NATIONAL ITS PROGRAM PLAN

INTELLIGENT TRANSPORTATION SYSTEMS

VOLUME I

EDITED BY

GARY W. EULER
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NATIONAL ITS PROGRAM PLAN

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Abstract

The purpose of the *National ITS Program Plan* is to guide the development and deployment of Intelligent Transportation Systems (ITS) in the United States. This, the First Edition of the Plan was a joint effort of ITS America and the United States Department of Transportation. The plan was developed through a consensus building process which sought the involvement of the entire ITS community. The *National ITS Program Plan* consists of four documents: an Executive Summary, a Synopsis, and two Volumes. The Executive Summary provides a very brief overview of the goals, objectives, and recommendations presented in the *National ITS Program Plan*. The Synopsis provides a fifty page encapsulation of the major subject areas within the document, with special emphasis on the area of deployment. Volume I focuses on the issues of goals, compatibility, deployment, and program assessment, and Volume II contains detailed descriptions and plans for each of the twenty-nine user services.

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PREFACE

This, the First Edition of the *National ITS Program Plan* was a joint effort of ITS America and the United States Department of Transportation. The plan was developed through a consensus building process which sought the involvement of the entire ITS community. Over 36 individuals participated actively as authors, and well over two hundred individuals from a wide range of organizations critiqued, commented, and otherwise contributed substantially to the material presented here.

The National *ITS Program Plan* consists of four documents: an Executive Summary, a Synopsis, and two Volumes. The Executive Summary provides a very brief overview of the goals, objectives, and recommendations presented in *the National ITS Program Plan.* The Synopsis provides a fifty page encapsulation of the major subject areas within the document, with special emphasis on the area of deployment. Volume I focuses on the goals of ITS, compatibility, deployment, and program assessment. Volume II contains detailed descriptions and plans for each of the twenty nine user services.

Work on the *National ITS Program Plan* formally commenced in June of 1993. The Second and Final Drafts of the Plan, completed in May 1994 and November 1994 respectively, incorporated the comments and contributions of a substantial number of individuals and organizations. In total, more than 4,000 draft copies of the plan were distributed to ITS America members, U.S. DOT staff, and the general public through the Federal Register process. Over 200 individuals and organizations commented and provided input for one or more of the drafts.

The process of developing the *National ITS Program Plan* was, in itself, a valuable exercise. The focus of the first draft was upon the creation of the user service development plans now contained in Volume II. The remainder of the draft consisted largely of annotated outlines. A Joint Writing Team (JWT) was formed and given the responsibility of developing the Plan. In the second draft, the deployment and deployment considerations chapters took shape, and with the third draft, deployment scenarios emerged. Each draft represented significant advances in our thinking about ITS technology, systems, deployments, and impacts.

Overall guidance to the JWT on the direction and structure of the Plan was provided by U.S. DOT officials and the ITS Planning Committee of ITS America. The Joint Writing Team, co-chaired by Doug Robertson (ITS America) and Gary Euler (US DOT ITS Joint Program Office), consisted of ITS America and U.S. DOT staff and ITS America members. The JWT members, acknowledged by name and organization below, worked extensively with ITS America members, U.S. DOT staff, and the general public with a goal of insuring balanced representation of the goals, objectives, concerns, and needs of a diverse ITS Community.

The field of ITS is advancing rapidly on many fronts; keeping abreast of it will require a continuing effort. This document will serve as the basis for periodic updates, which will provide information on current activities and projections for the future. Prior to the publication of the Plan, the U.S. DOT has undertaken an initiative to examine the role of government in all aspects of transportation. The results of this initiative may affect the plan.

ACKNOWLEDGEMENTS

A substantial number of individuals contributed to the content of this document. The members of the ITS America Planning Committee, participating U.S. DOT officials, and the Joint Writing team are listed with their affiliations below. The names and organizations of over two hundred individuals who reviewed and commented on one or more drafts of the Plan are listed in Appendix A.

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Members of the ITS America Planning Committee, chaired by Thomas Deen, TRB (retired), include*:

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CHAPTER I - NATIONAL ITS PROGRAM PLAN OVERVIEW

"We envision, during the next 20 years, the implementation of a national ITS program, comparable in scope to the Interstate Highway System, with major participation by the private and public sectors. The primary focus of such a program is the creation of a truly balanced transportation system that includes the following:

A national system of travel-support technology,(including computers, communications, information and systems technology) operating consistently and seamlessly from mode to mode and from state to state to promote the safe, expeditious, environmentally acceptable, and economic movement of goods and people.

A system that encompasses mobility and accessibility for urban, suburban, and rural transportation users. .

A new level of cooperation and commitment between the public and private sectors to deliver the systems and create the infrastructure that will implement a mobility revolution.

A vigorous U.S. ITS industry supplying both domestic and international needs.

A safe, efficient surface transportation system that complements and intemcts smoothly among air, transit, rail, maritime, and highway operations."

Adapted from: The IVHS America Strategic Plan for Intelligent Vehicle-Highway Systems in the United States and the United States Department of Transportation IVHS Strategic Plan.

1.0 INTRODUCTION

Surface transportation in the United States faces a number of challenges. Despite the fact that the United States has one of the best roadway systems in the world, mobility is declining and safety remains a serious problem. Congestion takes its toll in lost productivity, costing the nation an estimated $100 billion each year. Traffic accidents represent another $70 billion in costs, not including the loss of life or consequences of long-term injury. Inefficient movement of vehicles reduces productivity, wastes energy, increases emissions, and threatens the quality of life we enjoy. Transportation is vital to the social and economic health of the nation. The efficiency and effectiveness of surface transportation has direct impacts on economic growth, land use, competitiveness, and accessibility to health care and social services.

Intelligent Transportation Systems (ITS), formerly called Intelligent Vehicle-Highway Systems (IVHS), provide tools that can assist us in addressing these problems as well as anticipate and address future demands through an intermodal, strategic approach to transportation. ITS applies advanced and emerging technologies in such fields as information processing, communications, control, and electronics to surface transportation needs. If these technologies are effectively integrated and deployed, there could be a number of benefits including more efficient use of our infrastructure and energy resources, and significant improvements in safety, mobility, accessibility, and productivity.

The ***National ITS Program Plan (NPP)*** provides a comprehensive planning reference for the application of intelligent transportation systems. It illustrates how the goals of private industry, transportation users, and federal, state, and local government can be addressed through the development and deployment of ITS. It provides guidance for those who are considering or have proceeded with the development and deployment of ITS by making them aware of the background, issues, considerations and requirements associated with a nationally compatible, intermodal ITS. The NPP, developed through an interactive, consensus building process, presents the views, activities, and needs of the broad range of ITS stakeholders. The audience for the NPP includes the private and public sector leaders, transportation users and operators, educators, transportation produce and service providers, and the general public.

2.0 THE IVHS STRATEGIC PLANS

Congress formally initiated the National IVHS Program in the United States with the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. This act, described in Chapter 2, established the general goals for ITS in the United States. In ISTEA, Congress asked the United States Department of Transportation (U.S. DOT) to prepare a strategic plan to guide the development and implementation of ITS in the United States. In turn, the U.S. DOT requested that the Intelligent Transportation Society of America (ITS America), as a utilized federal advisory committee, prepare a strategic plan to serve as a foundation for the Congressional Report.

- The IVHS America ***Strategic Plan for Intelligent Vehicle-Highway Systems in the United States*** was published in May, 1992. This document, developed through a consensus-building process, established goals and objectives for a national ITS program. It identified key challenges to ITS deployment and sought ways they could be resolved. The strategic plan also suggested appropriate roles for public, private, and academic participants, and outlined a course of action to develop, test, and deploy ITS technology.

- The National Highway Traffic Safety Administration (NHTSA) also developed an ***ITS Plan,*** which was submitted to Congress in June, 1992. This plan describes NHTSA's plans and programs to employ ITS to reduce traffic accidents, injuries and fatalities.

- The United States Department of Transportation ***Intelligent Vehicle-Highway Systems Strategic Plan,*** based upon the NHTSA and ITS America strategic plans, was submitted to Congress in December, 1992. The U.S. DOT's strategic plan also set forth the goals, milestones, and objectives of a national ITS program. It established a U.S. DOT program organization and outlined the Department's role in creating an environment that was conducive to ITS development and deployment.

The National ITS ***Program Plan*** is the next step in this process. The NPP is a joint effort between the U.S. DOT and ITS America. It builds upon the visions of ITS described in these strategic plans to develop a single document incorporating the needs and perspectives of the broader ITS community.

3.0 PURPOSE OF THE NATIONAL ITS PROGRAM PLAN

The NPP was specifically developed to:

- ***Describe the National ITS Program.*** The NPP outlines the research, development, testing, and other activities necessary to achieve and support deployment of a range of ITS highway and public transportation services within the framework of a nationally compatible, intermodal system. The NPP describes federally-funded ITS programs, and identifies, whenever possible, work performed by other governmental, academic, and private sector organizations that have impact on ITS development and deployment.

- ***Ensurethat the intermodal aspects of ITS are considered.*** The concept of ITS is that of a "seamless" transportation system, allowing the safe and efficient movement of passengers and goods through a multimodal system. This edition of the NPP focuses on the transportation of people and goods over a range of surface transportation modes. While air transportation, non-passenger rail, and shipping are beyond the scope of the current NPP, it addresses the interface of public and private transportation with these modes.

- ***Guide investment decisions on program activities.*** ITS investment decisions are made by the Federal, State and local governments, and the private sector based upon their various goals, objectives, and resources. While Congress has provided significant Federal support for the ITS program, the NPP facilitates consideration of strategic investment tradeoffs. These tradeoffs ensure sponsorship of a set of projects that best addresses varied public interests and responds to policy considerations. The NPP can assist State and local governments who are making transportation decisions by describing the services that are available to meet their operational needs. The NPP can also provide information about market readiness and aid private sector decisions about investments in product development. The NPP provides a focus for public/private/interest group dialogue, and facilitates a coordinated, but still independent, decision-making process by government and private entities.

- ***Promote coordination.*** Success of the national ITS program relies on the cooperation and interaction of many diverse participants in both the public and private sectors. The NPP promotes compatibility and the coordination and integration of user service development activities to avoid costly duplicative efforts.

- ***Maintain a focus on deployment.*** The NPP focuses ITS programs and activities on achieving transportation goals and objectives through the deployment of a nationally compatible system. Two chapters of the NPP are exclusively devoted to the topics of deployment and deployment support. Another chapter, Program Assessment, focuses on measuring deployment progress.

- ***Assist in local policy decisions.*** The selection and deployment of many ITS user services will be based on local needs and policy considerations. The NPP can, for example, assist local decision-makers in evaluating the applicability of various travel demand management strategies to local conditions.

- ***Facilitate national program assessment.*** The NPP will provide a means of assessing progress against specific milestones, extent of deployment, and attainment of national program goals. It will also guide preparation of the U.S. DOT's annual Implementation Report to Congress required by ISTEA.

4.0 FEATURES OF THE NATIONAL ITS PROGRAM PLAN

The NPP is goal-oriented. The NPP is guided by the goals and objectives of the national ITS program, which were drawn from ISTEA, ***The Strategic Plan fur Intelligent Vehicle-Highway Systems in the United States*** prepared by ITS America, and ***The ITS Strategic Plan Report to Congress*** prepared by the U.S. DOT.

The NPP is user-oriented. The NPP was developed around the concept of "user services", e.g. the specific "services" and benefits that can be offered to users. The users of each service are clearly identified in the NPP and program activities are focused on meeting their needs. For example, individual travelers are the users of many of the services, but local traffic and public transportation management agencies, commercial and public transportation fleet managers, and commercial vehicle drivers are also the "users" of other services. These twenty-nine user services can be bundled in a variety of configurations for deployment to fit user needs and to achieve local or regional transportation goals and objectives.

The NPP promotes a shared vision of how ITS will be advanced in the United States. The NPP is unique in that it integrates a range of activities that are public, private or public/private in nature. It also reflects consideration of the views of many different groups, including the federal government, state and local government agencies, and private sector firms, as well as those focusing on specific public interest areas such as the environment or transportation safety.

The NPP seeks to establish consensus on descriptions of specific program activities and projects that lead to accomplishment of specific program milestones. The development and on-going management of the NPP represent a major accomplishment in public/private partnerships. Although none of the activities identified in the NPP are binding on any government agency or private organization, the NPP can serve as a valuable tool to all in the process of making decisions about investments of public and private funds.

The NPP is participative. The NPP has been prepared and will continue to be managed using a participative process. This document is a joint effort by the federal government and ITS America, and reflects the ideas and contributions of over two hundred different organizations and individuals. In particular, ITS America, as a Federal advisory committee, will continue to play a key role by participating in periodic program assessments and providing advice to the U.S. DOT on proposed updates and changes to the NPP. Participation by any interested organization or individual is solicited by U.S. DOT through Federal Register notices and public meetings.

5.0 ORGANIZATION OF THE NATIONAL ITS PROGRAM PLAN

The NPP is presented in two volumes. An Executive Summary and a Synopsis have also been prepared. The Executive summary presents a very brief overview of the goals, objectives, and recommendations presented in the NPP. The Synopsis is a fifty page encapsulation of the main topics discussed in Volume 1.

Volume I contains eight chapters that are summarized below.

Chapter I, National ITS Program Plan Overview, discusses the purpose, features, and organization of the NPP.

Chapter II, Origins of the National ITS Program, discusses the social and legislative environment that led to the formal creation of the ITS program. The chapter presents a discussion of the need for ITS, the goals and objectives of the program, and how these goals and objectives can be achieved through the deployment of ITS. It also defines the key participants, elements of the national ITS program, and the annual planning process.

Chapter III, User Services, describes the concept of user services and the grouping of services into “bundles”.

Chapter IV, National Compatibility, describes plans for achieving national compatibility through the development of an open national ITS architecture, ITS standards, and telecommunications systems.

Chapter V, User Services Integration, presents a conceptual framework for the inter-relationships among user services. User services are not likely to be developed independently.

Rather, they will be grouped or bundled according to the most likely development and deployment scenarios. This chapter provides a framework for logically grouping individual user services for development, testing and deployment.

Chapter VI, Deployment, presents a vision of ITS deployment and discusses optional roles for the public and private sectors and how these roles impact deployment.

Chapter VII, Deployment Considerations, identifies the major issues that might present challenges or constraints to ITS deployment. Topics addressed are legal and institutional issues, the need for new ways of doing business, outreach programs, funding, financial responsibilities, societal implications, and market uncertainties. Particular attention is focused on the barriers that affect deployment in the near-term.

Chapter VIII, Program Assessment, provides a framework for the assessment of the ITS program as well as the process for continuing to manage and update the NPP based on this assessment.

Volume II, of the NPP contains the individual user service development plans. The plans describe the needs that led to the user service, a description of the service and how it might operate, the technologies that could be used, and the major milestones and activities needed to reach deployment of the service. The individual user service plans also discuss potential costs and benefits, and the role of the public and private sector in the development and deployment of the service.

CHAPTER II - ORIGINS OF THE NATIONAL ITS PROGRAM

1.0 INTRODUCTION

The current emphasis of the ITS program is on forming a base from which to build ITS. This chapter presents some of the underlying issues that led to the development of the ITS program and it explores the societal, economic, and legislative influences that have shaped the ITS goals. These goals form the foundation for the ITS program. The chapter also presents an overview of the national ITS program, the key participants and their roles in the program, and the annual process for updating the National ITS Program Plan (NPP).

2.0 WHY DO WE NEED TO CHANGE?

The nature of surface transportation is being shaped by a number of challenges, constraints, and opportunities. There is no single answer to the complex transportation problems that confront many communities. There is no doubt that traditional approaches to providing mobility and improving safety will continue to be important, however, alternative ways of making existing roadways and vehicles safer and more efficient must be found. Rapid advances in ITS technologies will allow the development of new approaches to the solution of transportation problems, and to make traditional solutions more effective and efficient.

The following sections discuss the societal, economic, and legislative factors that have influenced, and will continue to influence the development and deployment of ITS.

2.1 Accessibility and Mobility

The basic challenge for transportation decision makers is to provide mobility and accessibility for all. Mobility, simply defined, is the ability to travel from one point to another. Growing congestion in the United States threatens the mobility necessary to the economic and social health of the nation. The concept of accessibility includes both the ability to safely and conveniently use the available transportation systems, and the recognition that access to goods and services may be met without physical travel. The Americans with Disabilities Act (ADA) makes access to public transportation for disabled individuals a national goal. In addition, the population in the United States is aging as the baby-boom generation matures. Access to safe, convenient, cost effective transportation is essential for the economic and social health of the nation, since lack of adequate transportation limits access to employment, education, medical care, and social and other essential services.

2.2 Dependence on the Single Occupant Vehicle

The single occupant vehicle (SOV) remains the primary means of transportation in the United States. According to the August 1993 joint U.S. DOT and Environmental Protection Agency (EPA) report, ***Clean Air through Transportation: Challenges in Meeting National Air Quality***

Standards, of 250 million daily passenger trips, 94 percent are made in automobiles or trucks and only 2 percent by public transportation. Automobile travel, as measured by vehicle miles traveled, has increased markedly, far outpacing population growth and the construction of new roadway facilities. More vehicles and increasing personal travel have contributed to the severe traffic congestion that has become familiar in many urban and suburban areas in the United States.

The addition of sufficient roadway capacity to meet current and projected demand for SOV travel is simply not possible in some areas. Therefore, the increasing demand for travel must be met by a more balanced transportation system. While private, single occupant travel will remain an important part of the transportation system in this country, maintaining mobility and environmental quality will require a greater use of higher occupancy modes of transportation.

Despite increasing congestion and delay, the public has been slow to shift from SOV to alternative modes of travel Travel by higher occupancy vehicles must be made more attractive and convenient, particularly for the daily commuter traveling to work.

2.3 Land Use and Demographics

Land use patterns determine, to a large extent, how transportation needs can be met. Demographic patterns further help to define the transportation needs of the population. Long term shifts from urban to suburban living have made suburb-to-suburb travel the dominant commuting pattern in the United States. Low density development makes the provision of efficient, convenient public transit service prohibitively expensive. However, to maintain mobility in suburban (as well as urban) areas, the average occupancy of vehicles must be increased.

2.4 Economics and Pmductivity

There is a strong link between transportation investment and economic productivity. A major restructuring of American industry is underway. There is a shift from heavy industry that required proximity to natural resources, to lighter manufacturing and service industries that need quick, reliable access to markets to maintain their competitiveness. The cost of congestion in the United States is estimated in excess of $100 billion a year. The Transportation Research Board (TRB) Special Report 242, ***Curbing Gridlock,*** reports that the cost of delay in U.S. urban areas, based on estimates of motorists' value of time and wasted fuel alone, has reached $43 billion a year.

2.5 International Competitiveness

Surface transportation policy must also address issues associated with global competitiveness. A major goal of ISTEA is to develop intermodal, national transportation systems that integrate road networks with ports and other facilities. This will effectively produce a "seamless" transportation system which facilitates the intermodal movement of freight across national and international boundaries.

2.6 Changes in Defense Industry

Because of reductions in military spending, defense companies are investigating commercial or civilian applications for their technologies. As noted in the U.S. DOT Report/Volpe National Transportation Systems Center report, ***Institutional Barriers to ZVHS: Defense Company Interviews and Case Studies,*** "the transportation arena has figured prominently in the search for new markets because of the natural technological fit between existing defense capabilities and the advanced technologies that are being integrated into the nation's transportation infrastructure system." The emerging ITS field is an example of one of the markets with a match between defense industry capabilities and advanced technology requirements..

