PUBLIC / PRIVATE PARTNERSHIPS

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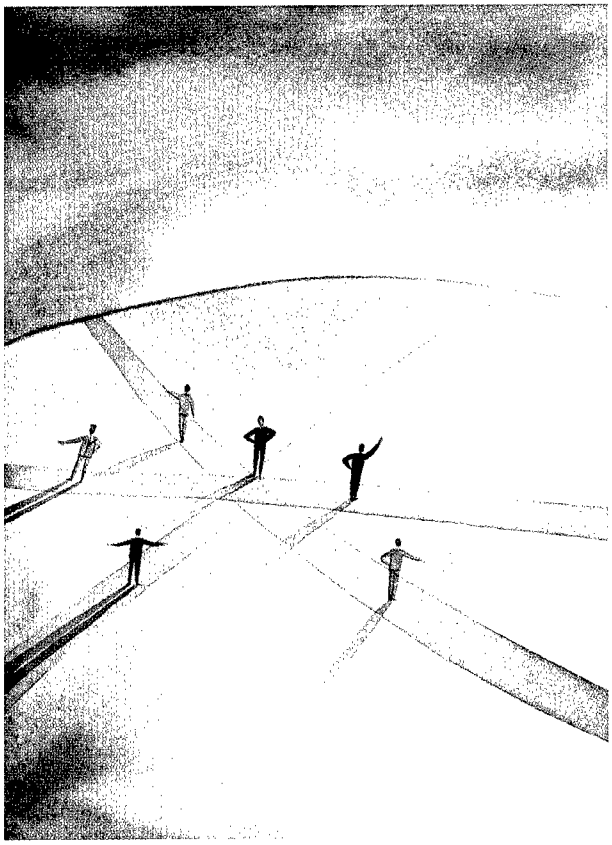

IMPLICATIONS FOR INNOVATION IN TRANSPORTATION

DECEMBER 1998

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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 are aimed at accomplishing multiple national goals.

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This report provides an assessment of public/private partnerships, the challenges they face, and their potential within the nation's transportation system. Included are examples that highlight activities in various transportation modes and the lessons they demonstrate. The report draws the following conclusions: (1) Public/private partnerships in transportation have had modest success as compared to other public policy agendas; (2) the success of these partnerships is limited by factors such as divergent motivations, limited resources, evolving legal constraints, and changing agendas among participants. Preventive strategies that minimize the impact of these challenges are needed; (3)in order for transportation-related partnerships to achieve a fuller potential, additional efforts are needed to leverage existing research and development investments and build new ones, possibly as part of the overall R&D investment environment. This report will support decision makers in the public, private, non-profit, and academic sectors as they examine and develop opportunities for public/private partnership in transportation and other related fields.

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Public/Private Partnerships:

Implications for Innovation

in Transportation

December 1998

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Public/Private Partnerships: Implications for Innovation in Transportation

Executive Summary

The national interest has always been closely tied to the progress of science and technology. Today, market globalization, increased competition, environmental concerns, and public health imperatives demand continued investment in the development and commercialization of new technology.

This report provides an assessment of public/private partnerships, the challenges they face, and their potential within the nation's transportation system. Included are examples that highlight activities in various transportation modes and the lessons they demonstrate. The report draws the following conclusions:

- Public/private partnerships in transportation have had modest success as compared to other public policy agendas.

- The success of these partnerships is limited by factors such as divergent motivations, limited resources, evolving legal constraints, and changing agendas among participants. Preventive strategies that minimize the impact of these challenges are needed.

- In order for transportation-related partnerships to achieve a fuller potential, additional efforts are needed to leverage existing research and development investments and build new ones, possibly as part of the overall R&D investment environment.

This report will support decision makers in the public, private, non-profit, and academic sectors as they examine and develop opportunities for public/private partnership in transportation and other related fields.

Partnerships: cooperative arrangements engaging companies, universities, and government agencies and laboratories in varying combinations to pool resources in pursuit of a shared R&D objective.[1]

I. Introduction

A. Innovation Through Research and Development Partnerships

Achievement of national goals such as economic growth, public safety, national security, and environmental sustainability will require continued aggressive exploitation and application of scientific and technological advances that arise through federal research and development (R&D) expenditures. However, the conversion of research successes into viable commercial products and services can often be impeded by the absence of market forces sufficient to stimulate private sector investment in development and production. This is particularly true when benefits may not be realized for years, when technological uncertainties are present, or when the marketplace is fragmented. Increasing attention is now being given to explicit collaborations between governmental agencies (federal and non-federal) and the private sector, which may overcome the obstacles imposed by the failure of market mechanisms.

A wide variety of mechanisms enable public agencies to work cooperatively, or in partnership, with the private and non-profit sectors in order to bring research and development to fruition through introduction and application of successful innovations. This report addresses one type of these cooperative efforts: public/private partnerships that focus on transportation and that involve the federal government. It categorizes these relationships and examines the challenges that can arise when trying to relate the interests of different organizations and stakeholders, particularly in the context of limited or diminishing governmental resources. This report also examines the potential of several transportation-related projects associated with the National Science and Technology Council, and provides guidelines for future partnership endeavors. The objective is to identify key lessons that may be successfully applied to future partnerships in the transportation R&D enterprise.

This report is based on an extensive literature review and a series of informal interviews on the topic. The bibliography references journals, texts, and cases that form the basis of

[1] "Endless Frontier, Limited Resources, U.S. R&D Policy for Competitiveness", Council on Competitiveness, 1998.

the analysis. Additional comments from practitioners and researchers in the field came from recent symposia and conferences related to the topic. [2]

B. The Evolving Role of Research "Partners"

Prior to World War II, the Federal government's R&D commitment was expressed primarily through the funding of land grant colleges (which began through the Morrill Act of 1862). During the post war period, the federal research budget grew in several ways. It grew *vertically* to support a greater volume of academic research programs and associate staff (faculty and graduate students). Fueled by a major boost in military spending, the federal research budget also grew *horizontally* to include new types of research programs, such as federal laboratories devoted to defense technology, transportation, energy, agriculture, and health care.

The end of the Cold War and the emergence of the American research enterprise as a preeminent world class model led to a major shift in research and development. Policy makers, legislators, and citizens began to ask what should be done and who should pay. The private sector proved somewhat reluctant to become involved in basic types of research that resulted in uncertain payback as compared to time, resource, and financial investments. Meanwhile, the federal government began refocusing away from large military-based research endeavors as part of an overall downsizing of federal resources.[3]

A recent report by the Council on Competitiveness ("Competing Through Innovation: A Report of the National Innovation Summit") highlights five strategic areas that influence the continued prosperity of the R&D system. Figure One summarizes the influence of these areas. One of the main areas of interest is "Market Vitality" that seeks to expand university/industry/government collaborations in order to speed the commercialization of new ideas.

As Figure Two highlights, science and technology research drives technology deployment and product development. Market demands dictate the areas in which development and commercialization of new technology can benefit the public good, resulting in new or enhanced products and services. However, the transition from research to commercial products is often impeded by factors such as fragmented markets, uncertainties as to product feasibility, and investor risk aversion. When the innovation is primarily directed toward a public good, such as safety, market forces may be insufficient

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[2] One current example is a conference entitled "Developing a National Transportation Science and Technology Strategy," sponsored by the National Science and Technology Council and the National Governor's Association (Chicago, IL; May 27-28, 1998).

[3] Historically, the Department of Defense has been a major supporter of partnership activity, due, in part, to America's increasing international defense responsibilities throughout most of this century. Other factors include the military's consumption of diverse and numerous goods and services, and the spin-off benefit provided to other policy areas such as energy and space exploration.

Figure One

Priorities to Strengthen U.S. Innovation: Results of National Innovation Summit

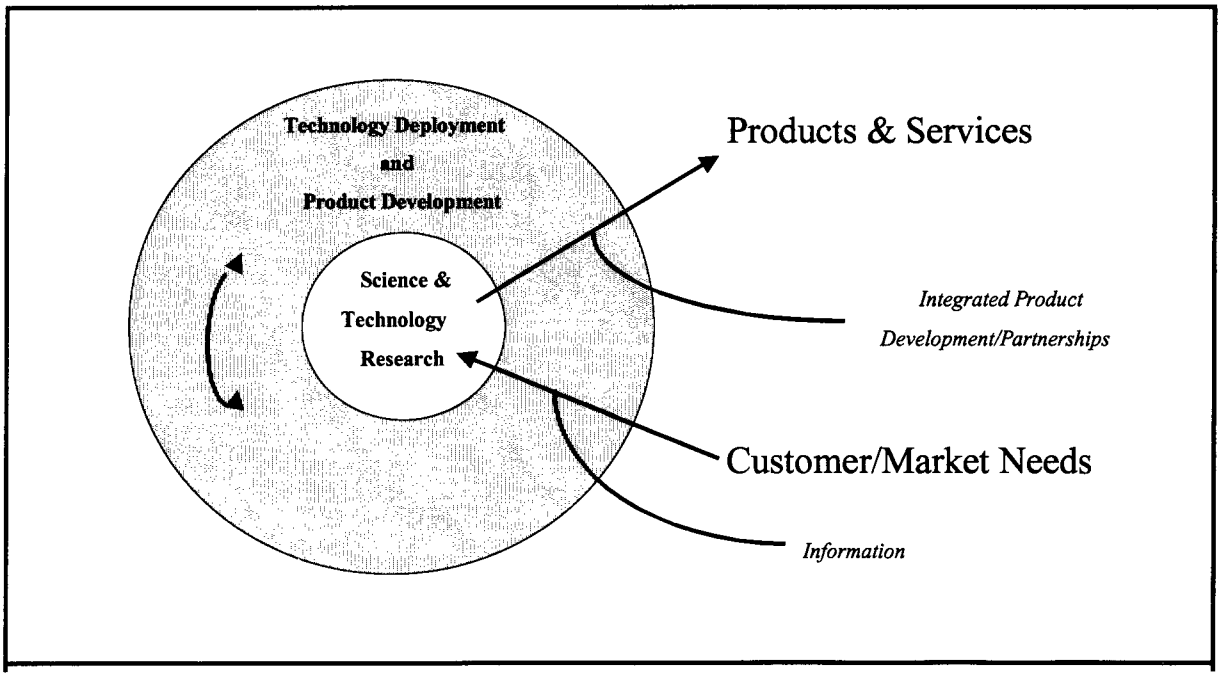
Cambridge, Massachusetts
March 12-13, 1998

	Greatest Long-Term Impact	Most Potential for Short-Term Progress
National Talent Pool	Increase the supply of American science and engineering graduates	Maintain immigration policies that attract research and technical talent from overseas to work in the U.S.
Research Base	Increase federal investment in frontier research	Stimulate private R&D through tax credits
Capital Availability	Contain long-term entitlement spending	Expand the availability of capital for early stage ventures
Market Vitality	*Expand university/industry/government collaboration to speed the commercialization of new ideas*	*Expand university/industry/ government collaboration to speed the commercialization of new ideas*
International Market Access	Increase the effectiveness and reduce the cost of intellectual property protection overseas	Reduce regulatory and other non tariff barriers

Source: *Competing Through Innovation*, Council on Competitiveness

Figure Two

Strategic Direction for U.S. Innovation



to motivate development and implementation. Public/private partnerships (as defined at the beginning of this section) offer a means for overcoming these impediments.

