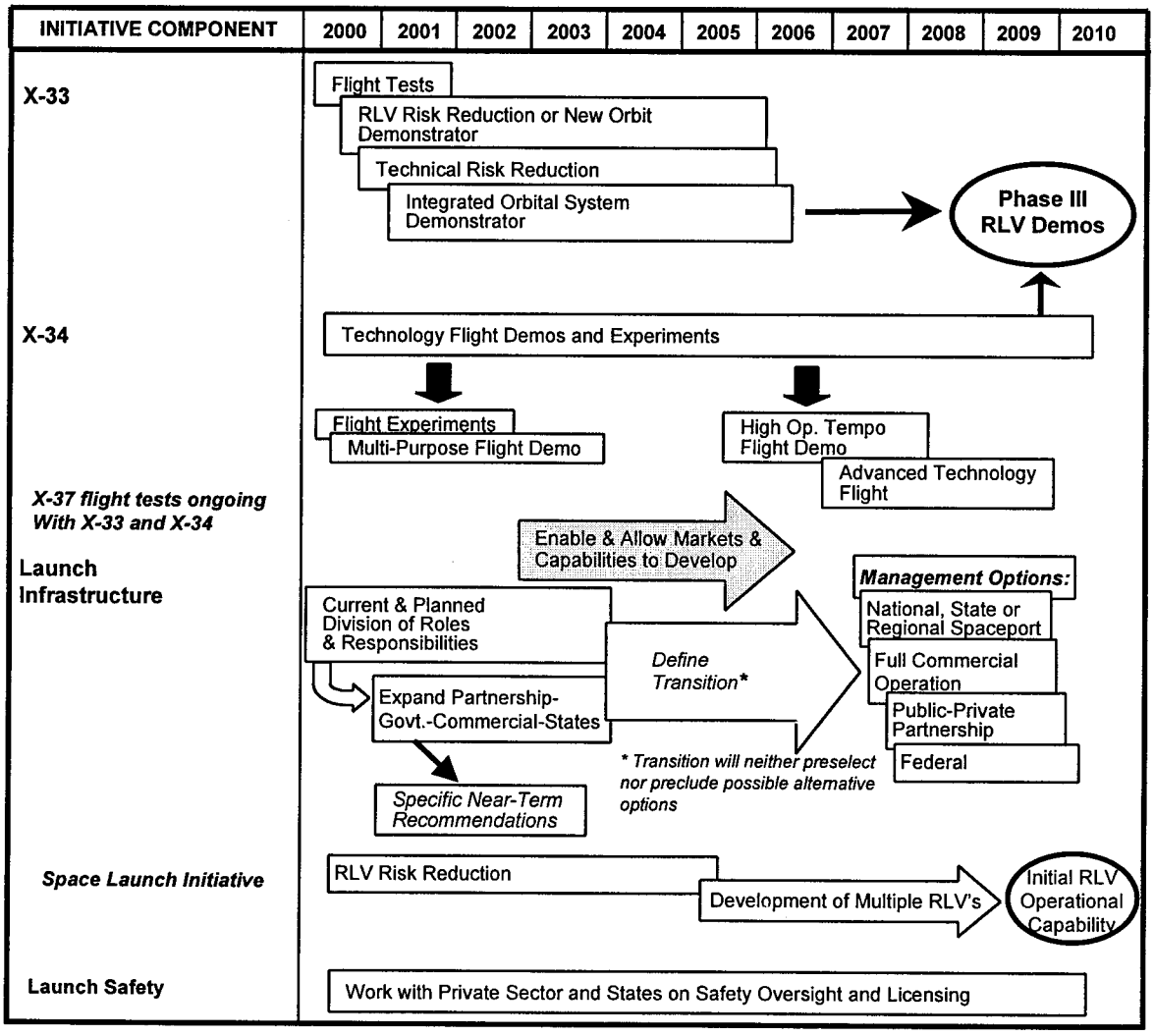
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

Among this partnership's many technical challenges are keeping up with the ambitious subsystem development, integration, and flight-test schedule for the X-33, X-34, and follow-on demonstrators; ensuring and proving that RLV technology is ready for commercialization; and balancing safety, performance, environmental impacts, and cost. The primary non-technical issue is overcoming the barriers that hamper cooperation among the sometimes-competing interested parties—Federal agencies, State authorities, commercial launch providers, launch site operators, and manufacturers.