2.7 The National Information Infrastructure

The telecommunications industry is also undergoing rapid change. The Information Superhighway, officially known as the National Information Infrastructure (NII), will use emerging digital technology to revolutionize the delivery of communications, education, and entertainment services, among others. The NII will be privately built, owned, and operated, The NII holds potential as a means to convey real time information on various transportation systems and to provide accessibility to services without the need to travel. This potential can be seen now through the increasing use of telecommuting and a range of services, such as airline reservations and shopping, from various information providers using the personal computer platform.

2.8 Fiscal Pressures

Increasing fiscal pressures challenge public officials to carefully examine how public funds are spent. Scarce funds must be used in the most effective way to provide the public with adequate levels of services. State and local governments must focus attention and resources on many other pressing priorities in addition to transportation, including crime, education, health care, homelessness, unemployment and poverty. Large investments in transportation infrastructure may no longer be the optimal choice for transportation spending when a less costly alternative will suffice.

2.9 The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)

ISTEA was structured to address a number of the societal challenges involved in providing accessible transportation. The purpose of the ISTEA was to provide a new vision of surface transportation in America. It included the goals of:

- enhancing the capacity, efficiency, and safety of the highway system, including alternatives to additional physical capacity;
- enhancing efforts to attain air quality goals established by the Clean Air Act;
- reducing societal, economic, and environmental costs associated with traffic congestion;
- developing and promoting an ITS industry in the United States, particularly creating an American presence in this emerging field of technology; and
- developing a technology base for ITS systems.

The ISTEA has led the U.S. DOT to begin developing the framework for defining and establishing the National Transportation System (NTS). The NTS will encompass all modes of transportation, including new technological innovations. Incorporated into the NTS will be the 155,000 mile National Highway System (NHS). NTS goals include, but are not limited to:

- identifying local, regional, and national bottlenecks, missing linkages and new required components in the Nation's existing infrastructure across all modes;
- implementing ISTEA's mandates to integrate all modes into the metropolitan and statewide transportation planning processes -- cost-benefit analyses for capital projects and management systems that address operations, congestion relief and intermodal system requirements must take into account the full transportation picture; and
- encouraging transportation decision makers at all levels to favor investments that further the interdependence of local, regional, and national networks, thus leveraging the benefits of all.

2.10 The Clean Air Act Amendments

The Clean Air Act (CAA) Amendments, coupled with the ISTEA have led Federal, State, and local governments to more clearly align transportation and air quality goals. The ISTEA requires the development of a national transportation system which is "environmentally-sound." The Intelligent Vehicle Highway Systems (IVHS) Act within ISTEA specifically requires promotion of those systems that enhance States' efforts to attain air quality goals established pursuant to the CAA.

The 1990 CAA Amendments set strict deadlines for "nonattainment" areas to meet national ambient air quality standards depending on the severity of their air pollution problems. Section 176(c) of the CAA makes it the affirmative responsibility of the Federal agency supporting an action to ensure that its activities conform to an approved or promulgated air quality implementation plan. It also prohibits metropolitan planning organizations (MPO) from approving any transportation plan, program, or project which does not conform to such a plan. A conforming plan or program must not cause, create, or worsen violations. It must not obstruct attainment and must demonstrate timely implementation of transportation control measures.

Both the ISTEA and the CAA Amendments compel Federal, State, and local governments to develop new strategies and mechanisms to address national transportation needs. This leads to considerable pressure to develop additional tools, besides traditional transportation control measures, to combat the damage caused to the environment by vehicle use.

3.0 GOALS AND OBJECTIVES

The National ITS program is structured to respond to the forces discussed in the previous section. The national ITS program goals and objectives have evolved as the program has developed. The goals are to:

- Improve the safety of the Nation's surface transportation system;
- Increase the operational efficiency and capacity of the surface transportation system;
- Reduce energy and environmental costs associated with traffic congestion;
- Enhance present and future productivity;
- Enhance the personal mobility and the convenience and comfort of the surface transportation system; and
- Create an environment in which the development and deployment of ITS can flourish.

The program goals set out in ISTEA provided the basic framework, and were expanded in both ITS America's ***Strategic Plan for Intelligent Vehicle-Highway Systems*** and the U.S. DOT's ***IVHS Strategic Plan.***

3.1 Improve the Safety of the Nation's Surface Transportation System

Reducing the number and severity of fatalities and injuries on the roadway system is an important objective of the national ITS program. ITS can positively impact safety by reducing the number of collisions and by reducing the severity of collisions when they occur.

Fewer collisions reduces the injuries and fatalities that may have resulted if the collisions had occurred. ITS can have a direct impact on the number of collisions that occur by providing systems that:

- assist the driver in avoiding collisions;
- monitor and advise the driver (or others) on the condition and safety readiness of the vehicle, driver, and driving environment; and
- enhance driver and vehicle performance and driver response to hazardous situations.

The automated highway system will ultimately create an automated highway system that is extremely safe.

Reducing the severity of collisions reduces the seriousness of the injuries and the number of fatalities. The severity of injuries received can be lessened by reducing amount of force occupants absorb during a crash and by providing prompt medical treatment to victims. In the event that a collision is unavoidable, collision avoidance systems may reduce impact speeds and thereby reduce the severity of injuries. Occupant restraint systems that deploy in the instant before a crash can provide additional protection to occupants during the crash. Incident management, hazardous materials incident response, and emergency medical services can reduce the time required to detect and respond appropriately to a crash. Prompt, appropriate medical treatment is effective in reducing the severity of injuries sustained and the number of fatalities.

Many ITS systems will be largely invisible to the traveler, others may produce profound changes in the traveler's environment. However, all ITS systems must be developed and deployed in a manner that does not negatively impact safety.

3.2 Increase the Operational Efficiency and Capacity of the Surface Transportation System

Capacity enhancements increase the absolute number of vehicles that can pass through some portion of the system under "ideal" conditions. Operational efficiency enhancements improve the flow of passengers, goods, and/or vehicles through the system without increasing capacity.

Traditional measures of mitigating congestion depend heavily upon the provision of new physical capacity, such as the construction of new facilities or the expansion of existing facilities. The social, environmental, and economic costs of traditional approaches are becoming prohibitive. Frequently, acquisition of new roadway right-of-way adversely impacts and disrupts businesses and neighborhoods, and has detrimental impacts on sensitive areas including wetlands, parklands, and historic and cultural sites. The congestion relief realized through the addition of new physical capacity may be disappointingly short-lived as the addition of new travelers to the system, often quickly negates the improvements. Activities that increase operational efficiency promise to represent desirable alternatives.

ITS can directly impact the operational efficiency of the transportation system by reducing ***disruptions due to incidents*** and ***improving the level of service and convenience*** provided to travelers. The impact of incidents can be reduced by systems that enhance the traffic operator's and emergency services' ability to detect, respond to, and resolve incidents, and provide travelers with the information necessary to avoid affected areas.

In addition to providing improvements in safety, the automated highway system (AHS) is capable of ***increasing roadway capacity.*** AHS will allow vehicles to travel at short headways (spacings between vehicles), at high speeds, thereby increasing the absolute number of vehicles that can pass through a section of roadway over a given period of time.

Some ITS technologies will allow transportation policy makers and planners to implement a wide range of Transportation Demand Management (TDM) services. TDM techniques, some of which are controversial, influence a traveler's choice of travel mode, travel time, and other travel behavior. TDM services encourage more efficient and effective use of available transportation capacity and reduce demand, rather than increasing system capacity. For example, a number of TDM techniques are targeted at making public transit an attractive alternative to SOV trips.

3.3 Reduce Energy and Environmental Costs Associated with Traffic Congestion

Congestion occurs when travel demand exceeds the operating capacity of the system. Under congested travel conditions, vehicles produce higher levels of air pollutants and noise, and consume more fuel for each vehicle and passenger mile traveled. The direct and indirect environmental impacts of ITS applications focused on reducing congestion are highly dependent upon the combination of technologies that are deployed. The systems deployed should be examined for their net contribution towards achieving environmental and energy goals.

In the short run, ITS user services should have a net positive effect on energy efficiency. A number of systems can be employed to reduce inefficient SOV travel by improving the convenience and attractiveness of carpooling and public transit, and the development of alternatives to travel. It is also apparent that alleviating congestion can ***reduce harmful emissions,*** particularly hydrocarbons and carbon monoxide (CO).

ITS, such as traveler information systems, could reduce overall congestion and delay by providing drivers with information on traffic conditions and public transit availability. This information would allow drivers to select less congested, alternate routes, or to select an alternate mode of travel. Diverting automobile travelers to less congested routes makes more efficient use of under-utilized infrastructure. From an energy standpoint, this appears preferable to vehicles inching along in stop-start traffic. However, the diversion of traffic from congested to uncongested routes could produce complaints of increased noise from persons residing along the “new” routes. This could necessitate the use of other traffic management and control techniques at the local level to alleviate such conditions. Route diversions may also result in an increase in the length of individual trips and an overall increase in vehicle miles traveled (VMT), offsetting some the benefits obtained by routing drivers away from congested facilities. Each situation will be unique, and will be influenced by the availability of suitable travel alternatives.

ITS can also be an important tool to develop effective strategies in accordance with the requirements of the CAA. This act requires State and local governments to implement strategies to attain reductions in emissions of ozone precursors, CO, and particulate matter. ITS can facilitate the development of measures, such as congestion pricing, which can be highly cost-effective in contributing to this effort. Moreover, would-be travelers can use ITS services to access information regarding control measures being employed, pricing schedules, availability of parking spaces at nearby park and ride lots, and convenience of other transportation options, such as bus arrival and departure times, vanpool availability, and car pool matching. The availability of such information could lessen reliance on SOV travel, and encourage use of alternative forms of transportation. Research is required to uncover more definitive findings on this issue.

The ***energy use impacts*** of ITS over the longer run are uncertain. It can be argued that, by making travel by automobile "easier," some ITS services could induce growth in private automobile travel. There is much debate and uncertainty about the probability and magnitude of such "induced" travel demand. Long-term projections in this area are complicated by the fact that there are other variables involved, such as demographic shifts, economic cycles and technological advances in related fields.

3.4 Enhance Present and Future Productivity

An objective of the national ITS program is to reduce transportation costs for all users of the surface transportation system, including businesses, operating agencies, fleet managers, and individuals.

Productivity can be improved by ***reducing the costs incurred by fleet operators and others,*** by ***reducing travel time,*** and by ***improving transportation systems planning and management.*** ITS can improve productivity by making better use of existing facilities, reducing travel times (improving mobility), and decreasing the need for additional facilities. The ITS program includes services that will improve public transportation customer service by providing better public transit information, schedule adherence, and responsiveness. Finally, the program aims to improve the quality and cost efficiency associated with the collection and use of data necessary for transportation planning, operations management, roadway construction and maintenance services, and user fees.

To reduce operating and manufacturing costs, businesses and manufacturers are reducing product cycles times (the time it takes to move a product from the factory to the selling floor) and emphasizing the use of "just-in-time" delivery systems to reduce inventory costs. These changes are resulting in more frequent and smaller size shipments. From 1980 to 1989, American business reduced inventories from 26 percent (final sales) to 20 percent and saved $14 billion. By 1995, 55 percent of the nation's manufacturers are expected to be using just-in-time delivery. These factors reinforce the need for investing in a surface transportation system that can provide flexibility required by new business structures.

3.5 Enhance the Personal Mobility and the Convenience and Comfort of the Surface Transportation System

Traveler mobility and accessibility can be enhanced through ITS applications. With real-time ***access to pre-trip and en-route information*** about routes, fares, and connections on bus and rail, and on automobile routes and traffic conditions, would-be travelers would likely find each mode easier to use. Ridesharing services and transit will have personalizing capabilities, such that affordable door-to-door service can be readily arranged even in areas with lower population densities. Other services are built around ***improving the security of travel*** on both public and private vehicles. Such secure, convenient, affordable door-to-door services have special appeal to elderly, handicapped, young, rural and inner city residents who are now reluctant or unable to use established transportation systems. Travelers using these services will have greater confidence about using new and various routes and modes. They will benefit from greater predictability about their travel times and experience a ***reduction in the stresses involved in their travel.***

3.6 Create an Environment in Which the Development and Deployment of ITS Can Flourish

A specific objective of the ITS program is to support the establishment of a significant U.S.-based industry for hardware, software, and services that can achieve substantial domestic market penetration and a strong international presence.

ITS will offer many opportunities for facilitating the development of new commercial products and services, and represents a potential global market for technologies and services. The United States is just one of a number of countries making considerable investments in transportation technologies and services. Established ITS programs are on-going in Europe and Japan, and interest and involvement in ITS is growing in Australia and elsewhere. While early efforts in Europe and Japan have given them the lead in the development of ITS technologies, the situation is changing. An ITS report titled, ***A Comparison of Progress in the United States and Japan through 1993,*** makes it evident that the United States is emerging as a leader in a number of areas. An important factor is the United States' continued investment in a unified NPP, an ITS architecture developed through consensus, and a commitment to resolving key institutional and legal issues. The approaches taken by both Europe and Japan leave unresolved such key questions as how a broad array of services will be integrated under a system concept and coordinated across international boundaries. These U.S. efforts could potentially facilitate the creation of markets and the deployment of ITS earlier than in Europe and Japan.

In order to reach full deployment, the national ITS program also includes the objective of diversifying and redirecting the transportation profession. This can be done through new education and training programs and by providing opportunities for individuals and organizations with diverse skill mixes to participate in ITS programs. ITS deployment goals can also be reached by drawing on our current domestic sources of technology and technical skill, most notably the defense industries, national laboratories, and other federally-funded resources.

The North American Free Trade Agreement (NAFTA) has significant transportation ramifications. A goal of NAFTA is to eliminate trade and investment barriers among Canada, Mexico and the United States. Because over 85 percent of the U.S. trade with Canada and Mexico moves by land transportation, NAFTA creates opportunities in land transportation by ensuring that U.S. companies can provide cross-border truck and bus services into these countries. It will also liberalize investment in land transportation services in Mexico, including intermodal terminals and landside port activities over a ten-year period. ITS technologies (for example, transponders, smart cards, global positioning systems, onboard computers, etc.) will be important tools in expediting the cross-border transfer of commercial drivers, trucks/buses, and cargo/passengers through international electronic clearance initiatives.

4.0 THE NATIONAL ITS PROGRAM

The national ITS program is organized around five general areas that collectively aim at improving all facets of highway and public transportation. They include:

- Research and Development
- Operational Tests
- National ITS Architecture
- Standards and Guidelines
- Supporting ITS Deployment

4.1 Research and Development

Research and development (R&D) activities provide the basic tools and knowledge bases required to achieve deployment of ITS services and systems. R&D is needed on specific technology components and on integrated systems that provide one or more ITS user services. R&D is also required on the safety and human factors aspects of ITS and the societal and institutional issues that must be addressed for the successful deployment of ITS. The results of R&D activities provide information to modify services or to proceed with operational tests.

4.2 Operational Tests

Operational tests bridge the gap between R&D activities and full-scale deployment of proven technologies. Whereas the R&D phase of the ITS program emphasizes both technologies and services, the emphasis in operational tests is on integrated systems and services. Operational tests are being implemented as partnerships among the public and private sectors and academia, with all partners sharing in the technical, financial, and administrative responsibilities.

Results of the operational test program will be key factors in evaluating potential ITS applications. Many combinations of technologies, architectures, transportation modes, and scenarios, such as urban and rural, should be evaluated in the real-world settings of operational tests. The primary emphasis of most field tests is on effectiveness and user assessments. Cost estimates and requirements are refined, and institutional and deployment issues are identified. Consistent evaluation techniques and parameters are essential in comparing the results of different operational tests on a national level. If the use of federal funds by states is authorized to support future deployment, operational test results will feed directly into the development of guidelines and standards which will determine eligibility for Federal-aid funding.

The U.S. DOT has established a program of open solicitations through the Federal Register to announce opportunities to participate in the operational test program. Appendix B provides a sample list of on-going operational tests. In addition, four areas have been identified as "priority corridors" for ITS activities using specific criteria provided in the ISTEA. These areas are: a Northeast Corridor centered along I-95 from Maryland to Connecticut; a Midwest Corridor including the Chicago metropolitan area and stretching from Gary, Indiana to Milwaukee, Wisconsin; the Houston, Texas metropolitan area; and a Southern California Corridor along I-5 from Los Angeles to San Diego. Operational tests will be negotiated each year within these corridors based on the plans of the region and needed activities as identified in the NPP.

4.3 National ITS Architecture

A national ITS architecture will serve as the broad framework for ITS deployment over the next twenty years. It will facilitate compatibility of ITS systems across the country, contributing to the successful development and deployment of ITS. The ITS architecture will define interfaces and how information flows among and between vehicles, roadside infrastructure, and transportation management centers to accommodate ITS. It will accommodate different levels of implementation and a wide range of system designs. Its flexibility will allow the ITS to evolve over time and will allow different goals to be supported across many regions.

The U.S. DOT initiated the National ITS Architecture Development Program in September 1993. Four teams led by Hughes Aircraft, Loral, Rockwell International, and Westinghouse Electric were selected to independently develop alternative ITS architectures. Each architecture is based on a twenty year planning horizon (1993-2012) and addresses the current set of user services. During the development of the architecture, such issues as "openness," standards, compatibility, and incremental deployment are being considered. The architecture task is being managed carefully to ensure that architectural, rather than design, issues are addressed. The development process includes a broad consensus-building effort to ensure that everyone who will be affected by the architecture will have an opportunity to provide input. A national architecture will be selected by the U.S. DOT in 1996 based on the results of analytical and real-world tests, performance, policy issues, and the consensus process.

4.4 Standards and Guidelines

Appropriate standards enhance the marketplace for both producers and consumers. Standards make it possible to have interchangeable system components. Interchangeable components eliminate unnecessary product development costs caused by differences in the way products interconnect, and foster area-wide deployment, increasing the utility of ITS to the user. Although the specifics will vary from one system to another, performance, interoperability, and other standards or guidelines may need to be developed.

The national ITS architecture will influence the development of safety, communication, vehicle and infrastructure standards. While standard-setting activities will certainly occur in parallel with the architecture development, some standards cannot be finalized until the national ITS architecture has been established. A number of recognized standards-making bodies are active in areas that impact ITS. They include, among others, the American Society for Testing and Materials (ASTM), the Institute of Electrical and Electronics Engineers (IEEE), the Society of Automotive Engineers (SAE), Electronic Industries Association (EIA), Institute of Navigation (ION), Institute of Transportation Engineers (ITE), National Electrical Manufacturers Association (NEMA), and the Telecommunications Industry Association (TIA).

4.5 Supporting ITS Deployment

While many ITS user services will be developed and deployed by the private sector, the public sector has a role in supporting and facilitating deployment. The U.S. DOT has established a program to address non-technical constraints to deployment, including public/private partnerships, intergovernmental cooperation and coordination, legal and regulatory constraints, intellectual property, environmental and other socioeconomic considerations. These issues are often cross-cutting, affecting many user services. Other activities currently underway are aimed at increasing public awareness and understanding of ITS user services, including an assessment of user acceptance and willingness to pay for various services.

The U.S. DOT's Early ITS Deployment Planning Program was established to educate state and local government officials on the critical issues related to deploying ITS. Throughout the life of the ISTEA, the U.S. DOT intends to offer deployment planning support to the 75 largest U.S. metropolitan areas and 30 of the major intercity corridors linking metropolitan areas. These planning studies will highlight the needs of the specific area and address the strategies to best accomplish those needs over both the short and long term.

5.0 KEY PARTICIPANTS

Implementing a nationally compatible system of ITS technologies and services in the United States will require unprecedented levels of coordination and cooperation. This effort will involve hundreds of entities and thousands of individuals representing the private sector, professional societies, public interest groups, the academic community, federal, state, and local governments, ITS America, and private citizens.