C. *The Legal Basis for Partnerships*

The U.S. Government has been involved in the development and dissemination of technological innovations since its inception; however, the idea of cooperative R&D or private sector partnerships is relatively recent. The current level of federal support for public/private partnerships is the culmination of an incremental process that has taken place over the past two decades.

Exhibit One identifies key legislation that has provided the policy basis for today's cooperative technology programs. The *Stevenson-Wydler Act* required federal laboratories to transfer federally developed, owned, and originated technologies to state and local governments and the private sector. This act also specified that a certain percentage of the laboratory's budget must be set aside for technology transfer activities. The *Bayh-Dole Act* encouraged the private sector to become more involved by allowing title to federally funded innovations developed in federal laboratories or universities.

Exhibit One:

Federal Legislation Related to Cooperative Technology Programs

- Stevenson-Wydler Technology Innovation Act, 1980
- Bayh-Dole University and Small Business Patent Act, 1980
- Small Business Innovation Development Act, 1982
- Federal Technology Transfer Act, 1986
- Omnibus Trade and Competitiveness Act, 1988
- National Competitiveness Technology Transfer Act, 1989
- Defense Conversion, Reinvestment, and Transition Assistance Act, 1992

The *Small Business Innovation Development Act* of 1982 established the Small Business Innovation Research (SBIR) Program to direct government seed funding to the small, high-technology company sector. Later, the *Federal Technology Transfer Act* of 1986, amended *Stevenson-Wydler* to authorize Cooperative Research and Development Agreements (CRADAs) between federal laboratories, industry, universities and state governments. The *Omnibus Trade and Competitiveness Act* (1988); the *National Competitiveness Technology Transfer Act* (1989); and the *Defense Conversion, Reinvestment, and Transition Assistance Act* (1992) also promoted this type of exchange.

Since 1992, Congress has enacted several major revisions to existing cooperative technology legislation, the original *Bayh-Dole Act*. These changes were intended to resolve some of the problems resulting from implementation of the initial legislation. Additional changes to this legislation can be expected; in spite of the polarized debate

over the proper federal role in R&D, experimentation with different types of partnerships must respond to economic constraints, competitive pressures, and technological demands. Some of the salient issues are:

- Industry is increasingly relying on partnerships with universities, with an emphasis on short-term research programs.

- Federal policy and financial support are vital to many partnerships; prospective cuts in federal funding are pushing research institutions to seek closer ties to industry and are prompting companies to reevaluate their R&D strategies.

- Recent initiatives designed to increase interaction between industry and the federal R&D establishment show promise in some areas, but have produced mixed results.

- Concerns over intellectual property and associated revenues have become an increasingly contentious factor in many industry/government/university partnerships.

In 1995, Congress passed the *National Technology Transfer and Advancement Act.* This act seeks to improve U.S. competitiveness by speeding up the commercialization of inventions developed through collaborative agreements between government and industry. The act also promoted partnerships between federal laboratories and the private sector by creating new incentives for laboratory personnel.[4]

Two other issues applicable to partnerships and cooperative arrangements were raised in a General Accounting Office report on the National Institute of Standards and Technology's (NIST) Advanced Technology Program's (ATP) FY 1997 selection process.[5] First, approximately half of the companies funded said that they would have pursued their project, even if they had not received federal funds. Second, the level of funding was not a reliable indicator of research results; companies collect data on various output indicators, such as investments and patents granted, but in general make limited use of them in their investment decisions.[6] The GAO study also found that universities actively pursued licensing opportunities. For example, Stanford University made $43 million from licensing in FY 1997, of which $40 million (almost 93 percent) was due to the *Bayh-Dole Act.*

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[4] H.R. 2544, "The Technology Transfer Commercialization Act of 1997," Congressional Record, Extension of remarks by the Hon. Constance A. Morella in the House of Representatives, September 25, 1997.

[5] "Federal Research: Information on the Advanced Technology Program's 1997 Award Selection," T-RCD-98-92, February 26, 1998.

[6] GAO did admit that their findings were only after the first year and that the results may be misleading since products may take several years before they begin to produce revenues.

In July 1998, the House of Representatives passed the *Technology Transfer Commercialization Act.*[7] This act revised part of the *Bayh-Dole Act* to streamline the ability of federal agencies to license federally owned inventions. Witnesses at earlier hearings indicated that several factors hindered the strategic advantages of using CRADAs to acquire intellectual property rights. These witnesses cited the lengthy (five month) and uncertain federal technology transfer process as a serious discouragement to licensing government-owned technology. The delays stem from a three-month notification period via publication in the *Federal Register*, and a subsequent 60-day period for filing objections. The use of the internet may reduce these delays and associated transaction costs. The *Technology Transfer Commercialization Act* also amended the *Stevenson-Wydler Act* by removing the restriction against introducing government-owned and -operated inventions into a CRADA. This act created a second path for licensing inventions as "stand-alones" or including them as a part of a CRADA; it effectively eliminated competitors from blocking actions on exclusive licenses by saying that they would accept non-exclusive licenses.[8]

[7] "Technology Transfer Commercialization Act of 1998" House of Representatives testimony, July 14, 1998.

[8] Testimony of Joseph P. Allen, Vice President, Marketing and Technology Assessment, to the House of Representatives Committee on Technology, September 25, 1997.

"...the competitive position of the U.S. economy hinges now more than ever on generating new ideas and translating them into products, processes, and services ...." Competing Through Innovation, p. 2

II. Partnerships as Tools for Innovation

A. Types and Motivations

Many governmental strategies may stimulate the deployment of innovations. Traditionally, these include public sector support of private sector initiatives through tax incentives, grants, and other special considerations. Public/private partnerships offer another approach.

Partnerships typically represent a diversity of motivations among the participants. Public sector participants may seek to advance a broad-based policy or research agenda. The federal government does this for R&D through its investment in basic research. Basic research is a fluid category of research, which may lack clearly defined goals. However, exploratory research at this level may identify future research targets. R&D partnerships may include participants other than the federal government and private industry. Non-federal public stakeholders in these arrangements may include state, regional, municipal, local, and tribal entities.[9] Potential private partners include the academic sector, non-profit entities, foundations, or specialized groups (e.g., chambers of commerce, National Governors' Association).

The private sector's interest in partnerships tends to have a narrow focus, due to stronger financial concerns and shortened time frames. Private sector partners may not have the finances, personnel, facilities, or other necessary resources to complete a project on their own. They may be even less willing to invest these resources if the potential dividends are unclear or distant in time. Private sector interests may also have more need for recognition of their contribution, both at the organizational and individual level.

Increasing interest in public/private partnership activity is due to both economic and policy objectives. As government seeks to balance budgets and contain deficits, there is renewed interest in determining what functions can be more efficiently handled by private sector entities.

B. Challenges to Creating Effective Partnerships

The statements of experts and related literature reflect an apparent consensus that technology has great potential to address many of society's problems, particularly in the area of transportation. However, it is the 'institutional issues' that may impede the

[9] Funding available from non-federal sources is usually minor. Recent state and local support comprised less than $400 million of an overall R&D budget of more than $160 billion.

productive collaboration of government, industry, and universities. These issues can be categorized into four basic areas: 1) divergent motivation among the participants; 2) limited resources; 3) perceptions of legal and institutional barriers and inadequate protection from unfair competition; and 4) the evolving agendas of public and private institutions.

1. Motivations

Entities that entered into a partnership for different reasons may find that the convergence of issues has limitations. Public sector partners have several inherent or explicit goals. The federal government facilitates innovations that enhance the Nation's well being and economic competitiveness. Administrations may seek to identify new funds and leverage existing resources in order to maintain programs, fulfill agency mandates, or save money. Overwhelming public attention to a specific policy area (e.g., transportation safety) may force the public sector to take action. Political considerations, as reflected in the needs of individual legislators and their constituents, may also motivate the public sector.

John Gibbons, the former Assistant to the President for Science and Technology, described the White House's *Transportation Science and Technology Strategy* in 1997:

> It [the strategy] responds to the greatest challenge facing the Nation's transportation system and the Federal R&D community – how to do more with less – by identifying innovative ways to partner successfully with industry and academia to leverage scarce R&D dollars.[10]

The private sector and universities, although interested in policy objectives, do not necessarily share a short-term stake in the development or implementation of these objectives. As Ratchford (1997) observes, private sector firms have two main interests in joining a collaborative effort: 1) increased profit may result from new technology that provides cost savings in existing systems, or that results in market growth via new products and services; and 2) development of new technologies often contributes to increased stock value (shareholder value). Private sector participation often is based upon a financial risk/benefit analysis. Risks include little or no return on investments and the potential release of proprietary information; the analysis weighs these against potential benefits to short-term plans and products. As a result, firms are attracted to research collaborative activities that contribute to a firm's short-term objectives and "technologies in the pipeline" (Hane, 1992).

Roos, Field and Neely (1998) describe the strong private sector support for SEMATECH, a consortium set up to revitalize the ailing semiconductor industry. Over the course of a decade, the federal government invested $800 million into SEMATECH while practicing a "hands-off approach." Consequently, the consortium has enjoyed strong industry leadership (it is often managed by former industry researchers) and has been publicly championed by semiconductor executives. This decade of support, according to Roos, *et*

[10] National Science and Technology Council, *Transportation Science and Technology Strategy*, November 1997.

al, is due to the clarity of the consortium's mission: "to improve the competitiveness of the U.S. chip manufacturers." This clearly articulated goal "helped participants overcome their hesitation about working together ... concerns over revealing sensitive problems were alleviated when it became apparent that many parties were facing the same issues."

The academic sector has motivations that are not necessarily congruent with private industry and the federal government. Universities seek to develop new knowledge and to convey that information to the next generation and to others in science. The eventual application of that research to policy or share holder objectives is often a secondary priority for many academic investigators. The "fragile contract" between research institutions, government, and industry requires addressing the interests of research sponsors while maintaining the integrity of the university mission.

Many universities seek an ideal partnership in which a single institution provides significant funding for research and innovation. Many states use industrial and governmental support of state universities to develop university research parks that serve as incubators of innovation, thereby forming a loose partnership within a given industry sector. For example, the close collaboration between North Carolina State University (Raleigh) and nearby environmental technology firms is due, in part, to the Environmental Protection Agency's investment in the nearby Research Triangle Park, a major laboratory.

2. Resources

Experts cite the availability and distribution of resources as a primary issue in the development and progress of research collaborations.

Resources include funding, staff, capital facilities, and equipment. Members of the private sector, who perceive the federal government as the source of many regulations or policy goals that require new technological solutions, argue that the government should provide funding to help develop and implement these alternatives. As one respondent exclaimed – "it [the partnership] amounted to Congress legislating that my company spend millions of its own money on their project!"