ACRONYMS

DOD	U.S. Department of Defense
FAA	Federal Aviation Administration
NASA	National Aeronautics and Space Administration
RLV	Reusable Launch Vehicle
SSTO	Single Stage to Orbit
STC	Spaceport Technology Center

Technology Roadmap for Next Generation Space Transportation Technology



13. ACCESSIBILITY FOR AGING AND TRANSPORTATION-DISADVANTAGED POPULATIONS

VISION

A transportation system that meets the mobility and accessibility needs of the elderly, the poor, persons with disabilities, and all other Americans without access to a private automobile.

GOALS

Create model alternative transportation systems that serve the needs of the elderly and transportation-disadvantaged people while taking full advantage of existing services, resources, and development patterns; promote development of transit-compatible communities that integrate transit and pedestrian services for all users; provide opportunities for employing welfare recipients by preserving communities and enhancing transit.

NEAR-TERM OUTCOMES

By 2001, increase to 11.78 percent the percentage of urban population living within a quarter mile of transit stops with service frequency of 15 minutes or less (non-rush hour) from a 1999 level of 11.24 percent.

Increase the percentage of key rail stations that are in compliance with the Americans With Disabilities Act (ADA) from 49 percent in 1999 to 58 percent in 2001.

Increase the percentage of bus fleets that are ADA-compliant from 77 percent in 1999 to 83 percent in 2001.

Increase the number of employment sites that are made accessible by Job Access and Reverse Commute transportation services; the goal for 2001 is 8,050 sites compared to 1,692 sites[17] in 1999.

Increase transit ridership from 43.10 billion passenger-miles in 1999 to 43.97 billion in 2001.

[17] 1999 preliminary estimate.

MAGNITUDE OF THE PROBLEM

Although the United States possesses one of the safest and most extensive passenger transportation systems in the world, the system is unable to provide optimal mobility for selected and growing portions of the population. These segments include the elderly, the physically challenged, and the poor.

Today, 12 percent of the U.S. population is 65 or older. Estimates suggest that by the year 2020, 17 to 20 percent of the population—or approximately 50 million Americans—will be over 65. The fastest growing cohort will be those least likely to have easy access to an automobile—those 85 and older. Yet, most of the elderly today are drivers and, by 2010, nearly all will be licensed. Having come to depend on the level of mobility afforded by the automobile, many elderly Americans will have to rely on alternative transit services once they are no longer able to drive.

Likewise, those young or old with physical disabilities have considerable mobility needs. More than 40 million Americans are disabled and many cannot drive or live in areas that are not served by transit. For these Americans, access to medical facilities, schools, training centers, and workplaces are critical to health and well-being.

Finally, welfare reform places a five-year lifetime limit on receipt of Federal cash assistance benefits, which means that welfare recipients must work. Most welfare recipients, and others with low incomes, do not own a car, and the "spatial mismatch" that often exists between the locations of jobs (about 66 percent of which are located in the suburbs) and the poor (75 percent of welfare recipients live in central cities or rural areas) exacerbates mobility problems. Most of the welfare recipients who will be required to work—and the heads of most poor households—are single mothers, which means that any effective mobility option must support the trip-chaining needs of working mothers, including work, child care, and other household management trips.

REQUIREMENTS

Government investment in paratransit has provided the vast majority of the transportation options available to those without access to an automobile who are not served by conventional fixed-route transit. *Paratransit* is typically defined as flexible-route, low- or medium-capacity vehicles serving a predetermined group of people, such as the elderly, for a fee. The need for these services is growing. Demand-responsive paratransit nationwide has doubled the number of miles traveled over the last 10 years to nearly 600 million miles per year.

Although paratransit fills an important transportation gap for many parts of the population, its financial viability has been underwritten with substantial government funding—Federal, State, local, and private—rather than from its own revenues. High operating costs and poor management strategies that do not optimize the use of drivers

and vehicles have made such services costly and less than fully responsive to their riders' mobility needs.

This partnership focuses on improving the mobility of the elderly and transportation-disadvantaged through better management of paratransit operations, advanced transit technologies, and livable communities. Partners will achieve these ends by:

Developing an ongoing process for coordinating and integrating Federal efforts to optimize existing transit and paratransit services.