The U.S. DOT will serve as a facilitator and a leader in the early stages of the development of ITS. It will provide the national emphasis and perspective on safety, congestion relief, mobility enhancement, environmental impact, energy conservation, productivity improvements, and system standards necessary to assure the development and deployment of a nationally compatible ITS. It will fund high-risk research, be a major participant in operational tests, and play a key role in ITS cost and benefit evaluation, Within the U.S. DOT, the key participants include the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), the National Highway Traffic Safety Administration (NHTSA), the Research and Special Programs Administration (RSPA), and the Office of the Secretary of Transportation (OST).

Other Federal agencies with important roles in various aspects of the ITS Program include the Department of Commerce (DOC), the Federal Communications Commission (FCC), the Department of Energy (DOE), the Department of Justice (DOJ), the Environmental Protection Agency (EPA), the Interstate Commerce Commission (ICC), the Advanced Research Projects Agency (ARPA), and the National Laboratories.

The Intelligent Transportation Society of America (ITS America) is chartered as a utilized Federal Advisory Committee to advise the U.S. DOT on the ITS program. ITS America has established a clearinghouse for data related to ITS research and development. Through workshops, conferences, and the committee structure, ITS America brings together the ITS community and provides a forum for the discussion of the challenges and opportunities presented by ITS. The mission of ITS America is to stimulate interest and activity in ITS and to coordinate and foster public/private/academic partnerships supporting the deployment of ITS.

The private sector has the principal responsibility for developing the technology and marketing the products and services that will bring ITS to fruition. It may also have an increasing role in providing and operating certain infrastructure elements on an entrepreneurial basis, and may play a key role in conducting operational tests. The private sector also includes fleet operators who will deploy ITS to improve their operations efficiencies. The private sector participants represent an extremely diverse group, each with a different set of goals, objectives, needs, constraints and opportunities.

State and local governments and transportation authorities currently own, operate, and maintain most roadway and public transit systems. These agencies will play a primary role in selecting, purchasing, installing, operating, and maintaining ITS components which interact with these systems.

Metropolitan Planning Organizations' (MPO) responsibilities and authorities have expanded as a result of ISTEA. MPOs are responsible for deploying ITS infrastructure based on local needs, priorities, and decisions, particularly in the areas of congestion management and air quality standards attainment. These broad new assignments place MPOs, working together with state and local governments, in a strategic position to advance ITS.

Professional societies will identify research needs, conduct research and policy studies, establish standards and protocols in their areas of responsibility, and collect and disseminate information to their constituents.

Academia plays an important role in the development of educational programs and as a partner in basic and applied research, development, technology assessment, technology transfer, and operational tests.

Public interest groups will help to ensure that appropriately balanced ITS alternatives are considered, that costs and benefits are properly weighed, and that a focus is maintained on meeting ITS goals and objectives and the needs of the greater community.

Private citizens will provide continuing feedback on the value of ITS services in a number of ways. Their comments and participation in ITS planning activities are invaluable in plotting program direction and measuring its progress. Private citizens will be the users and purchasers of many ITS products and will ultimately determine the success or failure of those products in the marketplace.

The roles of the key participants will evolve as ITS is developed and deployed. As pointed out before, ITS involves a significant paradigm shift in the planning, development, funding, operations, and maintenance of transportation systems. Public/private, private/private, and public/public partnerships will play a large role in both the development and deployment of ITS.

6.0 THE PROGRAM PLANNING PROCESS

The NPP is not a static document, but a step in an on-going process. The NPP will be updated regularly to reflect changes in program direction and priority. NPP updates will be in the form of a companion document that provides updated information on specific areas of the NPP. Every few years, a completely new edition of the NPP will be developed. The update will be a joint effort between the U.S. DOT and ITS America.

This update process will be conducted in parallel with the formal process ITS America will use to provide formal advice to the U.S DOT as well the development of the U.S. DOT report to Congress. All three of these activities are largely dependent on an assessment of the status of the ITS Program. That assessment process is described in Chapter VIII of this NPP.

ITS America will provide formal program advice to the U.S. DOT in the form of a Program Advice Memorandum (PAM). It will present ITS America’s counsel on program adjustments or other modifications for the two federal fiscal years following its submission.

The annual report to Congress is in response to a requirement specified in Section 6054 of the IVHS Act in ISTEA that U.S. DOT will provide an annual implementation report to Congress on the status of the ITS program. This report shall provide annual updates on program progress, including realized and possible benefits, cost-sharing arrangements, non-technical constraints, and recommendations for national action.

The schedule for NPP updates will be integrated with the schedules for these two related activities as well as the Congressional budget cycle and ITS America's Board of Directors and Coordinating Council meetings. Table 2-l presents the sequence of activities for the NPP update, the PAM development process, and the development of the Implementation Report to Congress.

Table 2-1 Program Planning Process

- New edition or update of the NPP is distributed.
- Presentation of U.S. DOT's program issues to ITS America. Public comments on the U.S. DOT program issues are solicited through the Federal Register.
- ITS America technical committees discuss and deliberate U.S. DOT's federal program issues, develop input for the ITS program assessment workshop, and suggest changes to the NPP.
- The ITS America Benefits, Evaluations and Costs (BEC) Committee hosts an ITS program assessment workshop. All of the technical committees participate. Results documented in a report. A Joint Writing Team begins to update the NPP.
- The ITS America Planning Committee drafts a Program Assessment Memorandum (PAM) based on the program assessment workshop report, committee input, and consideration of the U.S. DOT's program issues. ITS America and U.S. DOT complete the draft update to the NPP.
- Public comments on the update to the NPP are solicited.
- ITS America and U.S. DOT approve the update. The ITS America Coordinating Council and Board of Directors approve the PAM to the U.S. DOT.
- ITS America transmits the PAM to U.S. DOT.
- The first update to the NPP is released. The U.S. DOT submits its annual Implementation Report to Congress as required by the ISTEA.

CHAPTER III - USER SERVICES

1.0 INTRODUCTION

The national ITS program is focused on the development and deployment of a collection of inter-related user services. Twenty-nine user services have been defined to date as part of the national program planning process. This list of user services is neither exhaustive nor final. There are a wide array of transportation services that could develop that are not included in this list. In addition, the services here are expected to change over time. Some will develop largely as envisioned. New services will emerge, and others, for various reasons, will never be developed. This list of services, and the accompanying descriptions are expected to evolve through program plan updates and new editions.

The users of these service include travelers using all modes of transportation, transportation management center operators, transit operators, Metropolitan Planning Organizations (MPOs), commercial vehicle owners and operators, state and local governments, and many others who will benefit from deployment of ITS. Detailed plans for each user service are provided in Volume II of the NPP.

2.0 USER SERVICE DESCRIPTIONS

Although each user service is unique, they share common characteristics and features as described below.

- Individual user services are building blocks that may be combined for deployment in a variety of fashions. The combination of services deployed will vary depending upon local priorities, needs, and market forces. Within the National ITS Program Plan (NPP), user services have been grouped into “bundles” based on likely deployment scenarios as described later in this chapter and in Chapter V, User Services Integration.

- User services are comprised of multiple technological elements or functions which may be common with other services. For example, a single user service will usually require several technologies, such as advanced communications, mapping, and surveillance, which may be shared with other user services. This commonality of technological functions is one basis for the suggested bundling of services.

- User services are in various stages of development and will be deployed as systems according to different schedules. Some of the technologies required by various user services are currently available in the market place, while others will require significant research and development before they can be deployed. The development and deployment of an individual service will be guided by the policies and priorities established by both the public and private sector participants. These policies and priorities will evolve based on changing technologies, economic factors, and market conditions.

- Costs and benefits of user services depend upon deployment scenarios. Once the basic technological functions, such as communications or surveillance, have been deployed for one user service, the additional functions needed by one or more related services may require only a small incremental cost to produce additional, often significant, benefits.

- Many user services can be deployed in rural, suburban and/or urban settings. User services are not specific to a particular location. Rather, the function of the service can be adapted to meet local needs and conditions.

3.0 USER SERVICE BUNDLING

Although it may be possible to deploy a system that provides a single user service, in many cases, services are more likely to be deployed in combination with other services or "bundle" which share some commonality.

For purposes of discussion in the NPP, the twenty-nine user services have been sorted into categories termed "bundles." The services within these bundles, as shown in Table 3-1, may be related in a number of different ways. In some cases, the institutional perspectives of organizations that will deploy the services provided the rationale for the formation of a specific bundle. Other bundles were organized around common technical functionalities. These services could have been bundled in any number of ways. Table 3-l presents only one of a number of possibilities. When the services are actually deployed, it is likely that services will also be mixed and matched among the bundles, as well as within a single bundle. The technical inter-relationships among the user services, and the functionalities they may share are discussed in greater detail in Chapter V, User Services Integration.

3.1 Travel and Transportation Management

The Travel and Transportation Management user services were grouped in a single bundle because of the information they share about the surface transportation system. These services collect and process information about the surface transportation system, and provide commands to various traffic control devices. Travel management services disseminate this information to the traveler. When used in concert, these services can provide a comprehensive travel and transportation management system. These services also provide information to support the Travel Demand Management and the Public Transportation Operations bundles. Thus, the Travel and Transportation Management bundle will be of interest to transportation policy makers, public and private sector operators of transportation management centers, those involved in incident response or travel demand management, and private sector vendors supplying travel information products and services.

Table 3-1 User Service Bundles

Bundle	User Services
1. Travel and Transportation Management	1. En-Route Driver Information 2. Route Guidance 3. Traveler Services Information 4. Traffic Control 5. Incident Management 6. Emissions Testing and Mitigation
2. Travel Demand Management	1. Demand Management and Operations 2. Pre-Trip Travel Information 3. Ride Matching and Reservation
3. Public Transportation Operations	1. Public Transportation Management 2. En-Route Transit Information 3. Personalizd Public Transit 4. Public Travel Security
4. Electronic Payment	1. Electronic Payment Services
5. Commercial Vehicle Operations	1. Commercial Vehicle Electronic Clearance 2. Automated Roadside Safety Inspection 3. On-board Safety Monitoring 4. Commercial Vehicle Administrative Processes 5. Hazardous Materials Incident Response 6. Freight Mobility
6. Emergency Management	1. Emergency Notification and Personal Security 2. Emergency Vehicle Management
7. Advanced Vehicle Control and Safety Systems	1. Longitudinal Collision Avoidance 2. Lateral Collision Avoidance 3. Intersection Collision Avoidance 4. Vision Enhancement for Crash Avoidance 5. Safety Readiness 6. Pm-Crash Restraint Deployment 7. Automated Highway System

. En-Route Driver Information

Provides driver advisories and in-vehicle signing for convenience and safety.

Driver advisories are similar to pre-trip planning information, but they are provided once travel begins. Driver advisories convey real-time information about traffic conditions, incidents, construction, transit schedules, and weather conditions to drivers of personal, commercial and public transit vehicles. This information allows a driver to either select the best route, or shift to another mode in mid-trip if desired.

In-vehicle signing, the second component of en-route driver information, provides the same types of information found on physical road signs today, directly in the vehicle. The service could be extended to include warnings of road conditions and safe speeds for specific types of vehicles, such as autos, buses, and large trucks, but potential users include drivers of all types of vehicles. This service might be especially useful to elderly drivers, in rural areas with large numbers of tourists, or in areas with unusual or hazardous roadway conditions.

. Route Guidance

Provides travelers with simple instructions on how to best reach their destinations.

The route guidance service provides a suggested route to reach a specified destination. Early route guidance systems are based on static information about the roadway network or transit schedules, When fully deployed, route guidance systems will provide travelers with directions to their destinations based on real-time information about the transportation system. The route guidance service will consider traffic conditions, status and schedule of transit systems, and road closures in developing the best route. Directions will generally consist of simple instructions on turns or other upcoming maneuvers. Users of the service include not only drivers of all types of vehicles, but also non-vehicular travelers, such as pedestrians or bicyclists, who could get specialized route guidance from a hand-held device.

. Traveler Services Information

Provides a business directory, or "yellow pages," of service information.

Traveler services information provides quick access to travel-related services and facilities. Examples of information that might be included are the location, operating hours, and availability of food, lodging, parking, auto repair, hospitals, and police facilities. Traveler services information would be accessible in the home, office or other public locations to plan trips, and would also be available en-route. When fully deployed, this service will connect users and providers interactively to request and provide needed information. A comprehensive, integrated service could support financial transactions, such as automatic billing for purchases.

. Traffic Control

Manages the movement of traffic on streets and highways.

The traffic control user service provides for the integration and adaptive control of the freeway and surface street systems to improve the flow of traffic, give preference to public safety, transit or other high occupancy vehicles, and minimize congestion while maximizing the movement of people and goods. Through appropriate traffic controls, the service also promotes the safety of non-vehicular travelers, such as pedestrians and bicyclists. It requires advanced surveillance of traffic flows, analysis techniques for determining appropriate traffic signal and ramp metering controls, and communication of these controls to the roadside infrastructure. This service gathers data from the transportation system and organizes it into usable information to determine the optimum assignment of right-of-way to vehicles and pedestrians. The real-time traffic information collected by the Traffic Control service also provides the foundation for many other user services.

. Incident Management

Helps public and private organizations quickly identify incidents and implement a response to minimize their effects on traffic.

The Incident Management service uses advanced sensors, data processing, and communications to improve the incident management and response capabilities of transportation and public safety officials, the towing and recovery industry, and others involved in incident response. The service will enhance existing incident detection and verification capabilities to help these groups quickly and accurately identify a variety of incidents and implement a response. The improved response time will minimize the effects of these incidents on the movement of people and goods. This service will also help transportation officials predict traffic or highway conditions so that they can take action in advance to prevent potential incidents or minimize their impacts. While the direct users of this service are the public and private entities responsible for incident detection and response, the ultimate beneficiaries are commercial and transit operators, and the traveling public.

· Emissions Testing and Mitigation

Provides information for monitoring air quality and developing air quality improvement strategies.

The Emissions Testing and Mitigation service uses advanced vehicle emissions testing systems to provide information to identify environmental “hot spots” and implement strategies to either reroute traffic around sensitive air quality areas or control access to such areas. Other technologies provide identification of vehicles that are emitting levels of pollutants that exceed state, local or regional standards, and provides information to drivers or fleet operators to enable them to take corrective action. The service also provides transportation planning and operating agencies with information that can be used to facilitate implementation and evaluation of various pollution control strategies.

3.2 Travel Demand Management

The Travel Demand Management user services support policies and strategies that are aimed at reducing vehicle demand by developing and encouraging modes of travel other than the single occupant vehicle. The services in this bundle are designed to increase the use of high occupancy vehicles and transit by providing intermodal information to travelers prior to the beginning of a trip, and by making ride sharing and transit more convenient and easier to use. These services are also aimed at decreasing congestion by altering the timing or location of trips, or eliminating vehicle trips all together.

From a technical perspective, these services rely on information collected and processed by the Travel and Transportation Management services and the Public Transportation Operations services. Travel Demand Management services also interact with the Travel and Transportation Management services in terms of implementing control strategies that can provide incentives, or disincentives, to change travel behavior.

. Demand Management and Operations

Supports policies and regulations designed to mitigate the environmental and social impacts of traffic congestion.

The Demand Management and Operations service generates and communicates management and control strategies that support the implementation of programs to reduce the number of individuals who choose to drive alone, especially to work; increase the use of high occupancy vehicles, transit, and commuter rail: and provide a variety of mobility options for those who wish to travel in a more efficient manner, for example in non-peak periods. Demand management strategies could ultimately be applied dynamically, when congestion or pollution conditions warrant. For example, disincentives such as increased tolls and parking fees could be applied during pollution alerts or peak travel periods, while transit fares would be lowered to accommodate the increased number of travelers changing modes from driving alone. Such strategies will reduce the negative impacts of traffic congestion on the environment and improve overall quality of life.

- Pre-Trip Travel Information

Provides information for selecting the best transportation mode, departure time, and route.

Pre-trip travel information allows travelers to access a complete range of intermodal transportation information at home, work, and other major sites where trips originate. Real-time information on transit and commuter rail routes, schedules, transfers, fares, and ride matching services are available to encourage the use of alternatives to the single occupancy vehicle. Information needed for long, inter-urban or vacation trips would also be available. Real-time information on accidents, road construction, alternate routes, traffic speeds along given routes, parking conditions, event schedules, and weather information is also included. Based on this information, the traveler can select the best route, modes of travel and departure time, or decide not to make the trip at all.

- Ride Matching and Reservation

Makes ride sharing easier and more convenient.

The Ride Matching and Reservation service provides real-time ride matching information and reservations to users in their homes, offices or other locations, and assist transportation providers, as well as van/carpoolers, with vehicle assignments and scheduling. This will expand the market for ridesharing as an alternative to single occupant vehicle travel and will provide for enhanced alternatives for special population groups, such as the elderly or the handicapped.

3.3 Public Transportation Operations

The Public Transportation Operations bundle reflects the commonality of the transit authority as the most probable provider of these services. The transit authority is responsible for implementing systems that are capable of better managing the public transportation system and providing improved transit and mode choice information.

From a technical perspective, all of these user services will share a common public transit database. The data will be available for all of the services to customize for their specific function. This data will also support services in the Travel and Transportation Management and the Travel Demand Management bundles.

- Public Transportation Management

Automates operations, planning, and management functions of public transit systems.

The Public Transportation Management service provides computer analysis of real-time vehicle and facility status to improve transit operations and maintenance. The analysis identifies deviations from schedule and provides potential solutions to dispatchers and drivers. Integrating this capability with traffic control services can help maintain transportation schedules and assure transfer connections in intermodal transportation. Information regarding passenger loading, bus running times, and mileage accumulated will help improve service and facilitate administrative reporting. Transit personnel management is enhanced by automatically recording and verifying tasks performed by transit personnel.

- En-Route Transit Information

Provides information to travelers using public transportation after they begin their trips.

The En-Route Transit Information service provides information to assist the traveler once public transportation travel begins. Real-time, accurate transit service information on-board the vehicle helps travelers make effective transfer decisions and itinerary modifications as needed while a trip is underway.

- Personalized Public Transit

Provides flexibly-routed transit vehicles to offer more convenient customer service.

Small publicly or privately-operated vehicles provide on-demand routing to pick up passengers who have requested service and deliver them to their destinations. Route deviation schemes, in which vehicles leave a fixed route for a short distance to pick up or discharge passengers, is another way of improving service. Vehicles can include small buses, taxicabs, or other small, shared ride vehicles. This service can provide almost door-to-door service, expanding transit coverage to lesser populated locations and neighborhoods. Potentially, this services can provide transportation at lower cost and with greater convenience than conventional fixed route transit.

- Public Travel Security

Creates a secure environment for public transportation patrons and operators.

This service provides systems that monitor the environment in transportation stations, parking lots, bus stops, and on-board transit vehicles, and generate alarms, either automatically or manually, when necessary. This improves security for both transit riders and operators. Transportation agencies and authorities can integrate this user service with other anti-crime activities.

3.4 Electronic Payment

While this bundle contains only one user service, it supports deployment of many other services, both within and outside the transportation arena. This service will be developed, deployed, and operated by both public and private organizations.

- Electronic Payment Services

Allows travelers to pay for transportation services electronically.

Electronic Payment services will foster intermodal travel by providing a common electronic payment medium for all transportation modes and functions, including tolls, transit fares, and parking. The service provides for a common service fee and payment structure using “smart cards” or other technologies. Such systems could be expanded to become truly multi-use, accommodating personal financial transactions that are made with today’s credit/bank cards. The flexibility that electronic payment services offer will also facilitate travel demand management, if conditions warrant. They could, if local authorities so choose, enable application of road pricing policies which could influence departure times and mode selection.