However, federal spending in support of industrial consortia is a controversial policy. The use of increasingly scarce federal resources for partnerships is frequently attacked as an inappropriate cost to the public. Branscomb and Florida (1998) note that the public opinion on such spending resembles a pendulum. Federal support for SEMATECH, the Advanced Technology Program (ATP), and the Technology Reinvestment Project (TRP) has been characterized as a public subsidy to industry or as "corporate welfare": by many elected decision makers and opinion leaders. Others express concerns that such investments result in a de facto technology policy in which the government selects winners and losers, thus interfering with the marketplace.

3. Legal and Institutional Framework

Research partnerships are often thwarted at their initiation or fail during their operation because of perceived legal constraints or inadequate protections afforded to industry and university participants. For example, questions remain regarding ownership of intellectual, licensing or property rights resulting from federally sponsored research. A review of the Department of Transportation's University Transportation Centers Program (1997) suggests that these issues have impeded private sector participation. Consequently, many projects sponsored by the Program do not receive private funding that matches the federal government's investment, resulting in diminished potential to leverage public funding.

It is difficult to document the legal basis of this concern. Federal legislation, such as the *Bayh-Dole University and Small Business Patent Act* of 1980, enables universities and firms to license and patent the results of federally funded research. However, as indicated in the University Transportation Centers Program study, the perception of legal obstacles is one of many issues that dissuade private firms from joining partnership consortia.

4. Agendas

The recent record of collaborative R&D partnerships reflects the impact of change on established plans and relationships. For example, changing agendas in both the public and private sectors--as well as the arrival or departure of leaders who may champion or oppose the collaboration--are influencing factors.

The private sector, which often has a short time horizon, must respond to its own planning cycle and, in many cases, to shareholders' concerns. As a result, corporate managers may choose to end their participation prematurely if short-term benefits do not materialize.

The federal government must address time frames as they relate to the complex budget cycle and to the political longevity of coalitions that support specific programs. For example, although Congress authorized the National Maglev Initiative, established by the 1991 *Intermodal Surface Transportation Efficiency Act* (ISTEA), the Department of Transportation chose not to request funding at those levels. Over time, a policy emerged that favored incremental advances in intercity ground transportation over attempts to "leap frog" to a very high performance, but costly and commercially unproven, technology. This policy eventually resulted in the program's dissolution. The nature of a democratically elected government can also affect partnerships. Individuals who support a program may not be reelected or may be voted out of office by a new majority.

Maidique (1988) argues that successful partnership and innovation requires a special combination of entrepreneurial leadership, management acumen, and technological expertise. Successful partnerships benefit from the existence of an obvious issue entrepreneur, or "champion." Vice President Al Gore is one such champion of the

National Information Infrastructure (NII) program. By serving as the spokesman and by identifying resources, the Vice President keeps the NII on the national agenda and influences private sector participation. Issue entrepreneurs need not be in the White House to successfully support a partnership initiative. They must, however, demonstrate the ability to articulate clear goals, define the problem in a way that is inclusive to the participants, and maintain the status of the issue within the agency, company, or national agenda over time.

"I am committed to...realizing the vision...of a seamless and safe transportation system, with each transportation sector working effectively by itself and as part of a larger, interconnected whole to move the nation."

Rodney E. Slater
U.S. Secretary of Transportation

III. Representative Partnerships in Transportation: Three Modal Examples

The synergy that results from transportation-related projects provides a unique opportunity for public/private partnerships. Three innovative partnerships stand out as collaborative examples: **Partnership for a New Generation of Vehicles (PNGV)** (surface transportation); **Advanced General Aviation Transport Experiments (AGATE) Consortium** (aviation); and the **Fuel Cell Technology Development for Marine Applications** initiative (maritime). These three examples have produced innovations that benefit a broad spectrum of clearly established federal interests. The PNGV relates to governmental concerns with the environment and natural resources. The AGATE Consortium addresses government concerns over industrial revitalization and safety. The Fuel Cell Technology Development for Marine Applications initiative demonstrates the federal government's support for alternative technologies.[11]

A. Surface Transportation Case Study: Partnership for a New Generation of Vehicles (PNGV)

1. Partnership Description

The Partnership for a New Generation of Vehicles is a ten-year collaboration between the federal government and the U.S. auto industry. It focuses on improving the fuel-efficiency of passenger cars, with the specific intent of decreasing automobile emissions and increasing energy efficiency three-fold, without adversely affecting automobile size, safety, and cost. The partnership was announced in September 1993 by President Clinton and Vice President Gore, who described the program's technological challenges as "comparable to or greater than the Apollo project." It is a new model for government-industry interactions, replacing adversarial and confrontational relationships with cooperative efforts designed to preclude the need for regulatory actions through technological innovation.

"The remarkable, new, fuel efficient, experimental cars rolled out at the Detroit auto show prove that our partnership with the Big Three auto makers is showing results and that we can protect our environment and meet challenges such as global warming in a way that creates jobs and strengthens our economy."

Vice President Al Gore

[11] While this latter example is primarily a federal initiative, efforts are being undertaken to include and develop the private sector's participation.

a. Partners

Core participants in the PNGV are seven federal agencies, nineteen national laboratories, and the "Big Three" U.S. automobile companies. Over 300 organizations are also involved. The major federal partners are:

- Department of Commerce (DOC)
  National Institute of Science and Technology
  Advanced Technology Program

- Department of Defense (DOD)
  Defense Advanced Research Projects Agency
  U.S. Army Tank Automotive Research, Development, and Engineering Center

- Department of Energy (DOE)
  Office of Advanced Transportation Technologies
  National Laboratories

- Department of Transportation (DOT)
  National Highway Traffic Safety Administration

- Environmental Protection Agency (EPA)
  National Vehicle and Fuel Emissions Laboratory

- National Aeronautics and Space Administration (NASA)
  Ames Research Center
  Jet Propulsion Laboratory
  Marshall Space Flight Center
  Lewis Research Center

- National Science Foundation (NSF)

The mechanism for industry participation is the United States Council for Automotive Research (USCAR), an organization formed in 1992 by the Chrysler Corporation, the Ford Motor Company and the General Motors Corporation to coordinate administrative and information services for Big Three research consortia and tackle shared technological and environmental concerns.

In addition, more than 300 other entities, including small businesses, major automotive suppliers, universities, and individual inventors, have provided ideas and research support to the major partners. This effort has involved contracts, subcontracts, CRADAs, SBIR grants, and various shared research arrangements.

b. Partnership Structure and Roles

The historical role of the government has been to undertake long-term, high-risk basic research in support of national priorities. In the case of the PNGV program, the public interest in increased fuel efficiency and reduced emissions is clear and important, although market demand is not yet sufficient to motivate private-sector firms to make the necessary R&D investment. Government thus dominates the research component of PNGV.

The auto industry will implement development and commercialization of program results. In addition, USCAR and PNGV provide a framework for cooperation among the U.S. automobile manufacturers on pre-competitive technical issues, thus enabling them to compete more effectively in the global marketplace.

Overall PNGV policy is coordinated by an operational steering group consisting of senior level officials from government and industry, broken into subgroups. The government group includes representatives from participating agencies, the Office of the Vice President, the Office of Science and Technology Policy, and the Office of Management and Budget. Short-term coordination and management is the responsibility of subject-specific technical teams of government and industry representatives. Governmental policy and administrative functions are the responsibility of the Department of Commerce. The Department of Energy plays a major technical role: it receives the majority of federal PNGV funding; it has a variety of related R&D programs; and it is responsible for ten National Laboratories with relevant facilities and capabilities. The PNGV is reviewed annually by a distinguished standing committee of the National Research Council, which assesses the overall balance and adequacy of the program.

c. Scale/Funding

PNVG represents a major transportation R&D initiative, with FY98 funding of $227 million. Of this total, $145 million is closely aligned with the collaborative R&D efforts, while the balance is directed at long-term R&D needs. As the program focus shifts from basic research to prototype development, the primary financing burden will fall on industry.

d. Policy Objectives

The specific objective of the PNGV enterprise is to develop a concept vehicle. The research objective is fuel efficiency three times that of current standards (80 mpg for a mid-sized family sedan). Furthermore, the resulting vehicle should not require a compromise in performance, size, or utility; it should be fully compliant with current safety and emission standards; and it should have a cost of ownership equivalent to existing vehicles. Concurrently, the program seeks to develop advanced manufacturing techniques that will speed the delivery of new products to markets. Technologies that can lead to near-term improvements in vehicle fuel efficiency, safety, and emissions are another goal. More broadly, key policy objectives include diminished U.S. dependency

on foreign energy sources, reduction of harmful emissions and gases that can contribute to global warming, and a more competitive automotive industry.

e. Time Frames

The basic schedule for PNGV calls for a concept vehicle to be ready by 2000, with a pre-production prototype available by 2004. Late in 1997 the program met an important interim milestone: selection of four key technologies most promising for the achievement of PNGV goals. Continuing efforts will focus on these key technologies. In addition, all three auto manufacturers have unveiled advanced concepts suggesting real progress.

2. Discussion of Four Common Characteristics

a. Motivations

Although government and industry participants in the PNGV collaboration have very different motivations, these differing goals are not inherently in conflict and may be complementary. The primary Federal objectives are to mitigate adverse impacts of the nation's high level of petroleum consumption (e.g., vulnerability to oil price shocks and reduced supplies) and to reduce emissions of greenhouse gases and air pollutants. Additionally, there is concern that the absence of market demand for fuel-efficient vehicles would ultimately cause U.S. manufacturers to fall behind in the world market, damaging the national economy and causing unemployment in the auto industry. Intertwined with these concerns is the desire to achieve fuel economy and emission improvements through a more efficient mechanism than the regulatory approaches of the past.

For industry, the primary motivations includes a desire to avoid a regulatory solution, which industry sees as a highly inefficient means to achieve the desired end; and a desire to achieve advances in vehicle technology and manufacturing even in the absence of clear market demand.

b. Resources

Government funding for PNGV is distributed among multiple agencies. The program often involves a redefinition, expansion, or redirection of existing programs; it also draws on results of related programs in various agencies. At present, the PNGV budget is embodied explicitly in the R&D programs of DOE, EPA, DOT, DOC, and NSF. Since inception of the partnership, annual federal funding has ranged from $220 million to slightly over $260 million. Estimates for private expenditures are unavailable, but the original agreement calls for industrial investments equal to those of the federal government over the ten-year technology development and validation phase of the program.

c. Legal and Institutional Framework

Technical collaboration among automobile firms has generally been rare, due to competitive concerns and antitrust requirements. However, strong foreign competition in the 1970s and 1980s and passage of the 1984 Cooperative Research Act motivated a wide range of pre-competitive research collaborations involving industrial competitors. Compliance with government regulations also required the development of innovative automotive components. Industry became attracted to technical collaboration when: 1) research was long-range and pre-competitive; 2) technology led to no customer differentiation; 3) R&D was directed at a societal good; and 4) the supply base was important to R&D success. In the latter case, collaboration encouraged component suppliers to innovate and led to acceptance of standards that benefited all parties. USCAR, formed to promote this type of research, provided a structure that greatly facilitated the PNGV collaboration. It would have been a difficult and politically sensitive undertaking for the federal government to have developed an individual partnership with one or more of the major auto manufacturers. Thus, the existence of USCAR was a key element in the government's ability to work equitably with the industry to establish the PNGV.

d. Agendas

The partnership has followed approximately the path initially described. Descriptive materials now put more emphasis on global warming than energy security, but the goals and schedule are unchanged. The Department of the Interior was originally a modest participant, primarily in connection with recyclability and availability of materials; it is no longer listed as a participant. Unlike the early years, DOD and NASA no longer receive any of the PNGV budget, although they pursue complimentary R&D. Each automobile manufacturer now plans to produce its own concept vehicle and prototype, rather than a joint PNGV vehicle. But overall, the program has changed little in approach, scale, or objective.