Identifying gaps in Federal research, development, and technology.

Assuring that Federal activities are fully integrated and coordinated with State, local, and private efforts to improve mobility.

Developing innovative transportation alternatives, including regional paratransit and autonomous dial-a-ride transportation.

INVESTMENT STRATEGY

Participants

Federal: DOT (FTA—lead agency, Office of the Secretary, FHWA, NHTSA, ITS Joint Program Office, RSPA); DOL; EPA; HHS (AOA, CDC, NIA); HUD.

Other: State, local, and tribal agencies; MPOs; Area Agencies on Aging; housing authorities; associations; the private sector (information and communication system vendors, transit providers, employers); nongovernmental organizations; foundations (AAA Foundation for Traffic Safety, Easter Seals, Eno Transportation Foundation); and universities.

Management

The FTA's Office of Research, Demonstration, and Innovation provides overall program management for this partnership. However, the management structure and process make full use of existing mechanisms for interagency cooperation—for example, the ITS Joint Program Office, the Access and Mobility Coordinating Council, and joint FTA/HUD efforts—and incorporate ongoing guidance from non-Federal participants.

Critical Technology Elements and Activities

This partnership's major activities include the following (see the roadmap below). The entire partnership is presented in the NSTC's *Accessibility for Aging and Transportation-Disadvantaged Populations Implementation Plan.*

Access to Jobs and Reverse Commute: Created in 1998 by TEA-21, this program provides competitive grants to local governments and not-for-profit organizations to connect persons to employment. The Access to Jobs component focuses on welfare recipients and others with low incomes, while Reverse Commute provides access to suburban jobs for people at all income levels. Administered by the FTA, the program requires a 50 percent cost-share. Among the activities eligible for funding are new or expanded transportation services, deployment of innovative technologies, and promotion of transit voucher programs or employer-provided services.

Advanced Public Transit Systems: The transit element of DOT's ITS initiative, the APTS program applies advances in computer, sensing, telecommunications, and electronics technologies to improve public transportation. The program has five main components: research and development, system architecture and standards, operational testing and model deployments, technology evaluations, and innovation mainstreaming. A priority for 2000 and beyond is to apply APTS technologies to develop specialized services for people with disabilities, older people, inner city and rural residents, and others with particular mobility needs.

National Agenda for the Transportation Needs of an Aging Society: DOT, CDC, NIA, and numerous nongovernmental and private organizations are developing a national agenda for meeting older people's transportation needs. In 1999, the partners held a series of forums and focus groups across the country and sponsored an *International Meeting on Transportation for an Aging Society*, which was part of the Administration's participation in the United Nations International Year of Older Persons. In 2000, they will apply the results of this outreach to establish a *National Agenda and Strategic Plan to Provide Safe Transportation for a Maturing Society.* The agenda and strategic plan will include (1) a blueprint for addressing older people's transportation needs, and (2) preliminary guidance on programs, professional support, and funding requirements at the Federal and State levels.

Bridges to Work: This program links low-income, work-ready households in central cities with suburban jobs. The linkage is being achieved by means of collaborations that provide time-limited—but integrated—employment, transportation, and supportive services. The demonstration includes a random assignment of participants to an experimental or control group for pre- and post-data collection and evaluation. Five cities are participating: Baltimore, Chicago, Denver, Milwaukee, and St. Louis. Though the program is scheduled to conclude in December 2000, all five sites will continue their operations, if successful, using existing Federal, State, and local resources.

Project Action: A cooperative effort with Easter Seals, Project Action improves mobility for people with disabilities through technical assistance for technology and service innovations. The program has funded more than 80 research and demonstration projects in communities across the country, supporting the development of "virtual reality" travel training systems, comprehensive mobility planning services, and regional models for rural transit.

Program and Service Integration: Ultimately, this partnership will coordinate and integrate services deployed under APTS, Bridges to Work, and related programs, if partners determine that this is feasible. Further out, partners will focus on integrating ITS and other technologies with Access to Jobs services, transportation services for older Americans, and other demonstrations.