3.5 Commercial Vehicle Operations

These user services support the goals of improving the efficiency and safety of commercial fleet operations, and will benefit both the States and the motor carrier industry. Thus the CVO bundle reflects the commonality of using advanced computer and communications technologies to improve the safety and productivity of the motor carrier industry throughout North America.

From a technical perspective, the foundation for all of the CVO user services is information systems. Each service will require some set of information on the motor carrier, the vehicle, the driver, and, in some cases, the cargo. The services are interrelated in terms of the specific types and functionality of information and data required. This network of information will be accessible by States and motor carriers nationwide.

. Commercial Vehicle Electronic Clearance

Facilitates domestic and international border clearance, minimizing stops.

This service will enable transponder-equipped trucks and buses to have their safety status, credentials, and weight checked at mainline speeds. Vehicles that are safe and legal and have no outstanding out-of-service citations will be allowed to pass the inspection/weigh facility without delay.

By working with Mexico and Canada, a more efficient traffic flow would be provided at border crossings. The deployment of technologies in these countries could ultimately prevent overweight, unsafe, or improperly registered vehicles from entering the United States.

. Automated Roadside Safety Inspection

Facilitates roadside inspections.

Automated roadside inspections would allow real-time access at the roadside to the safety performance record of carriers, vehicles, and drivers. Such access will help determine which vehicle or driver should be stopped for an inspection, as well as ensuring timely correction of previously identified problems.

This service would also automate as many items as possible of the manual inspection process. It would, for example, allow for more rapid and accurate inspection of brake performance at the roadside. Through the use of sensors and diagnostics, it would efficiently check vehicle systems and driver requirements and ultimately driver alertness and fitness for duty.

. On-Board Safety Monitoring

Senses the safety status of a commercial vehicle, cargo, and driver.

On-board systems would monitor the safety status of a vehicle, cargo, and driver at mainline speeds. Vehicle monitoring would include sensing and collecting data on the condition of critical vehicle components such as brakes, tires, and lights, and determining thresholds for warnings and countermeasures. Cargo monitoring would involve sensing unsafe conditions relating to vehicle cargo, such as shifts in cargo while the vehicle is in operation. Driver monitoring is envisioned to include the monitoring of driving time and alertness using non-intrusive technology and the development of warning systems for the driver, the carrier, and the enforcement official. A warning of unsafe condition would first be provided to the driver and then to the carrier and roadside enforcement officials. This warning notification would possibly prevent an accident from happening. This service would minimize driver- and equipment-related accidents for participating carriers.

- Commercial Vehicle Administrative Processes

Provides electronic purchasing of credentials and automated mileage and fuel reporting and auditing.

The Commercial Vehicle Administrative Processes service provides the commercial carrier with the capability to electronically purchase annual and temporary credentials via computer link. It will reduce burdensome paperwork and processing time for both the State agencies and the motor carriers.

For automated mileage and fuel reporting and auditing, this service enables participating interstate carriers to electronically capture mileage, fuel purchased, trip, and vehicle data according to state. It would also automatically determine mileage traveled and fuel purchased in each state, for use by the carrier in preparing fuel tax and registration reports to the State agencies. This service would reduce the significant administrative burden on commercial carriers to collect and report mileage and fuel purchased within each State.

- Hazardous Material Incident Response

Provides immediate description of hazardous materials to emergency responders.

The Hazardous Material Incident Response service enhances the safety of shipments of hazardous materials by providing enforcement and response teams with timely, accurate information on cargo contents to enable them to react properly in emergency situations. The materials or combination of materials involved when an incident involving a truck or railcar carrying hazardous material occurs would be provided electronically to emergency responders and enforcement personnel at the scene so that the incident can be handled properly.

- Freight Mobility

Provides communication between drivers, dispatchers, and intermodal transportation providers.

The Freight Mobility service provides real-time traffic information and vehicle location for commercial vehicles. This service significantly enhances fleet operations management by helping drivers to avoid congested areas and improving the reliability and efficiency of pickups and deliveries. These benefits are particularly important for operators of intermodal and time-sensitive fleets who can use this ITS service to make their operations more efficient and reliable.

3.6 Emergency Management

Police, fire and rescue operations can use emergency management services to improve their management of and response to emergency situations. These user services have common functional elements such as vehicle location, communications, and response.

- Emergency Notification and Personal Security

  Provides immediate notification of an incident and an immediate request for assistance.

  The Emergency Notification and Personal Security service includes two capabilities: driver and personal security, and automatic collision notification. Driver and personal security capabilities provide for user-initiated distress signals for incidents such as mechanical breakdowns or car-jackings. When activated by an incident, automatic collision notification transmits information regarding location, nature, and severity of the crash to emergency personnel.

- Emergency Vehicle Management

  Reduces the time it takes for emergency vehicles to respond to an incident.

  The Emergency Vehicle Management service provides public safety agencies with fleet management capabilities, route guidance, and signal priority and/or preemption for emergency vehicles. Fleet management improves the display of emergency vehicle locations and help dispatchers send the units that can most quickly reach an incident site. Route guidance directs emergency vehicles to an incident location and signal priority optimizes the traffic signal timing in an emergency vehicle's route. Primary users of this service include police, fire, and medical units.

3.7 Advanced Vehicle Control and Safety Systems

Although each of these services addresses a separate function, they all contribute to the common goal of improving vehicle safety. With the exception of Automated Highway Systems (AHS), all of these user services are characterized by near-term reliance on self-contained systems within the vehicle. The functionality of these user services, however, can be enhanced by supplementing the on-board capabilities with additional sensors deployed in the infrastructure.

Within the vehicle, common functional elements, such as data storage, processing units, sensors, or actuators, could be shared among the user services in this bundle, including AHS.

- Longitudinal Collision Avoidance

  Helps prevent head-on, rear-end or backing collisions between vehicles, or between vehicles and other objects or pedestrians.

  The Longitudinal Collision Avoidance service helps reduce the number and severity of longitudinal collisions, such as head-on, rear-end or backing. It includes the sensing of potential or impending collisions, prompting a driver's avoidance actions, and controlling the vehicle temporarily.

- Lateral Collision Avoidance

  Helps prevent collisions when vehicles leave their lane of travel.

  The Lateral Collision Avoidance service provides crash warnings and controls for lane changes and road departures. It will reduce the number of lateral collisions involving two or more vehicles, as well as, crashes involving a single vehicle leaving the roadway. For changing lanes, a situation display can monitor the vehicle's blind spot continuously , and drivers can be actively warned of an impending collision. If needed, automatic control can provide rapid response to a situation. Warning systems can also alert a driver to an impending road departure, provide help in keeping the vehicle in the lane, and ultimately provide automatic control of steering and throttle.

- Intersection Collision Avoidance

  Helps prevent collisions at intersections.

  The Intersection Collision Avoidance service warns drivers of imminent collisions when approaching or crossing an intersection or railroad grade crossing that has traffic control (e.g., stop signs or a signal). This service also alerts the driver when the proper right-of-way at the intersection or grade crossing is unclear or ambiguous.

- Vision Enhancement for Crash Avoidance

  Improves the driver's ability to see the roadway and objects that are on or along the roadway.

  The Vision Enhancement service provides drivers with improved visibility to allow them to avoid collisions with other vehicles, obstacles in the roadway, or parked or moving trains, as well as help them comply with traffic signs and signals. This service requires in-vehicle equipment for sensing potential hazards, processing this information, and displaying it in a way that is useful to a driver.

- Safety Readiness

Provides warnings about the condition of the driver, the vehicle, and the roadway.

Safety Readiness services provide in-vehicle equipment that unobtrusively monitors a driver's condition and provides a warning if the driver is becoming drowsy or otherwise impaired. This service could also monitor critical components of the automobile internally and alert the driver to impending malfunctions. Equipment within the vehicle could also detect unsafe road conditions, such as bridge icing or standing water on the roadway, and provide a warning to the driver.

- Pre-Crash Restraint Deployment

Anticipates an imminent collision and activates passenger safety systems before the collision occurs or much earlier in the crash event than is currently feasible.

The Pre-Crash Restraint Deployment service anticipates an imminent collision by determining the velocity, mass, and direction of the vehicles or objects involved in a potential crash. The service activates safety systems in the vehicle prior to a collision, such as tightening lap-shoulder belts, arming and deploying air bags at the optimal pressure, and deploying roll bars. The response is based on the number, location, and major physical characteristics of any occupants.

- Automated Highway Systems

Provides a fully automated, "hands-off," operating environment.

AHS is a long-term goal of ITS which would provide vast improvements in safety by creating a nearly accident-free driving environment. In AHS, the vehicle is guided automatically rather than by the driver. Driver error is reduced or possibly eliminated with full implementation. Drivers could buy vehicles with the necessary instrumentation or retrofit an existing vehicle. AHS benefits include increased roadway capacity, enhanced safety, reduced fuel consumption, and reduced emissions.

4.0 USER SERVICE DEVELOPMENT PLANS

Development plans have been generated for each user service. Each User Service Development Plan identifies the needs that the user service is designed to meet, presents an operational concept for how the service might function in its fully deployed state, describes the technologies that the service might use, discusses potential costs and benefits, and provides an assessment of the public and private sector roles in developing and deploying the systems that will provide the service. The User Service Plans identify major issues or barriers that might impact development and deployment and the activities and milestones that must be accomplished to fully develop the service for system deployment. Detailed User Service Development Plans that describe the activities needed to bring each service to the point of deployment are contained in Volume II.

Features of the User Service Development Plans include:

- **User service development plans address the stated goals of the ITS program** and provide a framework by which user services can be combined, or bundled, into deployable products and services to achieve these goals and objectives.

- **An assessment of the roles of key public and private sector participants** involved in the development and deployment of the service are described in the user service plans.

- However, **the user service development plans do not define development or deployment policies.** The decision to undertake the necessary activities to develop a user service rests with the individual public or private sector entities involved. Similarly, deployment priorities and decisions rest with the responsible deploying entity, private or public sector provider, and the consumer.

- **The user service development plans are intended to be illustrative** without defining or implying a specific system architecture. The operational concepts and technologies described in the User Service Development Plans present a vision of how the services might be deployed, rather than dictating a deployment scenario. Thus, the activities within the development plans do not dictate the use of specific technologies, but simply present the possibilities as they are known currently.

- Similarly, the **user service development plans do not dictate specific future activities,** but are planning tools to guide and coordinate future activities.

- **The user service development plans are dynamic.** They will evolve as technology and experience change both public and private sector perceptions of the possibilities.

- **Unique safety, human factors, and institutional issues** are covered in each user service development plan. Cross-cutting issues are covered in other sections of the NPP.

- **User acceptance of ITS user services** will be the key to their success. Outreach, education and training, in both technical and public relations areas, must be addressed throughout all stages of user service development and planning.

- **General information and cost and benefit estimates** are contained in the user service development plans. Benefits and costs are rarely quantifiable for most services at their current stage of development. However, the relationships between costs and benefits are logically supportable.

5.0 CONCLUSION

Twenty-nine user services have been defined to meet the goals and objectives of the ITS program. These user services are grouped into seven bundles according to technological or institutional commonalities. User Services Development Plans have been generated for each of the user services. The User Service Development Plans address the activities needed to reach deployment of systems that provide these user services and to achieve the goals envisioned for the national ITS program by Congress, the general public, and the public and private sector participants.

CHAPTER IV - NATIONAL COMPATIBILITY

1.0 INTRODUCTION

Since the enactment of ISTEA, there has been a widely recognized need for ensuring that ITS develops in the United States in a manner that will ensure system interoperability nationwide. ISTEA states that the United Sates Department of Transportation (U.S. DOT) shall promote national compatibility, and ITS America conveyed formal advice to the US. DOT to undertake the development of a national ITS architecture which would identify the need for potential standards. The national ITS architecture and the development of standards will provide a framework from which an ITS program can be developed. This chapter describes these formal, on-going activities. In addition, this chapter addresses the current activities and issues in the telecommunications area. Telecommunications systems form the backbone for ITS since it relies heavily on the movement of information. Collectively, the outcomes of the architecture, standards, and telecommunications activities will contribute to the unification of technologically capable ITS into a coherent, interoperable national system.

2.0 NATIONAL ITS ARCHITECTURE

Development and deployment of an ITS, which is compatible on a national scale, requires a supporting framework to describe the governing plan and define the relationships among the system components. This framework is a system architecture. The goal of the ITS architecture is the definition of an integrated system whose component subsystems operate synergistically to provide compatible products, interoperability, and a full range of user services nationwide. Since the architecture will identify and describe component interactions, standards and protocols that do not exist for these interfaces can be identified and developed. ITS will be in a continuous state of evolution requiring the architecture to accommodate the replacement and expansion of components without the disruption of previously implemented systems. An open architecture fosters interoperable products that can compete on their merits in price and performance. ITS customers, be they private sector entities, government agencies, or individuals, will be able to choose from a variety of vendors.

The framework for providing ITS program direction will be a system architecture that depicts the master plan, defines the relationship among system components, allocates functions to subsystems, identifies the types of products and infrastructure needed to satisfy system requirements, and reflects stakeholder consensus.

2.1 Program Process

The national ITS architecture is being developed with a broadly based consensus and with full consideration of the public interest. Because the architecture must be capable of supporting effective, nationwide exploitation of technologies in areas such as surveillance, communications, data management, and control software, the development process employs the diverse talents and resources of varied, interested constituencies. Multiple consortia or contract teams were selected to participate in a two-phased architecture development program. The Federal Highway Administration (FHWA) within the U.S. DOT is overseeing and guiding the National ITS Architecture Development Program. In Phase I, the contract teams were led by Hughes Aircraft, Loral, Rockwell International and Westinghouse Electric. Each team developed competing candidate architectures. The teams with the most promising architectures were selected to continue during Phase II. Phase II will be conducted in an open, non-competitive environment where all participants will contribute to the development of a single, consensus architecture. The major objective of this two phase process is to define, evaluate and establish an open, national ITS architecture. As the architecture development program evolves, one of the crucial outcomes will be the ITS community's ability to work together in pursuit of common goals, thereby creating a mechanism for long-term cooperative undertakings. ITS America is working with the non-Federal government bodies, academia, special interest groups, the private sector, and private citizens to provide them the opportunity to participate and influence the architecture.

2.1.1 Phase I

The Phase I procurement began in September 1993 and continued through January 1995. The FHWA solicited proposals from multiple teams to conduct parallel efforts to define and evaluate an initial open, national ITS architecture. The four selected consortia teams worked independently during Phase I. The candidate architectures included system and subsystem descriptions, information flows and subsystem interface specifications. They also accommodated the requirements derived from the ITS User Services.

The basis for the ITS architectural development process was the formal, iterative systems engineering review process. The organizational interaction among the program participants involved was centered on the contract team products and the product reviews. The Phase I documents, listed below, were produced by each of the four teams and made available in October 1994.

- Mission Definition
- Vision Statement
- Traceability Matrix
- Logical Architecture
- Physical Architecture
- Analysis of Data Loading Requirements
- Initial Performance and Benefits Summary
- Architecture Evaluation Plan
- Feasibility Study (including Risk Analysis)
- Initial Cost Analysis
- Evolutionary Deployment Strategy
- Preliminary Evaluation Results Summary

2.1.1.1 Down-select

The down-select process, included as part of Phase I, began in October 1994 and concluded in January 1995. The objective of the down-select process was to identify the contract teams with the most promising candidate architectures. The selected teams will participate in a non-competitive manner in the development of the single ITS architecture in Phase II. Each team's candidate architecture was evaluated against criteria designed to measure its potential for advancing national ITS goals and objectives. The response of the ITS stakeholders during the consensus process was also taken into consideration in the down-select decision.

The down-select factors included Phase I architecture evaluations of the institutional and technological areas listed below and Phase II technical proposal evaluations.

- Technical and performance considerations
- Operational safety, reliability, maintainability and availability
- Programmatic risk associated with deployment, implementation and market acceptability
- User acceptance
- Cost considerations
- Demonstrated benefit
- Institutional and economic issues

The consortia teams led by Loral and Rockwell International were down-selected in January 1995 to continue the architecture development in Phase II.

2.1.2 Phase II

Phase II began in February 1995 and is scheduled for completion by mid-1996. This phase will be performed in stages. The first stage will be approximately six months in duration and will consist of the detailed refinement of the down-selected architectures by the selected contract teams. The selected contract teams will perform detailed analyses and system modeling to evaluate the Phase I architectures. The major activities during Phase II will include:

- Continued definition and refinement of candidate architectures;
- Development of evolutionary deployment strategies, to include identification and analyses of potential obstacles impeding deployment of ITS and services;
- In-depth analytical efforts and modeling required for complete and effective evaluation of the competing architectures, which accommodate urban, rural, and inter-urban scenarios in five-, ten-, and twenty-year timeframes; and
- The development of system performance projections and life cycle cost estimates

Phase II will be accomplished in a non-competitive environment and the teams will establish working groups for the second stage of Phase II activities. The second stage of Phase II involves synthesizing the different architectures into a single architecture. This stage is expected to be six to nine months in duration. The teams will work together to incorporate the best attributes of their approaches into a single architecture. After the final architecture has been completed, the supporting documentation will be developed during the remainder of Phase II.

2.1.3 The Need for Consensus

One of the predominant challenges associated with developing a national ITS is the diversity of participants who must be involved in shaping the program. While challenging, this diversity holds the key to ultimate success through broadly-based support from all parties in the public-private partnership. The critical element in gaining broad support is early and continuing involvement by all stakeholders.

The objectives of the consensus building program are to:

- Ensure consideration of stakeholder perspectives, and
- Ensure the broadest possible acceptance of the selected architecture.

The need for a consensus-based architecture is highlighted by the diverse contributors to the development, production, marketing, and adoption of ITS. Consumers will require confidence in the interoperability and long-term utility of ITS products. State and local governments investing in infrastructure, as well as private sector providers undertaking privatization of some traditionally government roles, will rely on the architecture to avoid product and system incompatibilities. The development of a broadly accepted architecture will identify interfaces requiring standardization to support national marketing strategies.

U.S. DOT and ITS America began the consensus-building process early in 1993 when it formed the ITS Architecture Consensus Task Force. The task force is comprised of approximately 40 ITS stakeholders, primarily from associations, societies, and interest groups. This Task Force disseminated information about the architecture program and supported the Consensus Building Team's efforts to address the interests of a broad range of stakeholders. Other elements of the consensus-building process include public forums throughout the country, committee activities, and focus groups to provide feedback on the architectures.

2.1.4 The End Product

The culmination of the Phase II architecture development process is the development of a nationwide, ITS architecture that facilitates the application of technologies to the reduction of surface transportation problems. The architecture will provide a framework for the development of ITS and will enhance the compatibility of system deployments. During its development, the architecture will be influenced by currently deployed ITS, on-going trends in the research and development communities, and operational tests that provide real-world results from the field. When completed, the architecture will also facilitate the identification of areas that can benefit from future research. These research areas could be pursued through either operational tests or research and development programs.

The architecture will accommodate the private sector's, state and local transportation agencies', and private citizens' needs, such as supporting congestion relief, improved public safety, environmental improvements, more effective intermodal transportation and the provision of a cost effective mix of services.

Selecting a national architecture provides leverage for deploying ITS services and products. The architecture will identify guidelines and interface and interoperability standards that should be developed and adopted. The resulting, comprehensive set of standards will catalyze deployment, especially by private sector providers. The private sector will undertake production and marketing initiatives in response to the risk reduction fostered by compatibility and increasing public acceptance of ITS. The assurance of nationally compatible deployment opportunities provides incentive for industry investment and confidence in future ITS expansion.