3. Conclusions

The longevity and accomplishments of the PNGV program reflect complementary motivations, significant resources, and a high level of commitment among the participants. The objectives and roles were clearly defined, and the program built on an existing pattern of R&D investment.

PNGV created a stronger awareness and interest regarding vehicle technology R&D; it has spurred innovative thinking both within and outside of that program. Its beneficial impacts include increased coordination and communication among government and industry. Participants describe many "success stories" related to specific individual technologies or component improvements attributable to the Partnership.

Despite appreciable progress to date, significant technical challenges remain and overall success is by no means assured. Considerable optimism exists regarding the fuel

efficiency goal; however, uncertainties remain regarding the cost objective, which will determine whether such cars come to market.

Critics have argued that PNGV, a relatively short-term and low-risk program, has undervalued technological approaches taking longer to implement but resulting in more dramatic improvements. Advances by foreign manufacturers (many supported by their governments) may ultimately provide sufficient market motivation for the industry to resume its historical role as the prime mover in automotive innovation.

Although PNGV developed largely out of existing R&D activities, its focused goals and program management accelerate the progress toward advances in fuel economy and advanced automotive technologies. The program offers a strong focus for the efforts of many parties; it has stimulated a high degree of coordination and collaborative decisions concerning identification of the most potentially rewarding research pathways. Major technological advances have been achieved. Five years after initiation of the PNGV, government and industry partners remain publicly supportive and enthusiastic.

The PNGV Program is a clear, current example of a true partnership among public and private sector entities. The program benefits from wide participation by government, industry, and academia; significant investments by all partners; a joint steering group; objective technical oversight; clear delineation of roles; and explicit goals.

B. *Aviation Case Study: Advanced General Aviation Transport Experiments (AGATE)*

1. Partnership Description

In the early 1990s, the ailing general aviation (GA) industry needed a solution that would revitalize the industry and provide the foundation for future growth. Statistics from the early 1980s showed that GA production had declined significantly. Cessna had not produced piston-powered aircraft since 1986; Piper Aircraft was in bankruptcy; and the Raytheon Corporation, a major defense contractor, had bought out Beech Aircraft. After being approached by congressionally supported GA industry executives, NASA Administrator Dan Goldin convened the General Aviation Task Force to examine the industry and to explore the possible role of NASA in its revitalization. In September of 1993, the task force made three recommendations:

- Stimulate the GA industry to work toward a vision for a Small Aircraft Transportation System;
- Promote the availability of NASA's resources through the use of *collaborative partnerships* – to share resources and expertise and to mitigate risk; and
- Apply those resources to four key technological areas most productive for the industry.

These recommendations prompted NASA to establish the Advanced General Aviation Transport Experiments Consortium (AGATE), a cost-sharing industry/university/government partnership intended to stimulate technological advances for the U.S. general aviation industry. AGATE is part of the NASA Advanced Subsonic Technology Program (AST) and is closely coupled with four additional NASA programs: the General Aviation Propulsion Program (GAP), the Aviation Safety Initiative, the Advanced Air Transportation Technologies (AATT) program, and the NASA SBIR Program The AGATE program began with the passage of the *General Aviation Revitalization Act* of 1994, which reduced liability for general aviation manufacturers.

> *"AGATE is making significant progress. Seventy companies are working together with government toward a common goal, revitalizing general aviation, and we are beginning to see products hit the market."*
>
> E. Randy Nelson
> Past Chairman,
> AGATE Executive
> Council

The goal of the AGATE Consortium is twofold: develop affordable new technology to ensure greater safety; and establish industry standards for airframe design, cockpit configuration, flight training, and airspace infrastructure related to the next-generation single pilot, four to six passenger, near all-weather light airplanes.

a. Partners

In order to achieve its goal, the program must enlist all of the general aviation community, including corporate leaders, engineers, designers, regulators, marketers,

pilots, and supporting personnel. The consortium has approximately 70 members, including NASA, the Federal Aviation Administration (FAA), 40 principal industry partners, and about 30 supporting members, such as the United States Air Force (USAF).

b. Partnership Structure and Roles

Management of the consortium is the responsibility of three entities: NASA, the FAA, and an Executive Council. The Executive Council is an elective body composed of nine representatives (five from industry, four from government) and eight "observing members." The Executive Council establishes strategy and advises AGATE partners on resource allocation, operating policy, and philosophy; it also represents the consortium to the public and to governmental bodies. This management structure allows the consortium to address changing policy, resources, and other institutional barriers by restructuring the alliance. The AGATE Alliance Association Incorporated (AAAI) is a private sector entity that facilitates the business administration functions of this fairly large partnership by providing industry-quality membership services.

c. *Scale/Funding*

Overall funding for the seven-year period from FY 1994 to FY 2001 is $500 million. Work packages are funded individually (e.g., a propulsion work package was recently funded for $50 million). The AGATE Executive Council determines the funding proportions for individual work packages.

d. Policy Objectives

The specific policy objectives of the AGATE program are to: 1) revitalize of the General Aviation industry; and 2) reduce the rate of fatal aviation accidents by a factor of five within 10 years and by a factor of 20 within 20 years. Private sector goals include delivery of 10,000 aircraft annually by 2007 and 20,000 aircraft annually by the year 2017. Environmental compatibility, increased aviation system throughput in all weather conditions, and affordable air travel are also goals of the Advanced Subsonic Technology Program, of which AGATE is a component.

e. Time Frames

The AGATE program began in FY 1994 and will run through FY 2001, with possible extension by Congress. Deadline extensions for several of the work packages will continue parts of the program beyond the year 2001.

2. *Discussion of Four Common Characteristics*

a. Motivations

As the various work packages within the AGATE program progressed and matured, the redirection of priorities and the need for additional work packages became evident. Under the direction of a strong Executive Council, such redirection has had minimal impact on the program as a whole. For example, as a number of work packages reach maturity, the need for a flight training work package became evident. The Executive Council agreed to this package for FY 1998 with the FAA as the lead. Work package funding for FY 1998 is provided by NASA; the FAA provides out-year funding.

Core partners within the consortium remain constant. New partners are brought into the consortium as unique resources are required. The SBIR Program is primarily responsible for bringing new partners on board as contract awardees.

b. Resources

The majority of the funding for AGATE comes from NASA and the FAA since both agencies are partnered in all work packages. The remaining funding for work package components is provided by additional partners. Both NASA and the FAA are able to bring their laboratory resources into the partnership. The distribution of resources throughout AGATE is made on the basis of the work package need.

c. Legal and Institutional Framework

The legal basis of the AGATE alliance is the Space Act-based Joint Sponsored Research Agreement (JSRA). The act is far more flexible than other conventional instruments such as Federal Acquisition Regulation (FAR) contracts or grants. The JSRA allows for sharing of resources so that government and industry can jointly sponsor pre-competitive R&D efforts. The FAA's Acquisition Management System (AMS) allows for greater ease of contract award.

d. Agendas

The creation of AGATE is the direct result of the economic state of the general aviation industry, the overall concern for safety, and the need to increase air system capacity.

3. *Conclusions*

The work of the AGATE Consortium will continue until FY 2001. The success of this group can be measured in the following ways: AGATE represents the General Aviation industry to the FAA as a cohesive group; and competitors work together toward solutions that will benefit the general aviation community at large. The FAA is concentrating on those issues necessary to revitalize an entire industry, rather than working with individual companies. At the 1996 Olympics in Atlanta, AGATE demonstrated the Heli-Star project, proving that a helicopter fleet could fly continuously in and out of the city in

heavy traffic and could operate semi-autonomously in a free flight mode by using advanced cockpit displays developed by the alliance.

Vital to the success of the AGATE Consortium has been the articulation of a clear vision for a Small Aircraft Transportation System. This vision encourages continued support for the program and provides a focus for the program's activities. In addition, the program's systems approach, which includes items such as pilot training, promotes involvement of the general aviation community in the overall program. The collaborative nature of AGATE provides a community of pooled resources (governmental, industrial, and academic) that lead to the generation of innovations that would be otherwise impossible.

The success of the program reflects the interactions of three types of participants:

- **Sponsors** (e.g., NASA, FAA, and industry leaders) who provide resources and place responsibility in the hands of champions.

- **Champions** such as Dan Goldin, NASA Administrator, and Dr. Bruce Holmes, AGATE Program Manager at NASA, and experienced collaboration facilitators such as experts from the FAA, industry, and academia. These participants spread the program vision and turn that vision into plans.

- **Change Agents** such as managers, engineers, and scientists in NASA, FAA, industry, and academia. These experts develop and carry out the detailed plans and tasks necessary to the program.

The AGATE Consortium also represents a high level of trust among the general aviation industry, NASA, the FAA, and academia within the alliance.

C. *Maritime Case Study: Fuel Cell Technology Development for Marine Applications*

1. Partnership Description

Fuel cells are a preferred technology option for the direct conversion of chemical energy to electrical energy. They are particularly promising as clean and efficient sources of energy for future generations of vehicles. The most basic energy-producing electrochemical reaction is the catalytic recombination of oxygen and hydrogen into water. Several options exist for the production, delivery, and safe storage of hydrogen fuel. These options include pure liquefied hydrogen, hydride carriers, and fossil fuels (diesel fuel, methanol, compressed natural gas, and renewable biomass wastes). The latter can produce hydrogen (and carbon dioxide gas) through electrolytic, catalytic, or chemical decomposition and oxidization. A variety of fuel cell prototypes have been developed and refined to improve power density, energy efficiency, size, cost, and performance. These prototypes use a range of primary energy sources, reformers, and on-board fuel processors; examples include Proton Exchange Membrane (PEM), phosphoric acid (PA), molten carbonate (MC), and planar or tubular solid oxide (SO) technologies.

The new fuel cells must be miniaturized and stacked to produce sufficient power for propulsion, and they must be amenable to refueling. These demands require new or modified infrastructure; new materials; new subsystem designs and interfacing; and safeguards for refueling, handling, and maintenance.