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

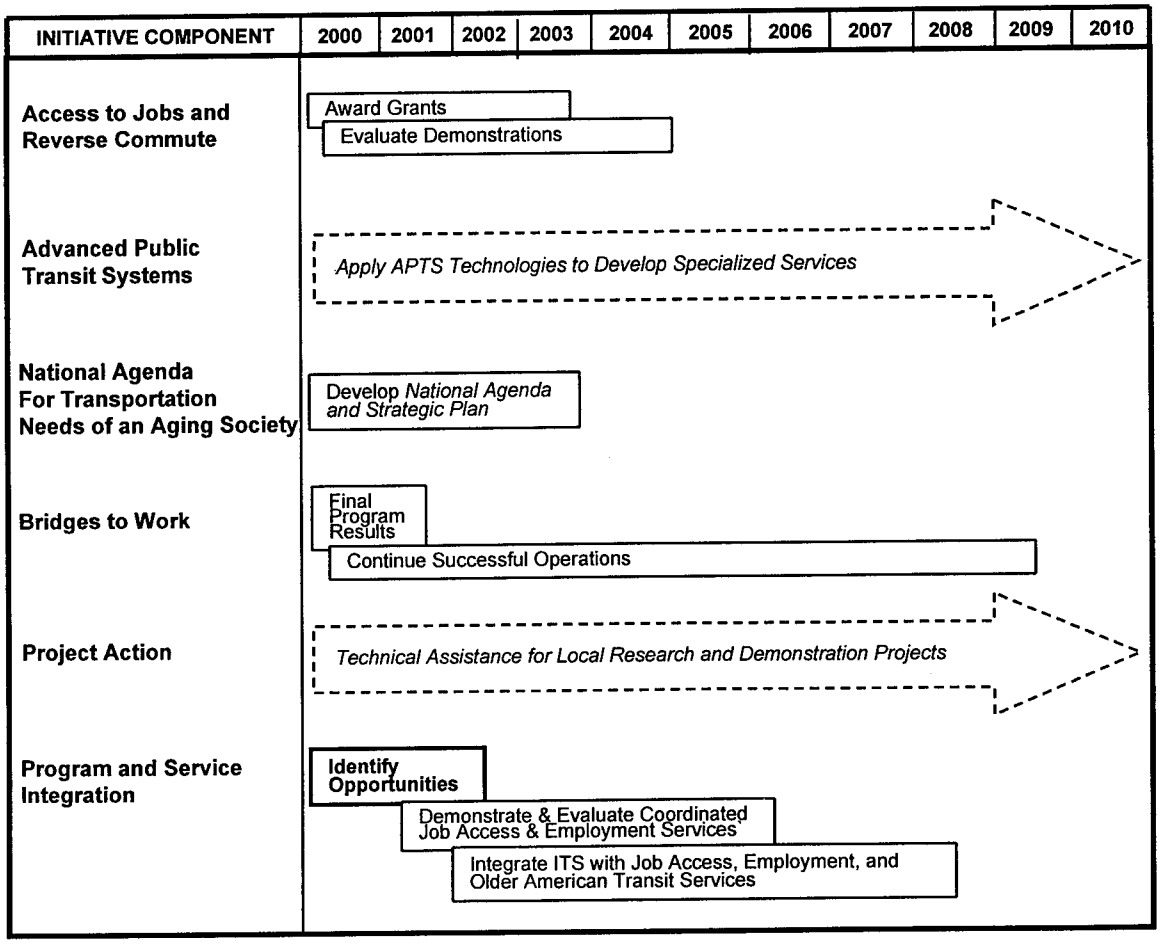
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

The primary technical challenge is integrating different information technologies and service providers for seamless transit service. This partnership also faces a major institutional barrier to implementation: the need to remove existing obstacles to effective interagency and public–private cooperation, particularly at the local and regional levels. In the longer term, it requires more effective linkages between transportation planning and the development of options for community and regional growth.

ACRONYMS

ADA	Americans With Disabilities Act
AOA	Administration on Aging
APTS	Advanced Public Transit Systems
CDC	Centers for Disease Control
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HHS	U.S. Department of Health and Human Services
HUD	U.S. Department of Housing and Urban Development
ITS	Intelligent Transportation Systems
MPO	Metropolitan Planning Organization
NHTSA	National Highway Traffic Safety Administration
NIA	National Institute on Aging
NSTC	National Science and Technology Council
RSPA	Research and Special Programs Administration
TEA-21	Transportation Equity Act for the 21st Century

Technology Roadmap for Accessibility for Aging and Transportation-Disadvantaged Populations



14. ENHANCED TRANSPORTATION WEATHER SERVICES

VISION

A transportation system that is significantly safer, with far greater capacity and efficiency, by reducing the impacts of adverse weather.