3.0 STANDARDS

Standards are a strategic element of accelerating ITS development and deployment. They facilitate national and global compatibility, interoperability, and can positively influence product design, manufacturability, operation, maintainability, performance, quality, safety, and cost. Principal standards-setting organizations are assessing the types of standards needed for ITS, and some standards development is in process. The national ITS architecture will provide a framework for identifying additional standards. Organizations are also formulating a process for coordinating ITS standards development. This section describes the organizational roles and relationships, current standards activities, and standards-setting processes.

3.1 Standards-Setting Organization Roles, Relationships, and Activities

3.1.1 Transportation Agencies

The U.S. DOT and its administrations, particularly the FHWA, the Federal Transit Administration (FTA), and the National Highway Traffic Safety Administration (NHTSA), have key roles in ITS standards development. These agencies can use operational test results, on-going deployment experience, and public safety issues to contribute to the standards-setting process. The Federal government role in the standards process is dependent on the particular type of standard. The government has a direct and primary role in adopting regulatory standards that assure and promote safety and the public welfare. In the development of industry consensus standards, government representatives can (and should) participate in efforts in which it has a technical or strategic interest, on the same basis as other interested members of the ITS community.

3.1.2 Utilized Federal Advisory Committee

ITS America, a utilized Federal Advisory Committee for the U.S. DOT, helps to guide ITS standards development. The ITS America Standards and Protocols Committee, whose membership represents government authorities, private sector stakeholders, and academic organizations, is chartered to "serve as an oversight and coordinating committee for all standards activities in the U.S. relating to ITS." The Committee identifies the needs and requirements for ITS standards, including intermodal or cross-modal standards. Once standards requirements are identified, the Committee works with standards developing organizations (SDO) to assure the coordinated development of needed standards. Although it is a member of the American National Standards Institute (ANSI), the Committee does not create standards; the Committee looks to traditional SDOs for standards development and would create standards only when no SD0 is available to do so. In general, the Standards and Protocols Committee identifies the need for a standard, promotes effective communication among standards-interested parties, and coordinates efforts to maximize efficiency. The Committee is in the process of developing an ITS standards database which will identify existing ITS-related standards, standards in development, future standards required, current research and test results that could impact standards, and future research and tests needed for standards. The standards database will reside in the ITS America International ITS Information Clearinghouse. The ITS America Standards and Protocols Committee will review, comment on, and monitor the ITS national architecture development for impacts on standards requirements. The Committee will also issue a formal Standards Development Plan which will identify standards priorities and provide a standards development timeframe.

3.1.3 National Laboratories

Two National Laboratories are performing management and research tasks which facilitate standards development: Jet Propulsion Laboratory (JPL) and Oak Ridge National Laboratory (ORNL). JPL is the U.S. DOT's ITS Architecture Manager and acts as a liaison between the architecture development teams and the SDOs. JPL led a task force that identified what existing and proposed standards can be used and what standards need to be developed. JPL is worked with ITS America on this activity. The results of their analysis are documented in a comprehensive catalog of ITS standards and protocols. The catalog contains an organized listing of ITS technology standards and interface protocols with current status and probable time frame for completion. It will evolve over time and will be available to the ITS community for comment and further contribution. JPL published a standards and protocols catalog in September 1994. The catalog is available to the ITS community for comment and further contribution. The catalog will evolve over time as updates are provided. The catalog will be used as the basis for the database described in Paragraph 3.1.2. ORNL is developing a standard Location Reference System (LRS) which will facilitate the dissemination of real-time traffic data and other spatially-related attributes between dissimilar map databases. The LRS will provide a mechanism to compensate for inherent differences in spatial accuracy, completeness, and currency. The LRS is being developed through a consensus process involving public and private industries and academia. ORNL is scheduled to produce a draft standard LRS during March of 1995 and will provide final LRS recommendations in September of 1995.

3.1.4 Standards Developing Organizations

SDOs have the role of authoring standards through a consensus process among industry experts, user community representatives, and general interest groups. SDOs are actively pursuing ITS standards development. A table of some of the U.S. SDOs, their particular topics of concentration within ITS, and their current standards activities is provided in Table 4-l. In addition to the SDOs in Table 4-1, the Radio Broadcast Data System Subcommittee of the National Radio Systems Committee (NRSC), sponsored by the Electronics Industry Association (EIA), has prepared a draft U.S. standard for FM subcarrier broadcast traffic information. Also, the National Electrical Manufacturers Association (NEMA) has developed a draft National Traffic Control/ITS Communications Protocol (NTCIP) during 1994 to standardize the interface among traffic sensors, traffic controls, and traffic management systems. The ANSI Tl Committee is developing wireline and wireless telecommunications standards that could be used for ITS applications.

The International Standards Organization Technical Committee 204 (ISO/TC 204), titled Transport Information and Control Systems (TICS), is developing international ITS standards. ISO/TC 204 is organized into the following working groups:

- Architecture
- Quality and Reliability Requirements
- TICS Database Technology
- Fee and Toll Collection
- General Fleet Management
- Commercial/Freight Fleet Management
- Public Transport/Emergency Fleet Management
- Integrated Transport Information, Management, and Control
- Traveller Information Systems
- Route Guidance and Navigation Systems
- Parking Management/Off-Road Commercial
- Human Factors and Man Machine Interface
- Vehicle/Roadway Warning and Control Systems
- Dedicated Short Range Communications for TICS Applications
- Wide Area Communications/Protocols and Interfaces

Table 4-1 Standards Developing Organizations

SD0	ITS Standards Topics Addressed	Standards Activities
ASTM (American Society for Testing and Materials)	Vehicle-to-roadside communications, traffic characteristics, traffic and application device interconnection protocols, smart materials and systems	. Specification for Highway Weigh-in-Motion Systems with User Requirements and Test Method . Practice for Highway Traffic Monitoring . Practice for Classifying Highway Vehicles from Known Axle Count and Spacing . Practice for Rubber Tubing for Traffic Counters/ Classifiers . Practice for Dedicated, Short Range, Two-way Vehicle-to-Roadside Communications Equipment . Specification for Data Formats from Traffic Data Collection Equipment . Guide Network Level Pavement Management
EIA (Electronic Industries Association)	R-3, audio systems and R-4, video systems	. Radio Broadcast Data System . High Speed FM Subcarrier . Digital Audio Radio . National Data Broadcasting Committee
IEEE (Institute for Electrical and Electronics Engineers)	Communications, electrical and software safety, and other topics within the field of electrotechnology	. Vehicle Radar . Lightning Protection for ITS Applications . Personal Communication Systems Applications within ITS Also developing: . Dictionary and glossary of ITS terms . Standard protocols and message sets for vehicle-to-roadside communications . Guidelines for the systems design applications, procurement, construction, installation, maintenance, and operation of ITS communications systems
ION (Institute of Navigation)	Navigation systems	. Recommended Practice for Benchmarking the Positioning Performance of a Navigation System
ITE (Institute of Transportation Engineers)	Equipment and Material Standards	. Controller Cabinets . Standard Vehicle Detectors . Model Performance Specifications for Paint, Powder, and Plastic Pavement Markings . Specifications for retroactive White, Yellow, and Black Thermoplastic Marking Materials

Table 4-1 Standards Developing Organizations

SD0	ITS Standards Topics Assressed	Standards Activities
NEMA (National Electrical Manufacturers Association)	Communication protocols	. National Tele-Communications IVHS Protocol . Software protocols for in-vehicle communication . Traffic control for ITS
TIA (Telecom-munications Industry Association)	Mobile communications systems	. Digital Two-way Mobile Communication Systems . Cellular and Personal Communications Equipment and Services
SAE (Society of Automotive Engineers)	Vehicle components and/or systems interacting with a vehicle	Recommended Practices: . Interface Between an On-Board Computer and a Communications Device . Navigation Message Set . On-Board Land Vehicle Positioning Device . In-Vehicle Sensor Interface for ITS Applications . Traveler Information Service Message List . Location Referencing System Data Dictionary Standard: . Map Database Truth-In-Labeling

Many of the ISO/TC 204 working groups are coordinated with the European Committee for Standardization (CEN/TC 278.) The Secretariat for ISO/TC 204 is held by the U.S. through the Society of Automotive Engineers. ITS America is the U.S. Technical Advisory Group (TAG) Administrator for ISO/TC 204. U.S. involvement at these levels demonstrates a significant national interest in ITS and increases the market potential for U.S. products and services.

3.2 Standards-Setting Process

An overall process for determining the ITS standards requirements and coordinating the standards development process is being formulated by the ITS America Standards and Protocols Committee. This process will promote the timely identification and development of needed standards and help to eliminate redundant standards activities. The processes by which individual standards are written, reviewed, approved, and published are generally well-defined by each of the SDOs, typically in accordance with the guidelines established by ANSI. Standards are set through a collaborative effort between industry experts, user community representatives, and general interest groups.

4.0 TELECOMMUNICATIONS SYSTEMS

Telecommunications systems are a combination of facilities, stations, and electronic circuits that transfer information through wireline (copper, coaxial, and fiber optics), and wireless (radio frequency and infrared) communications media. Telecommunications systems at the local, regional, state and national level will provide a means for infrastructure-vehicle, infrastructure-traveler, and vehicle-vehicle ITS information exchange as required by the user services. For example, real-time traffic information may be exchanged between mobile users (i.e., vehicles and Personal Communication Systems (PCS) users) and the infrastructure to assist in route guidance. Safety, credential, size, weight, and cargo data can be communicated from a commercial vehicle to the infrastructure for electronic compliance checks and weigh-in-motion (WIM). Examples of other ITS information that can be transferred via telecommunications systems are: automatic vehicle identification and location, traffic control information, traffic surveillance data, information for display on variable message signs interagency coordination messages, database processing messages, intermodal data for rail and transit, and traffic predictions. As discussed in Chapter V User Services Integration, telecommunications is a critical component in implementing almost all of the ITS user services.

Many SDOs, industry associations, and Spectrum Management Organizations (SMO) are estimating the telecommunications requirements necessary to develop and implement ITS. Current efforts include telecommunications standards development (described in Section 3 of this chapter), telecommunications technologies assessment, and radio frequency (RF) spectrum requirements analysis and allocation. Efforts must be coordinated aong the various transportation modes including transit, rail, and commercial vehicles, recognizing the interest that each has in the frequency spectrum and allocation areas. This section addresses several aspects of ITS telecommunications systems, including technology alternatives, technology selection criteria, deployment options, organizational roles and responsibilities, and current activities.

4.1 ITS Telecommunications Alternatives

The following paragraphs describe a variety of telecommunications techniques, as well as some of the particular factors that need to be considered for ITS applications. Each technique has its own advantages and disadvantages, depending on the specific application.

4.1.1 Telecommunications Techniques

- **Wireless broadcast** is a term that describes a family of communications techniques for transmitting information one-way over large areas, without a physical connection such as a cable or wire. A specific wireless broadcast technique called FM subcarrier broadcast exploits the technical features of a radio broadcast for widely disseminating information.

Other specific wireless broadcast examples are Highway Advisory Radio (HAR) and Digital Audio Broadcast (DAB). The wireless broadcast method of communications might provide a low-cost means for uniformly distributing limited traffic data to many mobile users in a metropolitan area.

- **Cellular technology** is used as another wireless communications method. Cell-based communications divide a given geographic area into cells, each of which employs a base station and transmitter. The cell size is directly proportional to the transmitter's power. The base stations are relatively low-power transmitters covering a short distance which allows the same frequency to be "reused" in a nearby area. To increase capacity, the system operator can split cells into microcells by adding lower-power transmitters with smaller zones. The net result is a flexible, growth-oriented use of capacity. Cell-based communications include paging and telephone applications. Cell-based paging techniques transmit information (messages) one-way. Cellular telephones offer a two-way information exchange.

- **Beacons** are specialized short-range, two-way communications devices. Communications between vehicles and infrastructure occur in the vicinity of a beacon, adding position or location-specific content. Infrared, millimeter wave, and microwave technologies can all support localized beacon communications.

- **Land-line communications** is a term that describes a family of communications techniques for passing information through a physical connection such as a cable or wire. Examples include common wire telephone lines and fiber optic cables. Relative to traditional wire-lines (i.e., coaxial and twisted pair), optical fiber offers higher capacity, increased speed, longer link distance, less susceptibility to severe weather, no electromagnetic susceptibility, and increased system reliability. Optical fiber is also lightweight and smaller than traditional wire-lines. However, fiber optic cable can be more expensive to implement and maintain than coaxial and twisted pair cable.

4.1.2 Fixed and Mobile Elements

ITS telecommunications involves information exchange among and between fixed and mobile elements. Mobile elements include vehicles and individuals with PCS, cellular telephones, and pagers. Fixed, or stationary, elements include transportation management centers, roadside equipment (infrastructure), and users with traditional fixed telecommunications systems in the home or office. A variety of telecommunications options exist for mobile and stationary elements, and each option has its own cost and performance trade-offs. These telecommunications options are described in the following paragraphs.

Fixed elements, such as traffic signals and traffic management centers, can communicate over land-lines and via radio or satellite. Cable television and telephone companies have deployed and are continuing to deploy millions of miles of land-lines. A variety of technologies are available for fixed telecommunications including: Synchronous Optical Networks (SONET), Asynchronous Transfer Mode (ATM), Switched Multimegabit Data Services (SMDS), Very Small Aperture Terminals (VSAT), Frame Relay, Integrated Services Digital Network (ISDN), and Tl lines (data rate of 1.544 Megabits per second, Mbps), T3 (44.736 Mbps) lines and lower speed digital and analog services.

Mobile elements, such as vehicles and cellular telephones, can communicate over wireless methods. A variety of technologies either exist or are planned for mobile communications. Possible technologies for one-way mobile communications include Highway Advisory Radio (HAR), FM subcarrier, microwave, and infrared. Two-way mobile technologies include cellular, two-way radio, microwave, infrared, and two-way satellite.

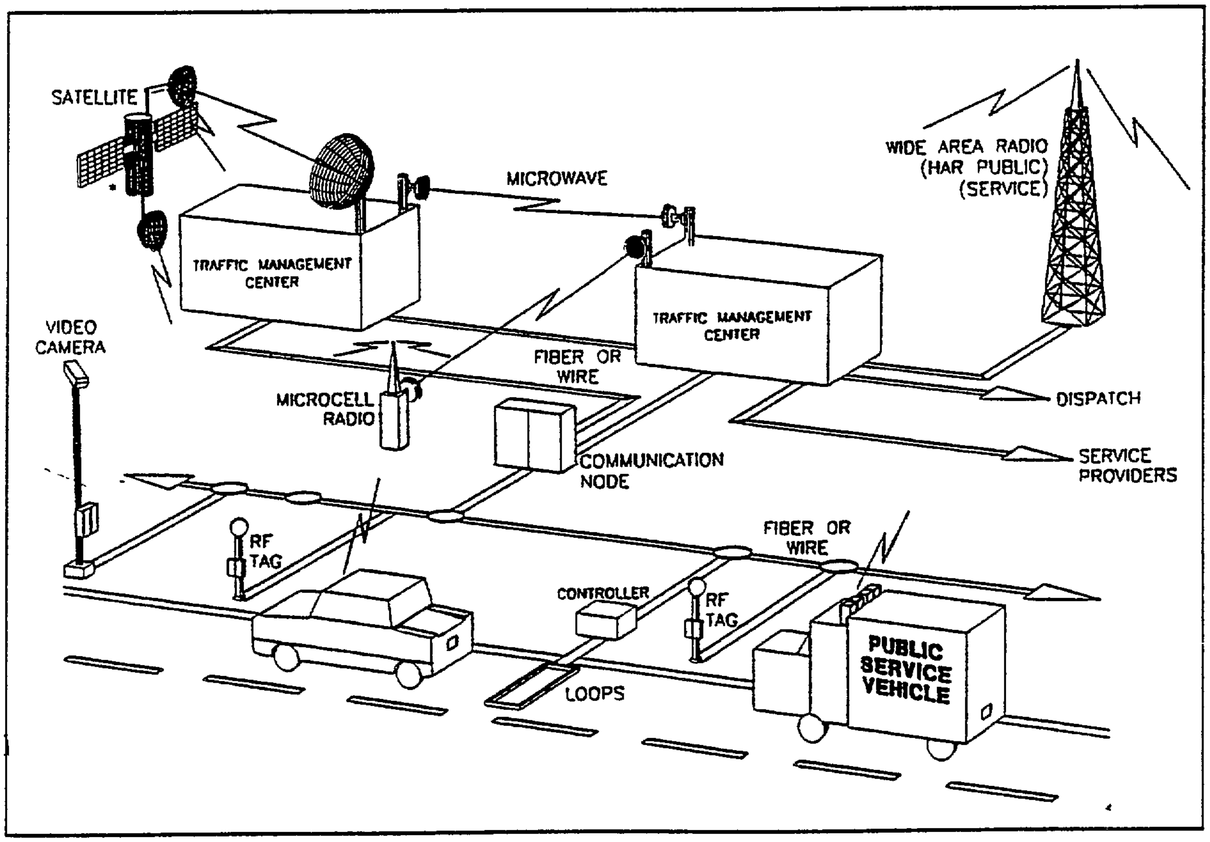
Determining the location of mobile elements is one ITS telecommunications requirement that is common **to** many user services such as route guidance, commercial vehicle operations, and emergency management services. Location of individual vehicles can be provided by roadside equipment such as in-pavement sensors, cameras, and radars. Also, the vehicles themselves can act as probes by providing useful information on position, speed, and road conditions from in-vehicle sensors. Satellites or more traditional (terrestrial) navigation techniques can also be used for determining vehicle position. The Global Positioning System (GPS) is a constellation of U.S. satellites that provide three dimensional position location around the world.

4.1.3 One-Way and Two-Way Communications

Some ITS applications can be implemented as one-way transmissions, and some require two-way interaction between ITS participants. Traffic reports, for example, could be broadcast as a one-way transmission to the vehicle. Vehicle probe reports, however, could use two-way communications between the vehicle and the infrastructure. Cell-based communications include wide area one-way and two-way links. Wireless broadcast schemes uniformly broadcast information (one-way) to anybody listening.

4.1.4 Short Range and Wide Area Communications

ITS applications require that telecommunications systems operate over short ranges as well as over wide areas. Short range ITS applications include Electronic Payment Services, In-Vehicle Signing, and Vehicle Location. Wide area ITS applications include telecommunications between traffic management centers, emergency response centers, and law enforcement agencies. Both wireless broadcasts and cell-based communications can provide information over long ranges. Localized beacons exchange information over short ranges (on the order of meters). The short-range feature of this technique results in information exchanges selectively among users, versus broadcast communications. The boundary between what is "short" range versus "wide area" will evolve over time. RF spectrum requirements will vary, depending on the range required for the application. Examples of various telecommunications systems are provided in Figure 4-2.



Source: Kimley-Horn and Associates, Inc.

Figure 4-2 Examples of ITS Telecommunications Systems

4.2 ITS Telecommunications Technology Selection Criteria

Procuring organizations need to consider several key system attributes when choosing a particular telecommunications technology. ITS telecommunications systems must be cost-efficient, reliable, maintainable, secure, and resistant to obsolescence, as well as interoperable, expandable, and compatible. High reliability is an essential system attribute to prevent losses of critical traffic information, ensure the integrity of electronically-collected toll revenues, prevent serious traffic congestion, and ensure operation of emergency notification functions. To improve reliability, the systems should have continual monitoring, automatic outage detection, and automatic rerouting capabilities. ITS telecommunications systems must be easy to maintain with minimum personnel at a minimum cost. Secure systems are needed to protect the information and to prevent eavesdropping, misuse, service theft, and malicious and inadvertent intrusion. Resistance to obsolescence is necessary because ITS applications will be deployed over several phases. Ideally, near-term hardware, software, and other network components would be compatible with equipment installed during later stages of deployment. ITS telecommunications systems must permit both geographic and vendor interoperability, as well as support for intermodal considerations. They need to operate over a variety of environments nation-wide, ranging from urban population centers to rural areas. The systems must be expandable so that additional capacity and additional user services can be accommodated. ITS telecommunications systems must support both fixed and mobile applications at both short and long ranges.