"The beauty of this interagency partnership is that the sum is greater than the parts. By coordinating together, doors open and opportunities materialize that would never have surfaced for any federal agency pursuing this technology alone. It is unfortunate, though, that for all of the potential benefits of fuel cells to the national transportation system, the DOT agencies have not been able to fund their share of the developmental work, especially since the Navy will no longer solely be able to financially support the majority of program goals from FY 2000 onward."

Daniel Gore, MARAD
Program Manager

a. Partners

The Maritime Fuel Cell Interagency Working Group (IWG) includes the DOT's Research and Special Programs Administration, the Maritime Administration, the U.S. Coast Guard; the U.S. Navy (USN) Office of Naval Research (ONR) and Naval Sea Systems Command; the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA); and the Department of Energy's Federal Energy Technology Center. The DOT's Federal Transit Administration (FTA) and Federal Railroad Administration (FRA) monitor the program. This interagency R&D consortium consists, to date, of federal agencies that participate in fuel cell research and that have missions consistent with its marine applications. While there are no non-federal partners at this stage of the project, program results may interest private sector concerns.

b. Partnership Structure and Roles

The key objectives of the Fuel Cell Technology Development for Marine Applications Program are to coordinate agencies' R&D programs, to communicate research findings, to avoid duplication of research through joint planning, and to leverage and share knowledge and resources. Unlike PNGV, this consortium has no explicit private sector partners; there is no industrial cost-sharing of marine fuel cell design. In addition, development and demonstration is indirect (e.g., required through a current U.S. Navy Broad Agency Agreement).

A Memorandum of Understanding (MOU), developed in 1997, clearly states each agency's R&D agenda, mission-related goals and objectives, and commitment to the partnership effort. This MOU was signed by all participants in 1997 or 1998 and will stay in effect until the R&D agenda (through 2006) is completed.

c. Scale/Funding

Federal funding is not specifically dedicated to this R&D partnership; the level of expenditures for collaborating federal agencies ranged from $2.4 million in FY 1997 to $7.5 million annually from FY 1998 through FY 2000. The U.S. Navy contributes the largest share ($2 million to $5 million per year). In this loose partnership based on shared goals, programmatic coordination, and open communication, partners generally conduct their own research, although they may contribute to another agency's R&D contracts via interagency fund transferal agreements. Participation is contingent on continued funding of fuel cell research through the annual budget submittal and appropriation cycle; advantages accrue to all through leveraging scant R&D resources.

d. Policy Objectives

The agencies participating in this R&D partnership have both shared goals and distinct, mission-related goals. For instance, the USCG goal is to operate fuel cells for ship propulsion power using diesel fuel. The primary MARAD goal is to foster commercial applications of fuel cells using both diesel fuels and natural gas, while the U.S. Navy's goal is to operate fuel cells on diesel fuels with one percent sulfur; NOAA is interested in fuel cells for environmentally clean and quiet research vessels.

e. Time Frames

The consortium objective is to achieve systems integration and operational deployment capability of maritime fuel cells by 2006. So far, the IWG has coordinated a three-phase solicitation. The Phase I objective is a 2500 kilowatt (KW) marine fuel cell plant operating on diesel fuel. Phase II objectives include land-based testing and demonstration of a sub-scale 500 KW fuel cell system based on Phase I design. The consortium recently contracted Energy Research Corporation (ERC) to demonstrate a direct fuel cell power plant on land and in a Coast Guard cutter. Phase III involves shipboard systems integration and comparison to dynamic models, followed by additional

at-sea testing. The consortium has also initiated a vessel-fuel cell integration study and a market analysis of fuel cells in the maritime industry.

2. *Discussion of Four Common Characteristics*

a. Motivations

The participating agencies' distinct, yet congruent motivations for promoting marine fuel cell developments have added diversity and depth to the overall effort. The integration of agency-specific motivations and goals has contributed to the robustness of the overall working group plan. Meanwhile, the working group has revisited the common goals and primary objectives to ensure that diverging motivations did not detract from the focus of the effort. The governmental partners hope to increase efficiency and environmental benefits by developing the marine fuel cell. Industry hopes to develop a new and robust energy source product, verify its market readiness, and ensure an initial market based on purchases by government clients.

b. Resources

Even partnerships of this nature that include combined goals and objectives and eliminated duplication of effort can be resource constrained. This working group wants to pursue both PEM and MC fuel cell technologies for marine use. However, at the existing funding and budget projections for all of the partners, the working group will have to select one technology before the beginning of FY 2000. The pooled fuel cell research resources will have to be used synergistically with those of industry participants, which cost-share indirectly on specific portions of device development, prototyping, test and evaluation, or shipboard integration. All partners will benefit from diluting technical risk at lower cost and from sharing the technical and environmental benefits expected.

c. Legal and Institutional Framework

This program does not present significant intellectual property ownership issues; each agency will utilize the R&D results to support its own mission. Industry will clearly benefit from cost-shared R&D, from dissemination of R&D results, and from federally subsidized or cost-shared development of new energy sources. The participating agencies also have the legal authority to contract jointly with the providers and to coordinate contract awards through a variety of available cost-shared vehicles (such as CRADAs and Broad Agency Announcements).

d. Agendas

The partnership constantly monitors progress and often adjusts schedule and budget priorities. Most of the changes are the result of industry requests for more time or for permission to expand the scope of the effort. These changes are to be expected due to the complex technical nature of the project.

3. *Conclusions*

Two models (the USN/ONR thermal and power performance model and the Defense Advanced Research Projects Agency (DARPA) Logistic Fuel Cell Program) have produced results encouraging to the future of marine fuel cell research. The two favored candidates for marine fuel cell technologies are the PEM and MC fuel cell concepts. Two Phase I contracts have been awarded: one to ERC for MC fuel cells, and one to MacDermott Technologies, Inc. and its subcontractor Ballard Power Systems for PEM fuel cells technology. The Coast Guard awarded its vessel-fuel cell integration contract to JJMA, a naval architect firm, with ERC as a subcontractor.

Communication is the key to this successful interagency R&D partnership. Monthly meetings of technical and program contacts ensure timely R&D work planning, information exchange on evolving R&D agendas and budgets, coordination of contract awards, and exchange of results. If successful, this technology may benefit other modes of transportation. A durable, high power, easily maintained, and environmentally benign fuel cell stack that could withstand the harsh marine operations environment would also be widely applicable to other transportation modes such as rail locomotives and transit vehicles.

"The key to U.S. competitiveness is innovation—the ability to deliver projects, processes, and services that cannot be easily or inexpensively produced elsewhere. If we are a stationary target—if we're not innovating very rapidly—other nations are going to catch up...."

Michael E. Porter, Harvard Business School

IV. Relevant Lessons for Transportation

In order to maximize the potential of public/private partnerships, decision makers must consider the specific challenges for this type of collaboration, especially the four criteria highlighted in this report: motivations, resources, legal and institutional issues, and agendas. This section examines the lessons learned and provides additional examples within the field of transportation. Figure Three summarizes these challenges and presents strategies that may enhance success.

A. Motivations

Both public and private sector partners can undergo changes in their original priorities in response to changing circumstances. Thus, the initial agreement on goals and objectives can become outdated or unrealistic over time. In the public sector, election results and changes in political priorities can cause these shifts; changes that affect the estimated risks or returns on investment can have a similar effect on private sector participants.

The PNGV example provides insight into how public and private motivations can work together. In this instance, each of the partners has a compelling, ongoing interest that makes the project work. Public sector interests seek an improvement in fuel efficiency for energy and environmental reasons, while private sector interests want to support their competitive edge while seeking to avoid further federal regulatory responsibilities.

B. Resources

It can be difficult to reach or maintain agreement on the proper level and kinds of resources that each partner is expected to contribute to the program. Disputes may arise from the sense that one or more participants is not contributing a fair share, or the feeling that one partner receives benefits disproportionate to its contributions. Partners may also adjust the level of resources they are willing to contribute to the project, due to changes in their priorities or their assessment of the prospects for success.

The difficulty in bringing together private sector partners to develop fuel cell technology for marine applications highlights the resource issue. Funding for this program comes from individual agency initiatives rather than federal legislation. Thus far the initiative has not been able to attract the technology and resources of private sector partners. In contrast, the AGATE Consortium brings together the knowledge and resources of 70 partners. New partners with additional expertise and resources are brought into the consortium as the need arises.

Figure Three

Summary of Challenges to Private/Public Partnerships in R&D; Possible Preventative Strategies

Challenges to Public-Private Collaboration	Characteristics of Challenge	Possible Preventative Strategies
Motivations	• Changing priorities of public and private sector participants. • Similar objectives diverge. • New perception of return on investment/risk.	• Evolving program scope to reflect changes in research and partnership needs. • Seek complementary objectives and strategies rather than identical goals. • Set realistic goals.
Resources	• Too few resources, e.g., funding, staff, and capital equipment. • Perceived inequity in distribution of resources. • Perceived inequity in distribution of benefits.	• Establish resource distribution for project life-cycle, using milestones/performance measures to trigger or validate changes in resource allocation between partners.
Legal and Institutional Issues	• Reservation and protection of partners' legal rights and obligations in intellectual property, licensing, liability, copyright and anti-trust.	• Determine legal rights and obligations at partnership formation in conjunction with a timetable for commercialization of product and publication of research findings. • Enact additional legislative relief to ensure partnership rights and responsibilities as well as time relief from competition.
Agendas	• Institutional agendas of individuals and partner organizations change over time. • Stakeholders for program change or withhold support. • Program entrepreneur or champion absent or withdraws.	• Establish 'stretch' goals in program time frame, e.g., attempt to identify attainable objectives to demonstrate progress within company planning and/or electoral cycles. • Identify multiple program champions throughout life-cycle: initiation, definition, development, and enforcement.

C. Legal and Institutional Issues

Public sector partners may assume that it is in the public's best interests to widely disseminate the information and technology that results from such collaborations. Private sector partners, on the other hand, may consider such results to be proprietary; that is a well-deserved reward for their own efforts and assumption of risks. Thus, a number of disagreements may arise related to the patenting, copyrighting, or licensing of the product or service that is developed; equitable sharing of the financial benefits from these activities; and ultimate 'ownership' of the end product.

The PNGV example highlights the potential legal constraints. During the initial planning and implementation phases, the project involved only U.S. interests. As a result of foreign competition and manufacturers' consolidations, each of the major American auto manufacturers is entering into international partnerships. The legal implications of using U.S. technology to benefit foreign interests have not been fully resolved.

D. Agendas

Agendas may evolve in different directions, just as motivations for participation can start to diverge over time, for minor or substantial reasons. For example, a company can make a business decision to withdraw from the market area for the product under development. In a similar manner, a government agency can receive new mission statements, based on heightened public awareness and/or legislative interest in a topic. Changes in the decision-making personnel in either group can lead to such shifts. If a strong advocate for a project suddenly leaves or is replaced, the project may 'run out of steam' if no suitable replacement advocate steps in to fill the gap.