GOAL

Develop seamless, cost-effective transportation weather information systems.

NEAR-TERM OUTCOMES

By 2001, reduce the rate of highway-related fatalities to 1.5 per 100 million vehicle-miles traveled.[18]

Reduce the rate of highway-related injuries from 119[19] in 1999 to 113 per 100 million vehicle-miles traveled in 2001.

Reduce the fatal aviation accident rate for commercial air carriers from 0.040[20] fatal accidents per 100,000 flight hours in 1999 to 0.031 per 100,000 flight hours in 2001.

Increase the number of runways that are accessible in low-visibility conditions from 1,084 runways in 1999 to 1,191 in 2001.

MAGNITUDE OF THE PROBLEM

The safety, mobility, and economic impacts of weather on transportation are considerable. The White House Office of Science and Technology Policy (OSTP) estimates that weather causes or contributes to 6,000 fatalities on U.S. highways and 800 aviation-accident-related deaths each year. More than half of all flight delays, and between 25 and 35 percent of all intercity road accidents, are attributable to adverse weather. Moreover, despite the fact that North America spends more than $2 billion a year on snow and ice control, road accidents increase during bad weather by a factor of two to five.

[18] Preliminary estimates show that this rate was achieved in 1999. If the final 1999 data confirms the preliminary data, the outcome goal may be revised downward.
[19] 1999 preliminary estimate.
[20] 1999 preliminary data.

Life-threatening and costly weather events are not limited to winter storms: The United States experiences more severe local storms and flooding than any other country in the world. In a typical year, the United States can expect about 10,000 violent thunderstorms; 5,000 floods; 1,000 tornadoes; and several hurricanes.

REQUIREMENTS

Advances in weather technologies and meteorology over the past decade hold promise for mitigating many of the impacts of severe weather on transportation.

For surface transportation, research, testing, and evaluation in this area have primarily addressed (1) winter maintenance, including road weather information systems (RWIS) for anti-icing and de-icing operations; (2) visibility; and (3) intelligent transportation systems (ITS). Within DOT's ITS program, a number of projects include weather information, five of which include such information as a core part of the system designs. These five projects are the Advanced Transportation Weather Information System, the Idaho Storm Warning System, TravelAid, a variable speed limit project in Nevada, and the Weather Information for Surface Transportation project, also known as Foretell. Of these, Foretell is the most comprehensive project with respect to adverse weather. It addresses the information needs of a range of surface transportation users and operators and works closely with the National Oceanic and Atmospheric Administration (NOAA).

A partnership among the FHWA, Iowa DOT, and the private sector, Foretell's objective is to demonstrate and evaluate an integrated weather information system—first within a "pilot" Midwestern region, then over multiple regions, and eventually throughout North America. The program's first phase will deploy a road and weather information system across five states in the Mississippi Valley region plus western Ontario: a total land area of almost 750,000 square miles. Fully integrated within a wider suite of ITS services, the system will make use of state-of-the-art weather radars and observing systems, including RWIS; the Doppler Weather Surveillance Radar (the FAA's and DOD's NEXRAD); Automated Surface Observing System; Advanced Weather Interactive Processing System; the NWS's Weather Forecast Offices; and advanced communication systems and weather satellites.

To reduce weather hazards in aviation, the FAA, NOAA, and other agencies are working with industry through the Aviation Weather Research Program. This program has two main objectives: (1) improve access to and delivery of aviation weather information, and (2) reduce the consequences of weather events by generating weather observations, warnings, and forecasts with higher resolution and greater accuracy than existing aviation weather services. Specific products under development will provide the following capabilities: accurately depict current and forecasted areas of in-flight icing, including severity and type; couple high-resolution and timely gridded weather data with interactive data assimilation and editing; forecast snowfall type and rate; detect and forecast en route turbulence, particularly clear-air turbulence; predict storm growth, initiation, and decay; make short-term predictions of ceiling and visibility in the terminal area; provide hourly

forecasts of windshear events; forecast terrain-induced hazards; and provide short-term forecasts of conditions that affect wake vortices.