Performance, institutional, and financial issues need to be understood for each specific ITS application when selecting an appropriate telecommunications technology. Key performance parameters include capacity, processing power, reliability, maintainability, operability, range, and speed. Institutional issues include privacy and the openness of architectures and standards. Such issues can affect multi-vendor product availability, compatibility, interoperability, and the ability to accommodate growth and technological advances. Financial evaluations must consider the cost of additional communications infrastructure (if needed) and operations and maintenance costs over the lifetime of the system. The use of existing communications infrastructure can minimize deployment costs. Using vehicles as probes, rather than using extensive roadside equipment, can reduce infrastructure operations and maintenance costs.

The required capacity of the telecommunications system is affected by whether the architecture is centralized or distributed. Centralized architectures allocate the processing within a few components, and distributed (or de-centralized) architectures allocate the processing over many elements. For example, route guidance calculations in a centralized architecture might be performed at a transportation management center and communicated to the vehicles, whereas route guidance calculations in a distributed architecture might be performed on-board individual vehicles. Estimates of message size, transaction volume, and user volume can be used to define capacity requirements. Similarly, data loading analyses need to be performed for each architecture option to determine capacity, configuration, and bandwidth requirements.

Another factor in selecting telecommunications technology is whether the deployment region is rural or urban. In rural environments, where the density of users is low and cellular and PCS providers are not yet widely available, infrastructure costs may preclude a terrestrial cellular architecture and favor satellite communications. Mobile satellite services which will be implemented over the next several years will be able to provide telecommunications for rural applications. However, in areas with high-rise buildings or overpasses, satellite communications performance degrades due to blockage. In urban areas, cellular telecommunications is generally preferable.

One of the institutional issues which needs to be addressed is the impact the deployment of ITS technologies can have on individual privacy. For example, one-way communications do not utilize individual user identification, however it prevents the user from making individualized requests for information. However, technologies which permit identification of specific vehicles could provide law enforcement officials with information such as speed and location. Freight operators may want secure communications to prevent their competition from accessing business-sensitive information such as when, where, and how freight is hauled.

Standards for telecommunications systems are extremely important. Standardizing the mobile user-to-infrastructure interface increases interoperability over geographic regions. Such standardization can be especially important for mayday communications to and from public safety services. Standardized communications protocols can facilitate compatible ITS deployment. Product performance standardization ensures equipment compatibility and fosters competition which lowers prices. Standardized electronic tags for toll collection, for example, ensures interoperability for a single tag over many states.

Another factor to consider is whether the standard for the telecommunications technology is “open” or not. The “openness” of a standard refers to whether it is a public standard, an open standard available for licensing, or a vendor proprietary standard. Public standards are available at no cost to all users, open standards are made available at some small cost to all users, and vendor proprietary standards are available only to either the developing organization or to a restricted set of licensees.

The selected architecture and telecommunications technologies determine what equipment consumers need to purchase to access ITS information. For example, consumers may need cellular telephones, FM radios, or specialized equipment. If, as in a distributed architecture, route selection is performed within individual vehicles, the consumer would need an in-vehicle map data base and perhaps equipment to receive expected travel times from the infrastructure. If, as in a centralized architecture, the infrastructure is highly sophisticated, the in-vehicle equipment costs are reduced.

4.3 Organizational Roles and Responsibilities

4.3.1 Domestic Spectrum Management Organizations

The RF spectrum to be used by ITS telecommunications systems is managed by public sector domestic and international SMOs. The Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) are the organizations which manage RF spectrum in the U.S. The FCC and the NTIA perform RF spectrum allocation, allotment, and assignment. The FCC, a government agency that is subject to oversight from the U.S. Congress, manages all civil RF spectrum, including state and local government uses. The NTIA manages portions of the RF spectrum used by the Federal government, including the Defense Department. The NTIA organization consists of representatives from Executive Branch departments and agencies within them that are major RF spectrum users (i.e., the Department of Transportation, the Federal Aviation Administration, all three military departments, and the National Aeronautics and Space Administration). Shared frequency bands are also managed by the FCC and NTIA through the Interdepartment Radio Advisory Committee (IRAC).

4.3.2 International Spectrum Management Organizations

Frequency coordination across national borders is extremely important due to the potential for RF interference problems. For frequency coordination across the national borders, the U.S. has bilateral agreements with the Canadian and Mexican government agencies responsible for RF spectrum, Industry Canada and the Secretaria de Communicaciones y Transportes de los Estados Unidos Mexicanos, respectively. The International Telecommunications Union (ITU) coordinates frequency assignments internationally. Initially, either the FCC or the NTIA (as appropriate) reviews U.S. proposals to change International Allocations. If the proposal is acceptable, it is forwarded to the State Department for nomination to appear on the agenda of the next World Radio Conference (WRC). The WRC will often forward the proposal to the Radio Working Group (ITU-R) for review and approval. The ITU “registers” HF Broadcast and Satellite frequencies because they need international coordination.

4.3.3 Utilized Federal Advisory Committee

ITS America, a utilized Federal Advisory Committee for the U.S. DOT, is proactively involved in ITS telecommunications matters and has formed a Telecommunications Committee. The Committee, whose membership consists of representatives from government agencies, private sector stakeholders and academic organizations, develops positions and recommendations pertaining to ITS telecommunications matters. The Committee monitors technology advancements in wireline and wireless telecommunications and addresses issues associated with optimizing telecommunications integration, including ITS telecommunications system integration with other public and private systems. The Committee is examining how ITS requirements could be coordinated with the National Information Infrastructure (NII). The ITS America Telecommunications Committee works proactively with the FCC and the NTIA on ITS RF spectrum matters such as spectrum management and electromagnetic compatibility. The Committee addresses actions by the FCC and the NTIA which impact ITS. The Committee is proactive in estimating telecommunications requirements, assessing RF spectrum needs, and planning for RF spectrum acquisition. As a result, the Committee formulates and recommends positions to the ITS America Coordinating Council and facilitates information transfer among stakeholders.

The ITS America Telecommunications Committee is establishing liaisons with U.S. and international organizations that can affect ITS telecommunications. Domestic organizations include the Transportation Research Board, the American Automobile Manufacturers Association, IEEE, SAE, the Association of Public-Safety Communications Officials (APCO), and the American Association of State Highway and Transportation Officials (AASHTO). The Committee is establishing liaisons with corresponding activities in Canada and Mexico to foster ITS communications commonality throughout North America. The Committee is also establishing liaisons with European and Japanese counterparts and with organizations within the ITU to maintain an awareness of international telecommunications developments.

Currently, the ITS America Telecommunications Committee is assessing RF spectrum resource requirements for ITS. Frequency and bandwidth requirements are mapped in a matrix with corresponding user services, ITS applications, communications functions, and supporting technologies. The Committee is working in conjunction with the National ITS Architecture Development Program to focus the contracted teams on spectrum issues, develop RF spectrum requirements, and plan additional actions for Phase II of the architecture program. The RF spectrum requirements for the Automated Highway System (AHS) and other ITS applications will be added to the matrix when they are identified. The Committee is also developing a course of action to obtain the spectrum needed for ITS. The spectrum requirements matrix is provided in Appendix D.

4.3.4 Public-Private Partnerships

Public-private partnerships can have significant benefits in ITS telecommunications systems. The government can be the catalyst and the facilitator to further encourage private sector involvement in ITS. The capabilities of the private telecommunications infrastructure can be integrated into the ITS telecommunications functions which could foster vendor competition, potentially improve performance, and lower overall costs. One option is a joint public-private partnership sharing of the telecommunications system development. If additional infrastructure were required, a private sector firm could install telecommunications cable and, in exchange for the use of right-of-way, provide the government agency with either reduced cost access to the system or a set number of fiber optic links for the agency’s exclusive use. Public-private partnership decisions and the role of private sector incentives need to be made with full knowledge of the impact on ITS communications systems. The availability of right-of-way should be done through a formal solicitation process so that all private sector providers are given equal opportunity to participate.

4.4 ITS Telecommunications and the National Information Infrastructure

ITS and National Information Infrastructure (NII) planners can take advantage of their common telecommunications requirements. The ITS America Committees on Telecommunications and Standards and Protocols are coordinating ITS requirements with the NII. The NII, often referred to as the "Information Superhighway," is currently undefined, but it is envisioned as a vast web of communications networks supporting wide and easy access to information exchange and related applications. The NII architecture is being designed to meet societal needs, support market-driven applications, provide maximum interoperability and interconnectivity, permit universal access, and provide user-friendly interfaces. The NII will provide many of the telecommunications functions necessary to support ITS. ITS applications and the NII both require telecommunications links to deliver information to fixed and mobile users. Integrating ITS plans and requirements with NII development will benefit ITS by increasing the compatibility and reducing the redundancy of telecommunications systems. ITS and NII planners should take advantage of the commonality by coordinating their requirements such as the location of trunk lines in relation to highways and the combined bandwidth needs. A thorough examination and usage of the NII infrastructure in a community will reduce costly duplication and unused capacity of existing NII assets. Dedicated ITS telecommunications systems may be needed in addition to the NII, because of certain ITS-specific applications, such as weigh-in-motion (WIM), electronic toll collection (ETC), and collision avoidance. The commonality between ITS and NII will be clarified in a U.S. DOT-sponsored study titled ITS Communications Alternatives Test and Evaluation. The U.S. DOT, with support from ITS America and in conjunction with other U.S. government agencies, will play an influential role in determining NII requirements and, as a result, will take full advantage of the common requirements between ITS and the NII to ensure compatibility and eliminate redundancy.

4.5 Telecommunications System Deployment Options

When deploying telecommunications systems for ITS, the deploying public or private organization generally has three options: 1) build and operate a dedicated ITS facility; 2) purchase services and facilities from private sector telecommunications providers; or 3) enter into public/private partnerships with private sector telecommunication providers. Each deployment method has its own advantages and disadvantages. Dedicated systems can provide known capacity, control, and potential long-term cost benefits. However, the risks associated with such systems include high initial investment costs, potential for technology obsolescence, difficulties with interfaces over separate jurisdictions, potential incompatibility between geographic locations and between user services, and costs and complexities of operation and maintenance. A dedicated system might duplicate existing private sector infrastructure and therefore be an unnecessary expense of resources. It might also have excess capacity which could raise costs and may necessitate either adding other applications onto the system or selling the excess capacity. Selling excess capacity or offering additional services to subscribers of a government-owned dedicated communications system places the government in competition with the private sector providers of telecommunications systems and services. This is an issue of fair competition in the market place and what type of role the government should play.

Existing publicly-available, private sector telecommunications systems require less of an initial investment, are continually upgraded with new technologies, and can provide geographic compatibility, user service compatibility, and ease of operation and maintenance. However, the risks associated with using the existing private sector-owned systems include lack of infrastructure availability and capacity along some highways, and high costs due to regulatory policies and lack of competition at the local level.

A third approach is a public/private partnership. Many partnership arrangements are possible. An example is one in which the public sector makes its right-of-way available to the private sector through a formal solicitation process. In general, the public sector may require a specific capacity, such as a specific number of fiber optic strands, be reserved for their dedicated use. In return, the private sector participant would be able to lay land lines along the right-of-way and sell the remaining capacity to their customers. One benefit of this type of arrangement is that telecommunications facilities would be located near the roadway, making it accessible for transportation data collection. In addition, maintenance arrangements could be negotiated between the participants. The availability of right-of-way should be done through a formal solicitation process so that all private sector providers are given equal opportunity to participate.

The optimum deployment method will vary, depending on several factors such as the specific ITS applications, the deployment region, solutions to institutional barriers, and changes in regulatory policies.

To determine the optimum deployment method, each procuring organization needs to perform an accurate cost and capability assessment over the life of the telecommunications system, including both initial investment costs as well as on-going maintenance costs and scheduled upgrades. Analysis of the dedicated government-owned system must address the issues associated with excess capacity and duplication of private sector telecommunications systems. Analysis of the existing private sector-owned systems must address the leasing fees and capacity availability. Analysis of a public/private partnership must address capacity, operations and maintenance costs, and the availability of right-of-way. In all approaches, liability issues should also be analyzed.

4.6 RF Spectrum Acquisition Strategy and Status

The overall telecommunications strategy of the ITS program is to make use of existing communications services such as cellular, personal communications services, and mobile satellite, whenever possible and minimize the need for dedicated spectrum. Many ITS user services can share spectrum with other applications. However, certain ITS applications, such as emergency services, safety-related applications, and short range applications such as WIM, ETC, and collision avoidance, might require dedicated spectrum that must be “allocated” by the FCC. “Allocation” is the process of designating RF bands for specific classes of use such as Land Mobile, Broadcasting, Space, etc. Dedicated ITS RF spectrum can be acquired either through reallocation of existing spectrum or through new spectrum sharing arrangements. The FCC and the NTIA have documented procedures for RF spectrum allocation, allotment, and assignment. The ITS America Telecommunications Committee tracks the technical and administrative processes of reallocation and sharing arrangements so it can identify opportunities to obtain needed ITS spectrum early in the process. ITS America will use their RF spectrum requirements matrix, augmented by inputs from the architecture teams and ITS America member organizations, to guide the acquisition process.

The status of the ITS frequency acquisition process is as follows:

- NTIA has allotted frequencies in the 220 MHz band (ten full-duplex channel pairs) on an experimental basis to ITS. These frequencies are allocated nationwide and are being coordinated with Canada and Mexico to achieve Continental compatibility. Currently, these frequencies are assigned to field tests, but the process of releasing them for non-government operational use by ITS is in progress and will likely be complete in 1995.

- Discussions are progressing with NTIA to allocate the band from 5850 to 5925 MHz to ITS as the primary service. The ITS America Telecommunications Committee will work with the FCC so this band, when changed to a shared status, retains ITS as a primary service. Recent initiatives by the satellite services to use this band for a satellite uplink will probably mean that ITS will be co-primary with the Mobile Satellite Service.
- A comment was filed for the “Refarming” FCC Docket to allot some RF spectrum in the 150 and 450 MHz bands to ITS to support interoperation with Public Safety agencies.

Currently, short-range telecommunications systems are operating at frequencies from 902-928 MHz, however they might transition to 5850-5925 MHz when the cost of high frequency devices decreases.

Accurate estimates of ITS RF spectrum requirements for each of the user services and a proactive approach to RF spectrum acquisition are in process. Forums such as the Communications Alternatives Test and Evaluation Study, the National Architecture Program, and the ITS America Telecommunications Committee will provide analyses to determine the overall ITS RF spectrum requirements and therefore determine the need for dedicated ITS RF spectrum.

ITS services that utilize dedicated RF spectrum will be of value to state and local governments as well as emergency service providers. These categories of users are exempt from RF spectrum competitive bidding. The extent, if any, to which dedicated RF spectrum will be subject to licensing through competitive bidding, is a topic that needs to be addressed.

Dedicated RF spectrum for ITS applications will require administration and frequency coordination services. Decisions need to be made regarding which organization should perform the frequency management functions for the dedicated RF spectrum.

5.0 CONCLUSION

The national ITS architecture and activities that coordinate ITS standards development and ITS telecommunications systems will facilitate national compatibility. The national ITS architecture describes the governing plan and defines the relationships among system components. Standards help achieve national and global compatibility and can positively influence other product attributes such as performance, design, manufacturability, and cost. A coordinated standards development process promotes timely identification and development of needed standards and eliminates redundant standards activities. Telecommunications systems provide information exchange for virtually all of the ITS user services. Many types of telecommunications technologies are available, and they are continually evolving. Technology choices will have to be evaluated according to the specific application, such as fixed or mobile, one-way or two-way, and short range or wide area. The national ITS architecture and coordinated standards development and telecommunications systems are strategic elements that can foster a nationally compatible ITS.

CHAPTER V - USER SERVICES INTEGRATION

1.0 INTRODUCTION

An understanding of the potential interactions, dependencies, and commonalities of ITS user services contributes to the development of an efficient, integrated ITS. Many of the activities required to promote development of any given user service may be common to several or all user services. Ultimately, ITS will impact the surface transportation system as a set of integrated transportation services which will improve efficiency and foster intermodal transport. Planning ITS deployment presents a complex and unwieldy task if approached as 29 separate endeavors. As discussed in Chapter IV, National Compatibility, the U.S. DOT is guiding the effort to define a consensus-based, national ITS architecture, which, when adopted, will facilitate and foster the establishment of standards and pave the way for national compatibility. While the architecture and standards efforts are underway, many members of the transportation community are seeking an understanding of the program's interrelationships. The first portion of this chapter identifies the members of the transportation community and their areas of interest. Next, the chapter presents an analytically-based tool capable of supporting deployment planning for investment and deployment in the absence of a national ITS architecture. This tool is the focal point of this chapter. It illustrates how the user services could be integrated according to common functions resulting in cost savings, increased capabilities and compatibility. The chapter also includes an assessment of risk associated with early deployments. This conceptual approach does not presume to prejudge the national ITS architecture, rather it is offered as a planning tool to assist those who are confronted with today's challenges.

2.0 DEPLOYMENT PLANNING

Deployment planning is taking place all across the country as various organizations analyze their transportation needs and consider ITS as a solution. The absence of an ITS architecture and some standards creates a degree of uncertainty for those confronted with near-term investment and deployment decisions. Deployment planning involves a variety of participants, non-technical and technical issues, and financial and time considerations. This section describes the various aspects of deployment planning in preparation for a discussion of user services integration.

2.1 Participants and Partnerships

Deployment planning will be accomplished by many different organizations and will require non-traditional cooperation among the participants. Public and private sector organizations will pursue these planning efforts individually or in partnership.

<u>Public Sector Participation</u> Much of the transportation infrastructure base deployed at this time is the responsibility of the public sector, namely state or local organizations. The federal

government does not deploy transportation infrastructure. It provides funding to the state and local governments to plan, develop, and deploy the transportation systems that they need. Public sector participation will be in the form of state and local departments of transportation, emergency services, police, utilities, transit agencies, and tourism. These public sector organizations make deployment planning decisions in their communities. Public sector deployments should satisfy the needs of their communities. Traditionally, public sector deployments concern traffic control, emergency services, public transportation, and toll collection.

Private Sector Participation A significant number of the deployment opportunities will be pursued primarily by the private sector. Some examples of these opportunities are in-vehicle products, information services, and fleet management services. Private sector participation will be in the form of private industry, motor carriers, and transportation and information service providers. The private sector has, and will, invest in advanced technology development and adaptation to satisfy needs in all types of markets. These technologies represent opportunities to develop systems that provide consumers with needed or desired capabilities. In some cases, technologies that were developed for the defense industry are being adapted to the transportation environment. Global Positioning System (GPS) applications have been in development for vehicle location and route guidance since the mid-1980s. GPS receivers are becoming smaller and easier to package. This investment by the private sector to develop better GPS receivers is driven by the potential revenue from the sale of these products. Fleet management is another application in which the private sector is deploying systems that do not involve the public sector. Organizations that operate vehicle fleets recognize the benefits and efficiencies of ITS and are deploying them to gain a competitive advantage in their markets. The telecommunications industry is providing wireline and wireless communications services and facilities, including fiber optic facilities, to most of the country. These services and facilities will provide a communications infrastructure to facilitate the deployment and delivery of ITS applications and services.