The work of ITS America is an example of shifting agendas. ITS America is a public/private partnership organization designed to accelerate the research, development and deployment of Intelligent Transportation Systems (ITS). In 1991, federal legislation requested that DOT develop an Automated Highway System (AHS) and vehicle prototype by 1997. This resulted in DOT's 1993 creation of the National Automated Highway System Consortium (NAHSC), a public/private R&D partnership. The partnership achieved its initial goals three years into its planned seven-year life span by demonstrating the fully automated, driverless vehicle platoon convoy. The DOT then changed the project due to an evolving set of priorities. The refocused Intelligent Vehicle Initiative (IVI) emphasizes more immediate highway safety and economic benefits from accelerated deployment of intelligent cruise control and collision avoidance technology. The objective of intelligent infrastructure has not been eliminated; priorities have been revised to focus on technologies that assist drivers and improve highway safety. This technology can be more widely deployed and accepted by the public.

Attachment A: Transportation Partnership Opportunities

The National Science and Technology Council (NSTC) was created in 1993 to ensure that the federal investment in research and technology is 1) coordinated to assure efficient use of federal funds; 2) focused on projects identified by users, industry, and other stakeholders as being the most critical to achieving success in agencies' missions; and 3) limited to areas where it is clear that major public benefits can be achieved only through cost-shared federal research.

With major involvement of the transportation and research communities, the NSTC Committee on Transportation Research and Development (R&D)[12] developed the first *Transportation Science and Technology Strategy* in 1997 to help Congress, the White House, and federal agency heads to establish national transportation R&D priorities and coordinated research activities.

The *S&T Strategy* articulates national transportation goals and defines specific initiatives that can expedite the research process and speed the introduction of new technologies into transportation systems and operations. The *Strategy* focuses on cooperation, coordination and partnering among *federal* agencies, but each initiative also reflects either an existing or potential public-*private* partnership addressing national strategic transportation goals. With initiatives being added and refined, this document reflects the September 1997 edition. Please note that some initiative titles have changed.

These partnerships represent areas in which a strong public sector component is necessary, due to market failures and institutional and other impediments that could otherwise delay or preclude achieving the desired public benefits. However, since the transportation enterprise rests primarily with the private sector and state and local governments, collaboration with these parties is necessary to the technical success and ultimate shape and implementation of most of the NSTC initiatives. Although private sector participation in these partnerships is subject to the possible conflicts, issues and incompatibilities noted elsewhere in this report, the value of collaborative efforts warrants their being actively pursued.

The following descriptions of existing and potential NSTC Partnership Initiatives indicate many opportunities for private and non-federal participation in NSTC initiatives, some already occurring and some still in the future. The information presented here suggests some of the possibilities; it is hoped that this material will stimulate thinking on additional ways in which public-private collaborations can enhance the achievement of national transportation goals.

[12] In 1998, the Transportation R&D Committee became a subcommittee under a new NSTC Committee on Technology.

A. *National Science and Technology Council Partnership Initiatives*

1. Aviation Safety Research Alliance

The Aviation Safety Research Alliance addresses the need to reduce the aviation accident rate as air traffic doubles over the next decade, as called for by the White House Commission on Aviation Safety and Security. Together with other partners, the FAA, NASA, and DOD will accomplish this through a coordinated program to 1) identify and conduct the research needed to meet the safety goal and 2) work with industry to deploy research results in the form of new safety technologies.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. Achievement of major safety advances in aviation will necessarily include aircraft manufacturers, air carriers, and aviation professionals in ongoing analytical programs with industry to determine the root causes of accidents and develop intervention strategies. Each party brings to this endeavor specialized knowledge and a necessary perspective on the implications of each strategy.

Roles. The predominant federal role in this initiative lies in taking the leading efforts to identify and conduct the research needed to meet the national aviation safety goal. While specific implementation areas will also be primarily federal (e.g., certification, standards, air traffic control), in many aspects industry will have the major role in deployment of research results in the form of new safety technologies and operational practices.

Motivations. Safety is the primary public sector motivation. There is a very strong and explicit federal responsibility to seek the highest possible level of safety for the traveling public. The aviation industry, in addition to having a traditionally strong commitment to safety, bears the sometimes-enormous cost of major crashes. Further, even maintenance of current accident rates as traffic continues to grow could yield a frequency of crashes that would diminish the attractiveness of air travel to the public. In general, the motivations of each element are mutually consistent and compatible.

Resources. In the aggregate, FAA, DOD, and NASA embody knowledge and experience with aviation safety and underlying technologies that is unmatched in the world. Aircraft and component manufacturers, air carriers, and other aviation system stakeholders can provide a rich depth of experience with specific technologies and operations, and appreciation for the overall practical context in which safety initiatives and improvements are applied.

Legal/Institutional Context. FAA and DOD have very strong and specific functional responsibilities concerning aviation safety, and NASA has for many decades worked closely with the aeronautics community in conducting R&D to advance relevant technologies. Since the aviation industry is highly sensitive to the cost (which it bears) of implementing safety measures, disagreement is possible in terms of the cost-effectiveness or overall attractiveness of specific approaches. The FAA's mandate to consider cost-

effectiveness can also create tension with aviation system stakeholders whose primary focus is safety alone. Joint research efforts with equipment manufacturers can raise problems associated with competitive considerations within the industry.

2. *Next-Generation Global Air Transportation*

Anticipating the future growth in air traffic, the government–industry Next-Generation Global Air Transportation partnership is developing the communication, navigation, and surveillance (CNS) and air traffic management systems required to make "free flight" a reality. "Free flight" refers to an airspace system that greatly increases user flexibility to plan and fly preferred routes, saving both fuel and time and affording more efficient use of airspace. This activity essentially transfers the free flight concept to an operational setting prior to full deployment.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. This partnership initiative embodies the application of rapidly advancing CNS technologies and new operational procedures to air traffic management functions that are essentially FAA responsibilities, also building on related NASA research. The economic and operational implications for air carriers are substantial, and implementation will significantly affect aircraft avionics. Thus, rapid progress and deployment of a cost-effective system will require a real partnership among airlines, manufacturers, and equipment suppliers.

Roles. The basic infrastructure elements of the Air Traffic Management (ATM) system are federally owned and operated (e.g., the Global Positioning System (GPS), FAA augmentations and overall ATM infrastructure), and FAA must establish the system architecture and operational practices and coordinate all facets of the system internationally. However, the broad CNS technology advances on which the system is based and will evolve are predominantly developed within the private sector, and many aspects of implementation will be the responsibility of air carriers and aircraft manufacturers. The industry will necessarily play a major role in system design, evaluation, and implementation, including identification of necessary refinements and evolution of the technologies, supporting methodologies, procedures, and functional capabilities.

Motivations. Mobility is the primary public objective. Safe, reliable, efficient, and consistent air transportation is also essential to the nation's economic well being, and providing the ATM function is a fundamental government responsibility. The success of the industry, for both manufacturers and operators, is determined by the ability of the air system to provide the necessary transportation capacity – both domestic and global – with maximum efficiency.

Resources. The federal side brings to this partnership a full understanding of what is required for effective and efficient air traffic management and analysis of potential system architectures, technology, and procedures, as well as a capability for R&D necessary for generation of new system elements. The private sector provides the perspective of users and equipment suppliers, and contributes an unmatched source of

real-world operational experience by which to assess system implementation. It will be central in operational testing and evaluation, and in developing a smooth transition path.

Legal/Institutional Context. The next-generation air traffic management system will be global and will draw on satellite-based navigation, positioning, timing and communication systems that serve many other functions as well. The GPS, which is at the heart of the system, is funded and managed for defense purposes, and many complex issues arise in achieving an appropriate balance in its characteristics and support among the many users and the uses to which it is put. Many parties, including foreign governments and airlines, have a strong interest in system decisions. Global compatibility of avionics and system concepts is highly important to air carriers. Some key technical factors will depend on internationally agreed frequency allocations. Technical issues relating to system reliability and integrity are accompanied by questions of liability for any possible failure.

3. *Next-Generation Transportation Vehicles*

The Next-Generation Transportation Vehicles partnership (formerly, Next-Generation Vehicles and Ships) addresses the problems of petroleum dependence, global warming, and pollution through research leading to the development of highway vehicles, locomotives, and ships that are better designed and more efficient. It has three major thrusts: 1) continue the PNGV and Advanced Technology Transit Bus (ATTB) activities and supplement them by also focusing on improvements in medium- and heavy-duty-vehicle fuel efficiency; 2) support the development, test, and demonstration of non-electric high-speed rail technology; and 3) demonstrate and develop the marine application of fuel cells.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. The federal government does not manufacture and sell vehicles. Implementation of advances in vehicle technology only occurs when private firms exploit and incorporate innovations in their products. In addition, their knowledge of the full spectrum of technologies and applications associated with personal and commercial vehicles is a necessity for effective incorporation of research-based advances.

Roles. In some cases, such as the personal motor vehicle, there is a highly functional and effective marketplace in operation. The federal role then lies primarily in relatively basic research, with industry playing the main role in development. Even here, public concern for safety, minimal environmental impact, and fuel efficiency may not be fully reflected by the market, warranting public investment in development of prototypes that can give reality and visibility to important innovations. In other cases, uncertainty on the part of either manufacturers or potential buyers may require greater federal involvement to stimulate application of valuable innovations, as in the case of alternative-fuel buses, rail vehicles or ships. The ultimate users–whether state/local agencies or companies–must be strongly involved to assure that their needs are met.

Motivations. The primary motivation for federal efforts in next-generation vehicles is concern to achieve reduced environmental impacts through greater fuel efficiency, which

also contributes to national security through reducing dependence on imported petroleum. There is also a strong federal interest in advancing the competitive position of the industry, which plays a major role in the U.S. economy. Manufacturer participation is largely based on the potential for new products, competitive advantage vis à vis foreign firms, and reduced likelihood of mandates and regulations.

Resources. Depending on the mode, the federal contribution may lie predominantly in conducting supporting research, funding of prototypes, or evaluation and demonstration of advances. The private sector role focuses on vehicle development and test, and state and local agencies can be critical as test beds.

Legal/Institutional Context. Given the largely private-sector framework for vehicle research, key issues can involve the relative competitive position of different vendors, concerns over the proper federal role in supporting product development, and complexities associated with multinational companies.

4. National Intelligent Transportation Infrastructure

The National Intelligent Transportation Infrastructure (NITI) refers to the integrated electronics, communications, and hardware and software elements that can support ITS. It is a communication and information "backbone" that will enable ITS products and services to work together to save time and lives. Analogous to the local- and wide-area networks used in many workplaces, the NITI will allow surface transportation 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.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. The technology for the NITI is virtually all coming from an energetic private sector, and the customers are, to a large degree, either state and local governments or operators of vehicle fleets, whether private or public sector. It is the users who best understand the needs, and the vendors who are expert in the technologies. However, deployment of the NITI is impeded by uncertainties over costs, benefits, performance and a lack of technical standards. Further, the degree to which national impact is achieved will depend on having an integrated and interoperable system.