INVESTMENT STRATEGY

Participants

Federal: DOT (ITS Joint Program Office, FAA, FHWA, FRA, FTA, RSPA, USCG—lead agencies); DOD (USACE); FEMA; NASA; NWS; OFCM; USWRP.

Other: Iowa DOT and other State DOTs, NCAR, MIT/Lincoln Laboratories, Forecast Systems Laboratory, National Severe Storms Laboratory, Environment Technology Laboratory, Cold Regions Research and Engineering Laboratory, Environment Canada, weather technology manufacturers and integrators, vehicle suppliers, ITS Service Centers, aviation industry, academia.

Management

For the Foretell program, the Iowa DOT is the lead public sector partner, with the cooperation of the other four states participating in the demonstration and the Province of Ontario. The ITS Joint Program Office and FHWA provide technical assistance for the project and about one-third of the funding required for Phase I. Castle Rock Services, which runs two ITS Service Centers in a public–private partnership with the Virginia DOT, is the private sector lead.

The FAA is the lead agency for the Aviation Weather Research Program, a partnership involving NOAA, the NWS, and other Federal agencies; airlines; airports; and the aviation industry.

Critical Technology Elements and Activities

This effort is related to the Aviation Safety Research Alliance, the Intelligent Vehicle Initiative, and the partnership for the National Intelligent Transportation Infrastructure, described in other sections of this plan. Broad activities include:

Prototype Demonstrations and Pilot Programs: This involves applications of weather technologies in specific modal, geographical, and climatological circumstances, and evaluation of benefits and costs.

Data Sharing: To combine weather data from disparate sources, this effort defines compatible data architectures and exchange standards and coordinates weather information services across agencies and with industry.

Meteorology and Data Sources: This involves the fusion of improved prediction algorithms and atmospheric models with weather information delivery systems. The goal is to apply advances in meteorology to provide weather products with far greater precision and finer resolution.

Information Dissemination and Display: This looks at strategies and technologies for delivering weather information to users. Specific issues include user interfaces for data selection; the display of information specific to particular users' needs; the design of interactive, human-centered displays; and the integration of information systems with ITS and air traffic control (ATC).

Funding Requirement

Funding will be provided from a mix of Federal, State, and local government and private sources. Federal funding will be determined through the annual budget process.