Public-Private Partnershius The public and private sectors will work together on many ITS deployments. The relationship between these sectors will be defined differently in each instance, but it will involve a close working relationship between two or more parties. An example of a public-private partnership is the investment of the public sector in an infrastructure deployment that could have potential benefits for the private sector. Both public and private sectors could work together to plan and develop an optimal system meeting the needs of the users and participants. Ideally, funding and time would be invested by all participants in an effort that would be mutually beneficial. Many of the operational tests will provide insight to how public-private partnerships can work. One such project is the TravInfo project in the San Francisco Bay Area. This project involves the development of a database of travel information that will be used by private sector developers to develop products for the general public. The relationship between the public and private sector to develop such a system requires that a public-private partnership be established. This partnership is a break from traditional modes of operation. Public sector plans and information need to be shared with the private sector to encourage the development of supporting technologies. The public sector procurement, research and development, system planning, design, deployment, and operations procedures may need to be reviewed or modified to facilitate certain aspects of the public/private sector relationship. Private sector capabilities and technology development horizons need to be shared with the public sector in order for deployments to be planned and funded, if necessary. This new relationship between the public and private sectors must be developed on trust and commitment to the common goals of increasing transportation safety, advancing ITS, and improving the nation's transportation system.

2.2 Decentralized Deployment Decisions

Deployment decisions will be made in a decentralized manner. State and local organizations will be deploying ITS in their jurisdictions, and commercial organizations will be deploying in their market areas. The deployment decisions of these organizations will be independent and based on the unique financial, planning, and service requirements of each organization. The unique characteristics of each application provide a basis for evaluating and developing deployment strategies and integrating user services. Private sector deployments are inherently decentralized due to their competitive nature.

2.3 Private Sector Business Strategies

Private sector organizations will make ITS investment decisions based on their estimates of potential return on investment and long term market growth. Inherent in these strategies is the realization that there will be a need for research and development funding. Thus, the tempo of potential ITS deployments will be influenced by the resulting flow of new technology products and their adaptability to ITS applications.

The areas discussed in this section have illustrated the various influences on the deployment planning process. Each has an impact on the integration of an ITS. When planning is being done for a system that crosses more than one organization, opportunities exist to leverage costs and assets to provide an optimal system. In some areas these are not common events. There are opportunities to share costs and assets of various organizations or participants in a system development and there are also opportunities to capitalize on the interrelationships among user services.

3.0 USER SERVICES INTEGRATION

ITS planning and deployments are proceeding, despite the absence of a national ITS architecture and the minimal availability of adopted standards. To assist a deployer in planning for the adoption of a system approach, relationships among the user services were analyzed to define what integration options are available. This discussion of User Services Integration is not to imply a system design but to point out how the user services could be integrated. Tools will be presented as templates to be adapted to each deployment situation.

Planning organizations should be aware of the benefits of integrating the user services in a system.

3.1 Functional Relationships Among User Services

Each of the 29 user services discussed in Chapter III was analyzed to identify candidate enabling technologies. This analysis is based on a wide range of technologies capable of supporting robust, fully functioned user service implementations. This does not imply that a user service deployment must necessarily include all of the enabling technologies or the functions they provide.

In order to keep the number of technologies at a manageable level, they were grouped into functional areas. In general, each functional area is comprised of one or more separate technologies which can be used interchangeably in a system deployment that provides a user service. For example, two-way mobile communications could be provided by either digital cellular telephones or two-way satellite communications. The functional areas are defined in Table 5-l.

Table 5-l Function Definitions

Function	Definition
Traffic Surveillance	Surveillance technologies that collect information about the status of the traffic stream. Possible technologies include loop detectors, infrared sensors, radar and microwave sensors, machine vision, aerial surveillance, closed circuit television, acoustic, in-pavement magnetic, and vehicle probes.
Vehicle Surveillance	Surveillance technologies that collect a variety of information about specific vehicles. These technologies include weigh-in-motion devices, vehicle identification, vehicle classification, and vehicle location.
Inter-Agency Coordination	Technologies that connect travel-related facilities to other agencies such as police, emergency services providers, weather forecasters and observers, and among Traffic Management Centers (TMC), transit operators, etc.
l-Way Mobile Communications	Any communication technology that transmits information to potentially mobile reception sites but cannot receive information back from those sites. Possible technologies providing this function include Highway Advisory Radio, FM subcarrier, spread spectrum, microwave, infrared, commercial broadcasts, and infrared or microwave beacons.

Table 5-l Function Definitions

Function	Definition
2-Way Mobile Communications	Any communication technology that transmits information to potentially mobile reception sites and allows receipt of information from those same sites. Possible technologies include cellular telephones, 2-way radio, spread spectrum, microwave, infrared, and 2-way satellite.
Stationary Communications	Any communication technology that connects stationary sites. Technologies include fiber optics, microwave, radio, laud lines.
Individual Traveler Interface	Devices that provide information flow to a specific traveler. Technologies meeting this function include touch screens, keypads, graphics displays and computer voices at kiosks; keypads, computer voice, and on-board display systems in vehicles; personal communications devices carried with the traveler; audiotex from any phone; and TV in the office or home.
Payment Systems	Technologies that enable electronic fund transfer between the traveler and the service provider. The technology areas include Automated Vehicle Identification (AVI), smart cards, and electronic funds management systems. This function overlaps with the Electronic Payment user service.
Variable Message Displays	Technologies that allow centrally controlled messages to be displayed or announced audibly to multiple users at a common location such as a roadside display or display board in a transit terminal. These technologies would typically be applied to provide information on highway conditions, traffic restrictions, and transit status.
Signalized Traffic Control	Technologies that allow for real-time control of traffic flow. Possible technologies include optimized traffic signals, ramp metering, reversible lane designation, and ramp/lane closures.
Restrictions Traffic Control	Operational techniques that restrict the use of roadways according to regional goals. Techniques include HOV restrictions, parking restrictions, **and road** use (congestion) pricing.
Navigation	Technologies that determine vehicle position in real time. Technologies that provide this function include GPS, LORAN, dead reckoning, localized beacons, map database matching, and cellular/radio triangulation.
Database Processing	Technologies that manipulate and configure or form at transportation-related data for sharing on various platforms. General purpose data base software currently exists and is currently being adapted to transportation needs such as data fusion, maps, and travel services.

Table 5-l Function Definitions

Function	Definition
Traffic Prediction Data Pmcessing	Data processing relating to prediction of future traffic situations. Algorithms under development include areas such as real-time traffic prediction, and traffic assignment.
Traffic Control Data Processing	Data processing related to the real-time control of traffic. Algorithms under development include optimal control and incident detection, and the interaction of route selection and traffic control.
Routing Data Pmcessing	Data processing related to routing of vehicles including the generation of step-by-step driving instructions to a specified destination. Algorithms under development include the scheduling of drivers, vehicles, and cargo; route selection; commercial vehicle scheduling, route guidance and multimodal dispatching.
In-Vehicle Sensors/Devices	Technologies providing a range of sensing functions to be located within vehicles. Functions addressed by these technologies include monitoring of vehicle performance and driver performance; determination of vehicle position relative to the roadway, other vehicles, and obstacles; improvement of vision in adverse conditions; and on-board security monitoring.

The user service bundles, introduced in Chapter III, are the starting point for determining the interrelationship of one user service to another. The bundles provide logical groupings and combinations of the user services. By analyzing a user service's relationship to other user services, a system may be conceived over a period of years in a comprehensive and deliberate manner. This approach makes it possible to optimize the use of funds and resources resulting in a more achievable and affordable system deployment.

The results of the analysis of functional commonalities are depicted in Figure 5-2. In the figure, the user service bundle is identified in the upper left hand corner of the chart. The left side of the chart lists the associated functions. The right of the figure lists the user services in the bundle. If a function supports full implementation of a user service, the intersection of the user service row and function column is marked. Note that in some applications it is not necessary to implement all supporting functions to successfully deploy a system providing a user service.

1. Travel and Transportation Management

Data Base Processing	Stationary Communications	Traffic Surveillance	2-Way Mobile Communications	Individual Traveler Interface	Variable Message Displays	Navigation	1-Way Mobile Communications	Traffic Prediction Data Processing	Inter-Agency Coordination	Routing Data Processing	Signalized Traffic Control	Traffic Control Data Processing	Vehicle Surveillance	In-Vehicle Sensors/Devices	Provides Deployment Basis For
●	●	●	●	●	●	●	●	●	●	●					En-Route Driver Information
●	●	●	●	●		●	●	●		●					Route Guidance
●			●	●		●									Traveler Services Information
●	●	●			●			●	●		●	●			Traffic Control
●	●	●	●		●	●	●	●	●		●	●			Incident Management
●	●			●	●		●		●		●		●	●	Emissions Testing and Mitigation

(The header row spans "Applicable Bundle Functions" over the first 15 columns.)

2. Travel Demand Management

Data Base Processing	Stationary Communications	Individual Traveler Interface	Variable Message Displays	Navigation	1-Way Mobile Communications	2-Way Mobile Communications	Inter-Agency Coordination	Routing Data Processing	Vehicle Surveillance	Payment Systems	Restrictions Traffic Control	Traffic Surveillance	Traffic Prediction Data Processing	Signalized Traffic Control	Provides Deployment Basis For
●	●	●	●	●	●				●	●	●	●		●	Travel Demand Management
●	●	●	●	●		●	●	●			●	●	●		Pre-Trip Travel Information
●	●	●	●	●	●	●	●	●	●	●					Ride Matching & Reservation

(The header row spans "Applicable Bundle Functions" over the first 15 columns.)

Figure 5-2 Functional Relationships Among User Services

3. Public Transportation Operations

Provides Deployment Basis For	Vehicle Surveillance	2-Way Mobile Communications	Stationary Communications	Individual Traveler Interface	Inter-Agency Coordination	Variable Message Displays	Data Base Processing	Traffic Surveillance	1-Way Mobile Communications	Navigation	Traffic Prediction Data Processing	Payment Systems	Routing Data Processing	In-Vehicle Sensors/Devices	Signalized Traffic Control
Public Transportation Management	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
En-Route Transit Information	●	●	●	●	●	●	●	●	●	●	●				
Personalized Transit Information	●	●	●	●	●	●	●			●	●	●	●		
Public Travel Security	●	●	●	●	●		●	●	●	●				●	

(Applicable Bundle Functions)

4. Electronic Payment

Provides Deployment Basis For	Vehicle Surveillance	1-Way Mobile Communications	2-Way Mobile Communications	Stationary Communications	Individual Traveler Interface	Payment Systems	Variable Message Displays	Data Base Processing	Inter-Agency Coordination
Electronic Payment Services	●	●	●	●	●	●	●	●	●

(Applicable Bundle Functions)

Figure 5-2 Functional Relationships Among User Services (Continued)

5. Commercial Vehicle Operations

2-Way Mobile Communications	Data Base Processing	Vehicle Surveillance	1-Way Mobile Communications	Stationary Communications	Individual Traveler Interface	In-Vehicle Sensors/Devices	Variable Message Displays	Navigation	Payment Systems	Routing Data Processing	Provides Deployment Basis For
●	●	●	●	●	●		●				Commercial Vehicle Electronic Clearance
●	●			●		●					Automated Roadside Safety Inspection
●					●	●					On-board Safety Monitoring
●	●	●	●	●	●		●		●		Commercial Vehicle Administrative Processes
●	●	●	●			●		●			Hazardous Material Incident Response
●	●	●	●	●	●			●		●	Freight Mobility

Columns 1–11: Applicable Bundle Functions.

6. Emergency Management

Vehicle Surveillance	1-Way Mobile Communications	2-Way Mobile Communications	Navigation	Data Base Processing	Routing Data Processing	Individual Traveler Interface	In-Vehicle Sensors/Devices	Traffic Surveillance	Inter-Agency Coordination	Stationary Communications	Variable Message Displays	Signalized Traffic Control	Traffic Prediction Data Processing	Provides Deployment Basis For
●	●	●	●	●	●	●	●							Emergency Notification & Personal Security
●	●	●	●	●	●			●	●	●	●	●	●	Emergency Vehicle Management

Columns 1–14: Applicable Bundle Functions.

Figure 5-2 Functional Relationships Among User Services (Continued)

7. Advanced Vehicle Control and Safety Systems

Individual Traveler Interface	In-Vehicle Sensors/Devices	1-Way Mobile Communications	Traffic Surveillance	2-Way Mobile Communications	Variable Message Displays	Signalized Traffic Control	Stationary Communications	Vehicle Surveillance	Navigation	Data Base Processing	Traffic Prediction Data Processing	Restrictions Traffic Control	Provides Deployment Basis For
●	●	●	●	●									Longitudinal Collision Avoidance
●	●	●	●										Lateral Collision Avoidance
●	●	●	●	●	●	●		●	●	●	●		Intersection Collision Avoidance
●	●												Vision Enhancement for Crash Avoidance
●	●	●			●		●						Safety Readiness
●	●												Pre-Crash Restraint Deployment
●	●	●	●	●		●	●					●	Automated Highway Systems

(The column headings above all fall under the spanning heading "Applicable Bundle Functions", except for "Provides Deployment Basis For".)

Figure 5-2 Functional Relationships Among User Services (Continued)

In the process of planning system deployments to support user services, deploying organizations will consider a broad spectrum of factors. First and foremost, service providers must consider the requirements and problems unique to their communities. While there is no attempt here to develop a model which factors in all possible considerations representative of urban, suburban, or rural communities, there are some investment related factors which lend themselves to analysis. One of the prime considerations is the return on investments associated with installing systems. Therefore, once a region has made a decision to deploy systems contributing to a user service in response to a specific need, community leaders and/or private sector providers will immediately want to know the implications of such an investment, not only in the near term, but for the duration of their planning horizon. Figure 5-2 depicts a model derived from an analysis of bundles of user services. Each user service has the complete set of functionalities visualized for a mature service as derived from the appropriate User Services Development chapter in Volume II.

3.2 Using the Functional Relationships Tool

Based on the observations in the previous section and an understanding of the elements in Table 5-1, it is possible to use Figure 5-2 as a tool in decision-making. The following paragraphs illustrate some examples for the use of this tool.

System Cost Options The most basic application of the information in Figure 5-2 is to analyze options and potential investments. As noted previously, the figure cannot and should not be used to select systems of lead services; that is the purview of a deploying organization's planning authorities. But once the selections have been made, Figure 5-2 can be the basis for initial cost estimates of a desired service since the acquisition costs of systems providing the functions can be estimated.

For example, if a system providing Pre-Trip Travel Information were needed and a decision was made to explore the costs of such a system, options could be evaluated by selecting different combinations 'of the functions applicable to Pre-Trip Travel Information in Bundle 2. These different combinations will denote various levels of complexity and service potential. Costs could be accumulated from various providers to provide a rough order of magnitude estimate of the system. Options could be evaluated and considered in the decision process.

Marginal Additional Investment Figure 5-2 can also be used to depict the nature of marginal investment required for deploying added functionality. It is important for managers to know if an investment satisfies only a current need or if it lays the groundwork for potential future improvements or expansions. The tool; without specifying any system, demonstrates that added functions can prepare a community for delivery of new services. Selecting the system to provide that function is a local choice based on numerous considerations.

For example, as shown in Figure 5-3, if investment funds are only available for the deployment of a system that provides Route Guidance, it is evident that En-Route Driver Information can be added with investment in two additional functions. Thus, an initial investment has provided one user service as well as the basis for a second user service with limited subsequent costs. The solid circles in Figure 5-3 illustrate possible functions available from a system with Route Guidance and the additional functions required to provide En-Route Driver Information.

Costs Applied Across Multiple Services Public and private planners are interested not only in near-term decisions, but also in mid-to-long term perspectives. Costing all of the functions in a bundle might be very productive. If such an estimate shows that the benefits of the common element costs can be amortized across all the services, the organization's leadership may be willing to commit to a significant investment. This is effective when the basic or most common function among the user services being considered is applicable to all the services. It should be noted that even though a function may be identified as common among several user services, it is not always the same type of application for each user service. For example, Database Processing will not necessarily be the same for Incident Management as it is for Route Guidance.

A commercial vehicle operator may investigate the possibility of using a single type of 2-Way Mobile Communications in a system that would be delivering Commercial Vehicle Electronic Clearance, Automated Roadside Safety Inspection, On-Board Safety Monitoring, and Freight Mobility. This communications system may be more expensive than a communications system for just one user service, however, when its effect is considered collectively, it could represent a significant savings in maintenance and operations.

1. Travel and Transportation Management

Applicable Functions															Provide Deployment Basis For These User Services
Data Base Processing	Stationary Communications	Traffic Surveillance	2-Way Mobile Communications	Individual Traveler Interface	Variable Message Displays	Navigation	1-Way Mobile Communications	Traffic Prediction Data Processing	Inter-Agency Coordination	Routing Data Processing	Signalized Traffic Control	Traffic Control Data Processing	Vehicle Surveillance	In-Vehicle Sensors/Devices	
○	○	○	○	○	○	○	○	●	●	○					En-Route Driver Information
●	●	●	○	●		●	●	○		●					Route Guidance
○			○	○		○									Traveler Services Information
○	○	○			○			○	○		○	○			Traffic Control
○	○	○	○		○	○	○	○	○		○	○			Incident Management
○	○			○	○		○		○		○		○	○	Emissions Testing and Mitigation

Figure 5-3 Marginal Additional Investment Example

Private Sector Marketing Decisions Figure 5-2 can also assist private sector product and service providers who market their systems to local government. Product and service providers will react to infrastructure acquisition decisions made by governments. They will plan product development efforts to capitalize on known future system evolutions that provide certain functionalities. In some cases, a public-private partnership can be developed between the local deployment authority and the private sector. Public sector infrastructure investments increase in value when they are complemented by private sector products that deliver the infrastructure data to the user. Giving the private sector insight into the public sector's planning activities, will allow the private sector to make informed investment decisions to support public sector plans. This will bring the public sector investment benefit back to the consumer. The public sector investments and planning will be made by the state and local deployment organizations, and it is at this level that the public-private partnership should be developed.

Cross-Bundle Assessments Close inspection of all the charts in Figure 5-2 reveals the amount of overlap in technology among user services in the bundles. In almost any decision scenario, the planner can perform a "cross-bundle assessment" of the potential for add-ons associated with a decision to implement systems of a priority service. For example, Stationary Communications is a common function to all of the bundles and more specifically, 20 of the 29 user services. The implementation of this function would have application not only to many user services, but also to many deployment organizations. Public and private deployment organizations could arrive at a consensus on the trade-off between selecting an optimum system to satisfy their needs or one that has the expandability and openness to accommodate both existing and future needs.

In all applications of Figure 5-2 it must be understood that any individual system implementation will require specific technology selections. As planning progresses, decision aids similar to Figure 5-2 will require periodic updating based on the specifics of the evolving system.

4.0 FUNCTIONAL RISK ANALYSLS

Planners making near-term deployment decisions must be aware that the selection of a national ITS architecture and the setting of standards may exert significant impacts on their decisions. Each decision analysis should incorporate a thorough risk assessment if a decision is made to proceed with a near-term deployment. This section offers a preliminary approach to such an assessment.

There are several ways to approach risk analysis. This risk analysis addresses the following considerations:

- A selected system may be at risk with regard to national compatibility. Downstream architecture decisions or standards selection may threaten the viability of the selected system.

- A selected system may be compatible only in a narrow regional context. Thus implementation or expansion of the system across regional boundaries may be at risk.

- A selected system may prove to be incompatible with other systems fielded after the selection of an architecture or the development of a relevant standard or protocol.

- A fourth consideration that will always be present is technological viability/maturity. Although this is an important consideration, the detail required to adequately discuss each technology's viability/maturity is beyond the scope of this chapter. The technologies are considered at the higher level of a function or system in this section.

Table 5-4 is a high-level risk analysis of system functions outside the framework of a national ITS architecture and in advance of the establishment of standards relevant to these systems. The table illustrates that it is possible to make a rough order of magnitude estimate of a function's risk. The table can be used as a guide which can be tailored by deployers according to the unique features of their particular systems.