Roles. The private sector can maintain the technology R&D efforts necessary to assure continuing product improvements and injection of the most recent advances. A strong federal role is a necessity in advancing deployment and demonstration, assessing results objectively, and facilitating the development of subsystem and interoperability standards. As users, local governments are critical in shaping the system design and deployment.

Motivations. The federal interest lies predominantly in the improved mobility and safety that the NITI will foster, with additional environmental benefits and improved national economic performance. The private sector seeks broadened markets, and state and local entities are primarily concerned with meeting their responsibilities to provide effective and efficient transportation facilities and services.

Resources. The primary resource offered by the federal partners, aside from deployment funding, is the ability to provide a vision for the overall system and to support and stimulate national consensus, standards and interoperability. It is also able to support specific activities addressing compatibility with current regulations, frequency spectrum allocation, and international coordination. The private sector brings both its technical expertise and an understanding of the marketplace and problems developing the market. State and local agencies can offer an in-depth understanding of the system requirements and potential non-technical impediments to NITI applications.

Legal/Institutional Context. As a practical matter, many challenges arise in NITI applications that often involve coordination and integration among many adjacent jurisdictions. Since the NITI markets are potentially very large, it is important that federal efforts do not give an advantage to a particular vendor and that federal R&D and investment policy not be inappropriately influenced by suppliers.

5. Intelligent Vehicle Initiative

The IVI (formerly, Smart Vehicles and Operators) is a government–industry program to accelerate the development and commercialization of safety- and mobility-enhancing driver-assistance systems. Overall emphasis is on four key areas: 1) evaluation of the benefits of IVI products, including collision-avoidance technologies, vision enhancements, and adaptive cruise control; 2) development of industry-wide standards for these products; 3) system prototyping; and 4) field test evaluations of the most promising products.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. Systems associated with the IVI will predominantly be deployed through incorporation into new personal automobiles and commercial vehicles. The automobile industry and its suppliers will necessarily be the focus of this outcome, and these parties have extensive relevant background information. However, safety advances, which are the primary objective of the program, have not generally stimulated strong market forces, leaving much of the exploratory and feasibility research phase, including analysis of benefits, to the federal government.

Roles. Topics of specific federal activity include analyses to clarify the potential value of various driver-assistance functional capabilities, exploratory research to assess conceptual approaches, system evaluations, leadership in generating and validating performance specifications and design guidelines, active support in developing voluntary interface, and system standards. In addition, integration of fixed highway infrastructure and vehicle-based systems will be implemented as needed. The private sector has the role of developing integrated systems that achieve maximum practicable safety performance at costs consistent with a broad market.

Motivations. Safety is the dominant public sector motivation. Federal participation is primarily driven by the expectation of significant reductions in deaths and injuries associated with motor vehicle crashes, which represent over 90 percent of all

transportation-related fatalities – in excess of 40,000 per year. The automobile manufacturers are highly supportive of reducing the national toll, but are necessarily focused on offering vehicles that are of enhanced attractiveness and therefore command greater investment from the public.

Resources. Federal understanding and experience in highway safety, including extensive databases, coupled with its objectivity and system-level perspective, will be coupled with significant explicit expenditures on concept exploration and assessment. The vehicle manufacturing community has not only the ability to develop practical systems and integrate them into vehicles, but also a rich understanding of motorist preferences and interaction with vehicle systems in general.

Legal/Institutional Context. The highly competitive nature of the industry poses a challenge in structuring its participation, as does the issue of foreign manufacturers. Industry also can have misgivings based on federal regulatory authority in this area, which could be exercised if clear cost-effectiveness were established but market forces prove inadequate for widespread adoption. This also involves broad product liability concerns.

6. *Transportation and Sustainable Communities*

The Transportation and Sustainable Communities initiative (formerly, Local Environmental Assessment Systems) explores how sustainable transportation and land use can help to achieve a balance among the often conflicting goals of economic growth, environmental quality, and sustainability. It will further federal agencies' efforts to work with each other and with other governments, the private sector, and the public to expand understanding of the consequences of transportation choices; develop better forecasting, planning, and assessment tools; conduct technology research; and develop sustainable community and transportation initiatives.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. The success of this initiative will depend on effective partnerships with public sector organizations, including Metropolitan Planning Organizations; local governments; regional and state transportation, environmental, energy, and social service agencies; transportation providers; Tribal governments; universities and research centers; the private sector; civic organizations; and advocacy groups.

Roles. Much of the expertise, innovation, and responsibility for transportation and environmental programs rests with state and local governments, regional institutions, business, and other non-federal stakeholders. These organizations will be responsible for developing visions and actions to improve the balance of economic, environmental, and social considerations in local communities. A key federal role is to provide resources for research and technical assistance, incentives for experimentation and innovation, and dissemination of best practices through education and outreach.

Motivations. Environmental benefits are the focal point of this initiative. Important federal and non-federal public-sector motivations for this initiative are the impacts of

transportation systems and land development patterns on air and water pollution, widespread congestion, inefficient land consumption, ecosystem degradation, and global climate change. (For example, transportation accounts for about one third of total domestic greenhouse gas emissions.) The Administration is committed to addressing the problem of climate change, as demonstrated by the President's October 1997 climate change proposal. The private sector is generally less motivated in this area, although there are potential markets in the development of new products and services.

Resources. Federal agencies bring to this initiative a broad perspective and overview of the societal impacts of non-sustainable activities. With federal funding, state and local agencies have the experience and insight to refine, test and evaluate a broad range of innovative sustainability concepts. The private sector has specific knowledge needed to understand and make effective use of innovative technologies that support sustainability.

Legal/Institutional Context. Achieving sustainable communities will require many changes that may be adversely perceived by specific stakeholders, and will call for coordinated actions among many public- and private-sector organizations. Political support for this topic is uncertain. For example, although TEA-21 authorizes significant funding for a *Transportation and Community and System Preservation Pilot Program*, legislation has been introduced that would prohibit use of FY 2000 funds by DOT "for activities related to sustainable transportation."

7. *Transportation Infrastructure Assurance*

The Transportation Infrastructure Assurance partnership (formerly, Total Terminal Security) is developing and implementing measures to improve the security of transportation information systems, passenger and freight terminals, and other infrastructure, as well as of the people and cargo using or transiting them. It addresses 1) the physical security of transportation terminals; 2) the security of vital communication and information systems; and 3) the development and dissemination of information about security incidents and assessments of threats to transportation facilities and operations.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. The breadth and complexity of protecting transportation infrastructure from the many potential threats will require a concerted and integrated effort by all involved organizations, both public and private. Sophisticated technology, comprehensive protective practices, appropriate regulations and standards, and a truly system-level perspective necessarily require all parties to develop solutions together.

Roles. In many cases the federal government has the responsibility to establish a legal and regulatory framework that assures compliance with basic countermeasures and protective strategies, and that overcomes compartmentalization of responsibilities by carriers, terminal operators, facility owners, law enforcement agencies and others. Objective evaluation of equipment and practices is also necessary to assure the best possible implementation. Vendors carry the major responsibility for development of advanced technologies, and those organizations implementing security must assure that all parties fully understand their operations and the implications of alternative strategies.

Motivations. This initiative addresses national security. The federal government is primarily motivated by its responsibility for assuring the security of people and goods in the transportation system, and thereby supporting the viability of the system. Public and private organizations with operational responsibility for transportation facilities, and users of those facilities, similarly seek security for users, freedom from disruption or disaster, and efficient compliance with regulations and recommended procedures. Equipment and service vendors share these goals, while being primarily motivated by the desire to provide effective and competitive products.

Resources. The federal government's defense and law enforcement functions enable it to play a strong role in understanding various security threats and applying a wide range of countermeasures. Particularly in the national laboratories, the government has a very high level of scientific expertise that can be applied to the very challenging technical problems that arise in surveillance and detection systems. The government also is in a position to have a broad perspective on the totality of the system. Facility operators and users have an awareness and understanding of practical operational considerations that are a necessity in designing and implementing effective systems. Vendors typically have expertise in application of specific technologies and production of cost-effective systems.

Legal/Institutional Context. By its nature, security efforts involve highly sensitive information that must be carefully safeguarded. Security systems must also be seamless, in the sense that no gaps arise as users transition from one location, jurisdiction, or function to another. The potentially great consequences of security lapses also raise liability issues among involved parties.

8. Enhanced Goods and Freight Movement at Domestic and International Gateways

Building on earlier investments in technology, port infrastructure, and freight terminals, this partnership is being developed to facilitate information exchange and technology demonstrations that promote the deployment of innovative logistics practices and information technologies at freight gateways. Initial efforts will focus on technology applications and demonstrations at the nation's border crossings and corridors, particularly with respect to innovations such as electronic commerce, electronic vehicle identification and location, smart cards for fee payment, and automated gates.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. Physically, ports and border crossings represent the intersection of nations and modes of transport. However, equally important is the interaction occurring at them among institutional entities: governmental regulators and inspectors, local authorities, cargo carriers, terminal operators, and others. The overall process that occurs at these gateways is typically a collaborative activity involving many players from both the public and private sector. While some elements of this initiative may lie predominantly in one sector or the other, most require a significant degree of coordination, integration, and standardization among the various players.

Roles. Regulatory oversight, provision of public infrastructure, and enhancement of national security are fundamental federal responsibilities associated with border crossings, ports and terminals, and other freight facilities. Basic transportation infrastructure at border gateways and waterways is a primary role of the federal government. At each border crossing, many federal agencies perform functions related to customs inspection, immigration checks, enforcing the standards for food/agricultural products, and vehicle safety checks. In general, the primary federal functions are controlling border and waterway operations for national security objectives and ensuring the availability of freight rail service and compliance with commercial motor vehicle safety. On the other hand, the transportation functions that the gateways exist to serve are predominantly private sector operations. At ports, it is the carriers and terminal operators (whether public or private) that will be the users (and purchasers) of innovative technologies. At border crossings, infrastructure will be largely federal, but still requires integration with private sector technology and operations.

Motivations. At the highest level, the federal interest lies in removing impediments to the nation's economic efficiency and competitiveness, including defense mobility, while assuring the security of borders and full adherence to laws and regulatory requirements. Encouragement of the joint use of military facilities and collaborative DOD efforts to develop next-generation container movement capabilities provide added incentives. The federal necessity to achieve efficient coordination with agencies such as the U.S. Customs Service and the Immigration and Naturalization Service is also a key motivating factor. Ports, freight terminals, and border crossings affect a broad array of state, local, and private carrier stakeholders receptive to the application of advanced technologies to improve the efficiency of international freight operations.

Resources. The federal side provides a detailed understanding of the regulatory and legal functions to be performed at gateways, as well as the funding for infrastructure to support those functions. It also has a broad perspective on the national importance of interoperability, standardization, and seamless movement of goods. State and local governments and port authorities contribute a rich understanding of gateway planning, design, and operation, and are the implementers of terminal-area demonstrations.