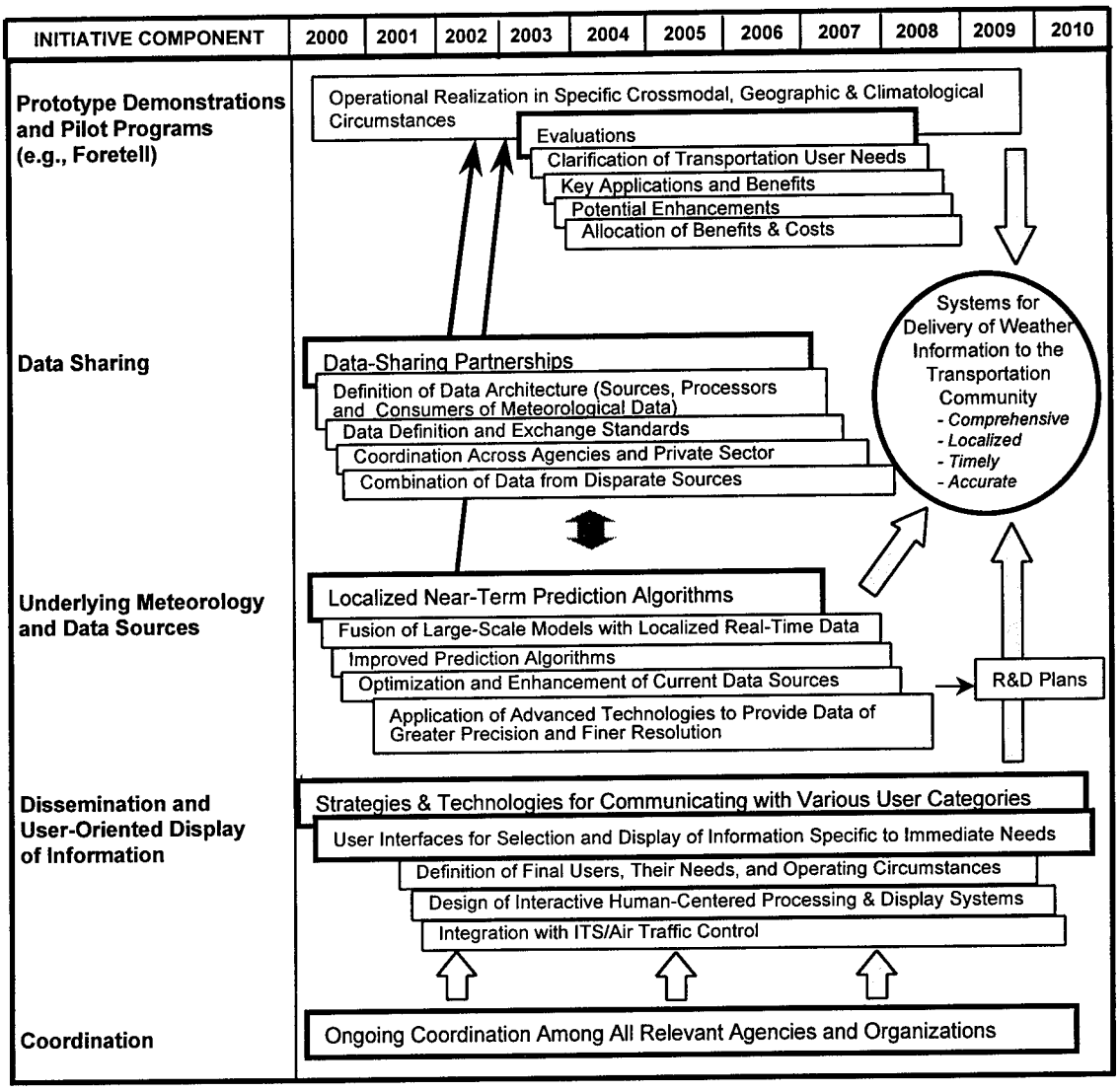
TECHNICAL CHALLENGES AND IMPLEMENTATION ISSUES

The most formidable challenge for both Foretell and the Aviation Weather Research Program is technological: fusing the entire set of weather data-collection systems; integrating this data with the full array of information, communication, and ITS technologies; and disseminating weather information in multiple easy-to-use formats.

ACRONYMS

ATC	Air Traffic Control
DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation (also State DOTs)
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
ITS	Intelligent Transportation Systems
MIT	Massachusetts Institute of Technology
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NEXRAD	Next Generation Weather Radar
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OFCM	Office of the Federal Coordinator for Meteorology
OSTP	Office of Science and Technology Policy
R&D	Research and Development
RSPA	Research and Special Programs Administration
RWIS	Road Weather Information System
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USWRP	U.S. Weather Research Program

Technology Roadmap for Enhanced Transportation Weather Services



APPENDIX
PARTNERSHIP IMPLEMENTATION PLANS

Aviation Safety Research Alliance/Next Generation Global Air Transportation

National Research and Development Plan for Aviation Safety, Security, Efficiency and Environmental Compatibility. November 1999. Available at: http://scitech.dot.gov

National Intelligent Transportation Infrastructure

National Intelligent Transportation Infrastructure Initiative. September 1997. Available at: http://www.its.fhwa.dot.gov/cyberdocs/welcome.htm

Intelligent Vehicle Initiative

Intelligent Vehicle Initiative Business Plan. November 1997. Available at: http://www.its.fhwa.dot.gov/cyberdocs/welcome.htm

Transportation and Sustainable Communities

National Research Agenda for Transportation and Sustainable Communities. September 1999. Available at: http://scitech.dot.gov

Transportation Infrastructure Assurance

Intermodal Cargo Transportation: Industry Best Security Practices. May 1999. Available at: http://scitech.dot.gov

Enhanced Goods and Freight Movement at Domestic and International Gateways

Partnership to Promote Enhanced Freight Movement at Ports and Intermodal Terminals: A Strategic Plan. February 2000. Available at: http://scitech.dot.gov

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Accessibility for Aging and Transportation-Disadvantaged Populations

Accessibility for Aging and Transportation-Disadvantaged Populations Implementation Plan. September 1999. Available at: http://scitech.dot.gov