Legal/Institutional Context. Many institutional complications arise due to the overlapping or interacting jurisdictions associated with most gateways and requirements for a sufficient degree of equipment and data standardization and interoperability. Establishment of design and performance standards and system architecture for advanced technology, such as freight radio frequency identification devices and dedicated short-range communications systems, are among the functions that require a strong federal coordinating and facilitating role.

9. Monitoring, Maintenance, and Rapid Renewal of the Physical Infrastructure

This partnership will create an environment that fosters an unprecedented level of collaboration and synergy on infrastructure research, demonstration, testing, evaluation, and technology transfer to state and local agencies. The partners will collaborate both on developing new technologies and on accelerating market acceptance of existing products.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. Federal research relating to transportation infrastructure – primarily road facilities, but also including ports and airports – can only be shaped, evaluated, and applied through participation of users and facility operators.

Roles. The federal government has a stewardship role in disbursing fuel tax revenues for infrastructure construction and enabling the most effective use of those funds through research to improve materials and practices. To a large degree, state and local governments, and independent transportation authorities are responsible for infrastructure construction and maintenance, so they are best equipped to bring a practical perspective. The private sector has expertise concerning specific current construction materials and practices.

Motivations. The primary federal motivation for this initiative is to advance the technologies that enable public transportation funds to be expended as efficiently as possible, and to ensure that users get the best possible performance and the most infrastructure for their money. At the state and local level, better materials can enable a fixed budget to go further in meeting transportation needs. The private sector is seeking products that will permit them to serve their customers better and develop new products.

Resources. The federal participants offer a broad and extensive experience and a national perspective on the system that is sensitive to the needs in all areas of the country. State and local governments have a practical understanding of the real-world environment, workforce capabilities and skills, and the value of various infrastructure characteristics. The private sector has experience in converting new approaches into viable products and educating customers.

Legal/Institutional Context. The very large number of jurisdictions and vendors can be a serious impediment to diffusion of knowledge concerning new materials and practices. The very long lifetime sought in infrastructure complicates the evaluation process.

10. Accessibility for Aging and Transportation-Disadvantaged Populations

This partnership focuses on improving the mobility of the elderly and transportation-disadvantaged through better management of paratransit, advanced technologies, and livable communities. One component consists of developing, deploying, and testing a regional paratransit program that uses selected information technologies, including automatic vehicle location, geographic information systems, computer-aided dispatch, and electronic fare collection.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. Information technology holds real potential for improving paratransit services. However, two issues currently limit paratransit operators' abilities to improve their services through technology: 1) the high costs of the necessary information and communication systems and 2) the need for interagency coordination to maximize use of existing capital and resources and to realize service efficiencies. Resolution of these issues requires effective

collaboration and partnership among private and public paratransit providers; local, state, and federal agencies; and information technology companies.

Roles. In this partnership, the role of paratransit providers is to coordinate their scheduling and service delivery by providing trips to all customers within a service region, through use of off-the-shelf information and communication systems. The role of government agencies is to facilitate such coordination through grants, technical assistance, and regulatory reform where required. Finally, the role of private companies is to participate in initial service demonstrations to validate the system design.

Motivations. The focus of this initiative is mobility. For service providers and government agencies participating in the partnership, the goal is to expand service while reducing operating costs. For the private sector, the primary motivation is the potential to develop a broad new market by demonstrating the efficacy of regional paratransit operations.

Resources. Resources available for this partnership include federal and state grants to transit agencies, paratransit operators, human service agencies, and area agencies on aging; financial support from employers and retail centers looking to attract workers or new customers; and technology components from vendors or system integrators.

Legal/Institutional Context. There is some question whether current federal regulations permit paratransit providers to use categorical funds for serving other groups; for example, providers today cannot use Temporary Assistance for Needy Families (TANF) funding to pay for any trip unless a welfare recipient is on the vehicle. Another issue is interagency cooperation: although the technology appears to be available, there remains a need for far greater coordination among providers at the local and regional levels.

11. Enhanced Transportation Weather Services

The Enhanced Transportation Weather Services partnership addresses the transportation impacts of adverse weather through the development of comprehensive weather information systems. One element will make use of state-of-the art weather radar, observing systems, and forecasting methods to demonstrate and evaluate an integrated weather information system—first within a "pilot" Midwestern region and eventually throughout North America. A second component is the Aviation Weather Analysis and Forecasting Program, which will improve access to and delivery of aviation weather information and reduce the consequences of weather events by generating weather observations, warnings, and forecasts with higher resolution and greater accuracy.

Needs/Opportunities for Non-Federal and Private-Sector Partnering. Public agencies predominate in collection of meteorological data and generation of forecasts, but specialized or localized forecasting is increasingly performed by the private sector. Numerous agencies need to collaborate in generating the necessary data for localized weather services.

Roles. The federal role is to bring together data from many sources and to develop means of generating weather predictions that can be applied on a very localized and near-term basis. The private sector focuses on enhancing and tailoring this information to meet the needs of specific customer groups.

Motivations. The public sector motivation is, first, to enhance transportation safety through more-timely warnings, and, second, to foster enabling technologies for more responsive, appropriate, and efficient operation of transportation system maintenance and services in times of inclement weather. In addition, benefits to the transportation sector help to justify investments to improve the entire weather service infrastructure in the nation. The private sector seeks the raw materials to develop new products and markets.

Resources. Public sector resources include the substantial infrastructure and capabilities of the National Weather Service and other agencies working with weather data and services. The private sector has extensive experience with consumers of specialized weather services and how best to present such information.

Legal/Institutional Context. The primary institutional issue that arises in this area is the concern of the private sector that public weather services will provide a level of detail that inhibits development of their markets. Coordination among the several federal agencies, each with its own mission and responsibilities, is also a challenge.

B. Potential Areas for New Initiatives

Consideration is being given to development of NSTC Partnership Initiatives in several new areas. Two that have advanced the furthest are Maritime Safety and Space Transportation.

1. Maritime Safety

Targeted research and development in the areas of human factors, vessel technology, and advanced information systems have the potential to significantly advance the prevention of maritime casualties. Topics that could be addressed include advanced training technologies for mariners; improved small vessel designs and structures; real-time weather systems; GPS applications; and integration of sea-based and land-based intelligent systems for traffic management and rapid emergency response.

The federal government has a strong mandated responsibility for the safety of ports and waterways, but many of the needed advances, including improved vessels and information technology applications, are primarily the responsibility of the private sector. Marine safety is an end in itself from the federal perspective, and offers reduced costs, greater operational efficiency, and potential markets to the private sector.

2. Space Transportation

Without affordable and reliable access to space, the future of the space program and the U.S. space transportation industry are hindered by the high cost, low reliability, and poor operability of payload launch. A partnership among NASA, the FAA, and U.S.

aerospace and related companies could take advantage of the respective strengths of government and industry and lead to development and demonstration of pre-competitive, next-generation technology that will enable the development of full-scale, highly competitive, and reliable space transportation.

Continuation of the trend toward commercialization of near-earth space transportation can best be accomplished through exploiting NASA's experience and research capabilities and DOT's understanding of the commercial space launch industry in concert with the market-oriented perspective and specialized technical skills of private-sector firms. On the federal side, the primary motivation would be to assure that the nation makes the most beneficial and economically productive use of space-based systems, and that U.S. firms have predictable and efficient access to space. Those firms, in turn, must appropriately establish competitive positions in existing markets and create new products and services.

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5.	www.nga.org	National Governor's Association
6.	www.sice.oas.org	Organization of American States
7.	www.ott.doe.gov	Department of Energy Transportation Technology
8.	www.ppp.beyondgov.ca	Public-Private Partnership Homepage
9.	http://ce.ecn.purdue.edu	Infrastructure Innovation Partnership
10.	www.darpa.mil	Dual Use Applications Program
11.	www.aerospatiale.com	European Aerospatiale
12.	www.lanl.gov	Los Alamos National Laboratory
13.	www.epa.gov	Environmental Protection Agency
14.	www.gao.gov	General Accounting Office
15.	www.defenselink.mil	Office of Secretary of Defense – Public Affairs
16.	www.bos.frb.org	Federal Reserve Bank of Boston
17.	www.mep.nist.gov	Manufacturing Extension Partnership
18.	www.doi.gov	Department of the Interior (Public-Private Partnerships)
19.	www.ccities.doe.gov	Department of Energy: Clean Cities Partnerships
20.	www.oneworld.org	Department for International Development
21.	www.fhwa.gov	Federal Highway Administration
22.	www.fta.dot.gov	Federal Transit Administration
23.	www.nsf.gov	National Science Foundation
24.	www.ta.doc.gov	Department of Commerce, Technology Administration
25.	www.rci.gnet.org	Rapid Commercialization Initiative Homepage
26.	www.grc.ntis.gov	National Technical Information Service: Government Research Center

List of Acronyms

AAAI	AGATE Alliance Association, Incorporated
AASHTO	American Association of State Highway and Transportation Officials
AATT	Advanced Air Transportation Technologies
AGATE	Advanced General Aviation Transport Experiments
AST	Advanced Subsonic Technology Program
ATM	Air Traffic Management
ATP	Advanced Technology Program
ATTB	Advanced Technology Transit Bus
BTS	Bureau of Transportation Statistics (U.S. Department of Transportation)
CNS	Communication, Navigation and Surveillance
CRADA	Cooperative Research and Development Agreement
DARPA	Defense Advance Research Programs Agency
DOT	United States Department of Transportation
ERC	Energy Research Corporation
FAA	Federal Aviation Administration (U.S. Department of Transportation)
FHWA	Federal Highway Administration (U.S. Department of Transportation)
FRA	Federal Railroad Administration (U.S. Department of Transportation)
FTA	Federal Transit Administration (U.S. Department of Transportation)
GAP	General Aviation Propulsion Program
GPS	Global Positioning System
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
IVI	Intelligent Vehicle Initiative
IWG	Interagency Working Group
JPO ITS	Intelligent Transportation Systems Joint Program Office (U.S. Department of Transportation)
MARAD	Maritime Administration (U.S. Department of Transportation)
MEP	Manufacturing Extension Partnership
MOU	Memorandum of Understanding
MTI	MacDermott Technologies, Inc.
NAHSC	National Automated Highway System Consortium
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration (U.S. Department of Transportation)
NII	National Information Infrastructure

NITI	National Intelligent Transportation Infrastructure
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NSTC	National Science and Technology Council
ONR	Office of Naval Research
OSTP	Office of Science and Technology Policy (White House)
PNGV	Partnership for a New Generation of Vehicles
R&D	Research and Development
RCI	Rapid Commercialization Initiative
RDT&E	Research, Development, Test and Evaluation
RSPA	Research and Special Programs Administration (U.S. Department of Transportation)
S&T	Science and Technology
SBIR	Small Business Innovative Research Program
TANF	Temporary Assistance for Needy Families
TEA-21	Transportation Equity Act for the 21st Century
TRP	Technology Reinvestment Project
USCG	United States Coast Guard (U.S. Department of Transportation)
USN/ONR	U.S. Navy/Office of Naval Research