The definitions of levels of risk in terms of a system's ability to operate over a sustained period of time (system viability) are as follows:

- <u>Low Risk</u> - System viability will experience minimum impacts by architecture and standards development.

- <u>Moderate Risk</u> - System viability is readily and affordably adaptable to architecture and standards development. Some functions are conservatively identified as moderate because of cross region compatibility risks. Within their own operating areas, deployment risk is low.

- <u>High Risk</u> - System viability (in many cases across geographical and functional boundaries) is potentially at risk by architecture and standards development.

Table 5-4 Risk Evaluation

Functions (See Table 5-1)	**Evaluation Data**	**Risk**
Traffic Surveillance	Traffic Surveillance technologies exist in many fonns today and are deployed. It is a regional compatibility issue. Risk exists across regional boundaries. The use of existing, standards-compliant equipment reduces risk sensitivity,	Architecture Low Standards Low
Vehicle Surveillance	Vehicle Surveillance technologies do not have a large deployment base and the technologies are still being developed. It is primarily a regional compatibility issue but can have some national and product level compatibility issues as well. The need for nationwide compatibility increases risk sensitivity.	Architecture High Standards Mod
Inter-Agency Coordination	Inter-Agency Coordination technologies are currently deployed and are not necessarily complex. It is a regional compatibility issue. Risk exists across agency boundaries.	Architecture Low Standards Mod
1 -Way Mobile Communications	1 -Way Mobile Communications technologies are currently deployed. Examples are currently in use and applications are being developed. It is a national and regional compatibility issue. Protocol compatibility increases standards sensitivity.	Architecture Low Standards Mod
2-Way Mobile Communications	2-Way Mobile Communications technologies currently exist and ITS are being developed. Spectrum and protocol compatibility issues exist on the national, regional, and product levels. Protocol compatibility increases standards sensitivity.	Architecture Low Standards Mod
Stationary Communications	Stationary Communications technologies are deployed and demonstrated to be effective. Existing infrastructure is available.	Architecture Low Standards Low
Individual Traveler Interface	Individual Traveler Interface technologies are being developed and a few have been deployed. Architecture and Standards sensitivity is dependent on data complexity and human factors issues.	Architecture Mod Standards Mod

Table 5-4 Risk Evaluation

Functions (See Table 5-l)	**Evaluation Data**	**Risk**
Payment Systems	Payment Systems technologies are in testing and the technology maturity issues vary. It has compatibility issues on the national, regional and product levels.	Architecture Mod Standards High
Variable Message Displays	Variable Message Display technologies are deployed and the technology is immature. No compatibility issues exist.	Architecture Mod Standards Mod
Signalized Traffic Control	Signal Traffic Control technologies are deployed. There are a number of configurations and algorithms. It has compatibility issues on the cross-boundary regional level.	Architecture Low Standards Mod
Restrictions Traffic Control	Restrictions Traffic Control policies are being employed and are locally determined. Regional coordination is required.	Architecture Mod Standards Mod
Navigation	Navigation technologies are beginning to be deployed and location technologies exist. Autonomous capabilities reduce risk sensitivity.	Architecture Low Standards Low
Database Processing	Database Processing technologies exist; immature adaptation to transportation needs. Database processing technologies are the backbone of many user services. It has compatibility issues on the national, regional, and product levels. Multiple database structures increase risk sensitivities.	Architecture Mod Standards Mod
Traffic Prediction Data Processing	Traffic Prediction Data Processing technologies are being developed. Technologies are immature due to algorithm evolution. It has compatibility issues on the regional level. It is standards sensitive due to algorithm compatibility.	Architecture Low Standards Mod

Table 5-4 Risk Evaluation

Functions (See Table 5-l)	Evaluation Data	Risk
Traffic Control Data Processing	Traffic Control Data Processing technologies are deployed in small numbers. The basis of this technology lies in algorithm maturity. It has compatibility issues on the regional level.	Architecture Mod Standards Mod
Routing Data Processing	Routing Data Processing technologies exist. The deployment base is still small and the lack of map database standards could cause compatibility problems.	Architecture Mod Standards Low
In-Vehicle Sensors/ Devices	In-Vehicle Sensor/Device technologies are in development and some have been deployed (vehicle performance monitoring). Overall, the technologies are immature. It has compatibility issues on the regional and product levels.	Architecture Mod Standards Mod

4.1 Deployment Risk Assessment Example

Table 5-4 is, at best, one additional filter through which a deployment planner can refine a decision regarding early deployments. The table should be used as a template to conduct a risk assessment during the deployment planning process. All decision-makers should be aware of the potential risks involved with a planned deployment.

The following is an example of how risk assessment can be used in conjunction with the functional relationships identified in Figure 5-2. For this example, a decision has been made to pursue a system deployment providing En-Route Driver Information. The functions that are applicable to En-Route Driver Information in Bundle 1 of Figure 5-2 are evaluated for their levels of risk using Table 5-4. As Table 5-5 illustrates, there are no high risk functions identified for this application.

Table 5-5 Risk Assessment Example

Moderate Risk Functions	Low Risk Functions
. Database Processing . 2-Way Mobile Communications . Individual Traveler Interface . Inter-Agency Coordination . Routing Database Processing . Variable Message Displays . l-Way Mobile Communications . Traffic Prediction Database Processing	. Traffic Surveillance . Navigation . Stationary Communications

From this very rudimentary assessment, the planner can advise decision-makers with the following strategic options:

. It is possible to invest in partial functionalities to support en-route driver information in the present timeframe with very acceptable risk. This course of action would provide less than a fully functioned service but would pave the way for the complete service subsequent to the completion of the architecture and development of relevant standards.

. Transportation planners can develop a phasing strategy which minimizes risk and allows for near- to mid-term funding allocation in support of a coherent deployment plan.

. The decision-makers could opt to accept a moderate level of risk and plan now for near-term full function deployment as the technology becomes available.

5.0 CONCLUSION

The User Services Integration chapter describes some aspects of ITS which are generally understood by many in the transportation community but are infrequently discussed in an integrated narrative. The delivery of user services will be brought about by investments in systems. The systems will be fielded because they provide certain functionalities which satisfy requirements established in the markets and at the local government and private sector levels where investments will be made. An assessment of the planning process reveals the following insights:

- The user services will not be deployed or operated as 29 separate and independent entities.

- There are numerous ways of undertaking the analysis of the interactions among the user services. There is no right or wrong way. Rationale should be identified.

- Functional commonalities exist between the user services and should be considered in deployment decisions. Systems which deliver user services will not just appear, they will be selected, and the people making those technology choices will be motivated by certain institutional priorities. Efforts are underway to bring together organizations involved in an ITS deployment. The creation of Metropolitan Planning Organizations (MPO) is important to address the needs of many stakeholders together and help solve these issues with a coordinated solution. The MPOs are key to bringing ITS to areas where jurisdictional boundaries often overlap or are vague. Ignoring organizational perspectives may lead to technically sound, but irrelevant conclusions. Thus, the bundles were formed from this dual view of what can influence system selection.

- Near-term investment planning in ITS is complicated by the absence of a national systems architecture and the immature stage of standards development. These conditions introduce risk into potential acquisition decisions because compatibility is a key consideration for successful implementation.

- Relationships between the user services and functions derived from an analytic base such as Figure 5-2 can support the planning process and lead to a comprehensive assessment of outcomes related to acquisition choices. In the interim, until the selection of a national architecture and the setting of standards, deployment assessments will have to be tempered by an understanding of risk.

CHAPTER VI - DEPLOYMENT

1.0 INTRODUCTION

ITS deployment makes it possible for the users of the transportation system to realize the benefits of ITS. It is a multi-phased process, that builds upon itself. ITS deployments have already occurred in some areas of the country. Innovations will cause the evolution of systems already deployed and the implementation of systems in areas where ITS may not have been applicable or possible in previous phases. The evolution of ITS deployment will depend on institutional renovations, funding, on technology developments, and the will of communities to apply new technology-based solutions to transportation problems.

At this time there is no definitive, centralized scheme to deploy ITS throughout the nation. State and local agencies and private sector organizations are making their individual deployment plans and, in many cases, implementing them. ISTEA provides for the research and testing of ITS technology but allows deployment to be shaped by market forces, making it uncertain how ITS will evolve.

This chapter presents a vision of how ITS deployment could happen. This is not to imply that this vision is the only vision or that deployment will only happen as presented. Rather, it is presented to initiate an open discussion about deployment, public policies, institutional and technological issues, and the roles of the Federal, State, and local governments, and the private sector. These discussions will shape the deployment vision of the ITS community and identify the changes required in public policies and the roles of the public and private participants in ITS to attain that vision. The chapter begins with an assessment of current deployment in the public and private sectors with examples of deployed systems. Following the current deployment assessment is a vision of future deployment. This vision provides a platform to analyze the effects of contrasting levels of public and private sector involvement and the outcome of each on selected issues concerning deployment. This analysis and discussion is presented to inform the public policy debate and private sector market policy discussions that are taking place across America.

2.0 EXISTING ITS DEPLOYMENT

ITS involves the application of technology-based solutions to transportation problems. Many of the technologies have been in existence for well over two decades. New communications systems and improved computing capacity have been used increasingly to address the transportation problems that emerged in the 1980s.

Public sector deployments are addressing issues, such as

- Congestion and the limitations on expanding roadways to provide new capacity,
- The need to improve mass transit system management efficiency, and

- Cost reduction and convenience enhancement of toll systems.

The private sector has deployed systems that address, among others,

- The need to improve the management and operational efficiency of commercial fleets and
- The growing market demand for traveler safety, security, and information.

Current ITS deployment is illustrated in Figure 6-l. It points out the types of systems that have been deployed in various parts of the country. Commercial vehicle operations deployment activities are shown in the top half of the figure. ITS deployment in the areas of travel and transportation management, public transportation operations, electronic payment, emergency management, and advanced vehicle control and safety systems is shown in the lower half of the figure. The following paragraphs provide some detail of currently deployed ITS.

Travel and Transportation Management Many metropolitan areas and State DOTS have deployed, or are in the process of deploying, some form of centrally-controlled traffic signal system, freeway surveillance system and/or incident management program. These systems are managed actively through human intervention using signal timing, ramp metering, variable message signs and/or communication over highway advisory radios or commercial broadcast networks. Traffic surveillance technologies include loop detectors, video, and Automated Vehicle Identification (AVI). Freeway service patrols are operated with both public and private sector participation in conjunction with some incident management programs.

Current information gathered by ITS AMERICA and U.S. DOT indicates that there are approximately 12 freeway operation centers, 85 local traffic control centers, 31 freeway service patrols, and 47 incident management programs. A recent survey of State traffic engineers carried out by ITE indicated that 38% of the respondents were actively involved in advanced freeway traffic management system activities. Adaptive traffic control system technologies are available at this time, however, operations and maintenance budgets and public sector skills level are restricting wide deployment. In addition, few of the systems that are deployed are linked electronically to one another to share data. They operate, for the most part, independently.

Some private sector services, such as Metro Traffic and Shadow Traffic, use aircraft to gather traffic information. Some freeway operation centers supply traffic information to these private sector services where it is fused with other data and disseminated to the public. This information is provided to the user by radio or television broadcast or telephone services. Traffic information is also supplied from freeway and traffic management centers by variable message signs on freeways and arterial streets. Route guidance data is provided to the user through the use of in-vehicle systems and personal computer software packages. In-vehicle route guidance is provided with static data at this time, since a lack of real-time

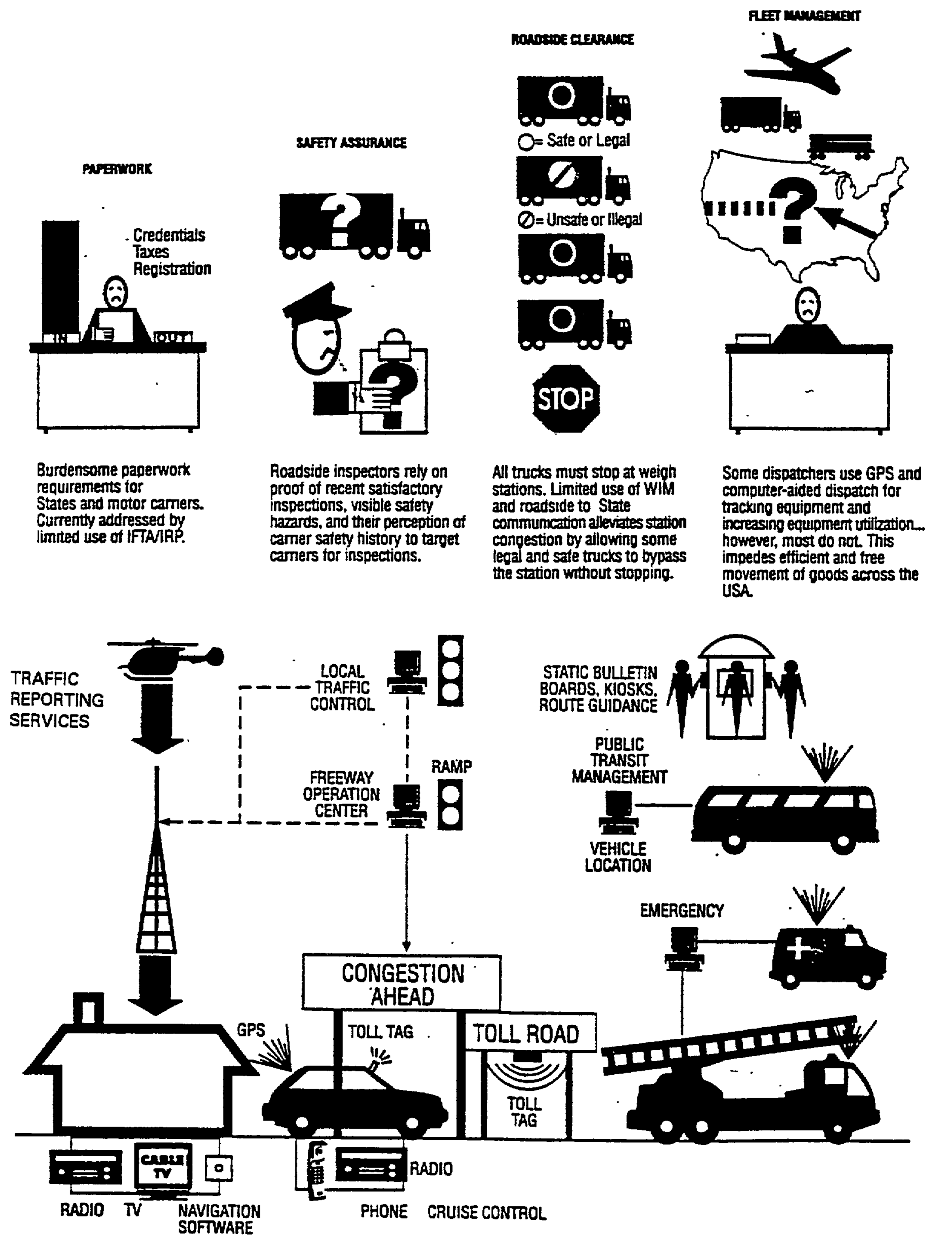


Figure 6-1 Deployment Today

data and a lack of data consistency across regions restricts the development of dynamic route guidance systems.

Public Transportation Operations Scheduling and run-cutting software are in use at most medium and large transit agencies. Computer aided dispatch transit radio systems and Automated Vehicle Location (AVL) systems are becoming more common, since the number of ancillary uses for the information is a growing incentive for agencies to acquire them. Fourteen transit properties currently have AVL capability. Location information is provided by Global Positioning System (GPS), signposts, or map-matching applications. Despite the large amount of transit data that is beginning to be collected, sharing of data between transit and traffic management systems is very low.

Demand responsive trip scheduling software is in widespread use on transportation systems for the elderly and disabled. Route deviation schemes exist on a few small systems. A number of high tech transit security devices have been in use for some time. These devices include closed circuit TV cameras at major transit facilities (e.g., transit centers, park and ride lots, rail stations), slow scan, recording security cameras on-board transit vehicles and emergency alarm functions built into vehicle radio systems.

Electronic Payment Electronic toll collection systems are being deployed in various parts of the country. Approximately 20 automated electronic toll collection facilities are currently deployed. In some regions, efforts are underway to implement systems that cross state lines. Currently, the deployed electronic toll systems are not interoperable, however, standards development is progressing to address this issue. Electronic fare collection systems that use magnetic-stripe technology for collecting public transportation fares and parking fees have been deployed.

Commercial Vehicle Operations The Heavy Vehicle Electronic License Plate, Incorporated or HELP, Inc. and an operational test titled Advantage I-75 are furthering Commercial Vehicle Operations (CVO) user services, especially electronic clearance. HELP, Inc. allows those participating, transponder-equipped heavy vehicles that are safe and legal to bypass weigh stations and Ports-of-Entry at highway speeds. HELP, Inc. has operational sites in its member States. Advantage I-75 has three test sites nearing completion in Kentucky and Ohio along the Interstate 75 corridor.

Automated vehicle identification (AVI) and weigh-in-motion (WIM) technologies are being applied to gather information on credentials and vehicle weight. For routine roadside safety inspections of a truck or bus, a number of states are using pen-based data input devices to reduce the total time for uploading the inspection data to existing state and national safety databases. A national carrier safety information system will link the existing Motor Carrier Management Information System (MCMIS) to 100 roadside inspection sites electronically by 1996. This will enhance the selection process of inspectors by identifying carriers with a high-risk safety record or those with no inspection history. This system will be expanded in

1997 to include driver and vehicle data at a total of 200 sites. These activities are made possible by the cooperative partnerships that have been established between states and the CVO community.

Private truck and bus companies use technology to enhance safety and productivity. Carriers incorporate safety data, such as engine temperature and the number of hours a particular driver has been on the road, into their routing and dispatching decisions from on-board devices. Several carriers are deploying GPS-based AVL systems to enhance their fleet management capabilities. These systems often use existing communications systems, including satellite communications, for the transmission of data from the vehicle to the fleet management center.

Emergency Management Approximately 24 emergency management systems are equipped with AVL and 104 are planned to incorporate AVL into their management systems. In addition, the Enhanced 9-l-l deployment currently being undertaken provides for automatic phone number and location identification which can improve emergency vehicle assignment and routing. The existing Public Safety Answering Point (PSAP) system routes 9-l-l calls to the appropriate service provider in the proper location. These systems will put the required emergency services on the scene faster and more efficiently.

Advanced Vehicle Control and Safety Systems The VORAD system, a longitudinal and lateral collision warning system, has been deployed by Greyhound on a portion of its bus fleet. This deployment is expected to reduce accident rates which will lower costs for operating and maintaining the fleet. The driving public will also benefit from safer coexistence with buses on the road, and the bus passengers and driver will benefit from safer bus travel.

Specific examples of the current deployments described in the previous paragraphs are listed in Table 6-2. User services that are being provided by the deployment of these systems are also listed in the table. Deployment today is taking place without requirements for coordination or interoperability. Pockets of deployment are appearing due to the aggressiveness of some State and local governments who have identified needs and recognized the benefits of applying ITS technology solutions to address their needs.

3.0 A DEPLOYMENT VISION

Given the breadth and variety of ITS, no picture of future deployment can be completely accurate or satisfactory to every stakeholder. Yet it is possible to present snapshots of where ITS deployment could be in 5 years, in 10 years, and beyond. This vision of a possible, even desirable, deployment evolution can provide a focus for defining the issues, influences, and barriers to deployment and the steps that can be taken to overcome them.

Table 6-2 Examples of Current ITS Deployments

System	User Service(s) Provided	Status
Transportation Management · *Los Angeles Automated Traffic Surveillance and Control* · *Seattle Freeway Management System* · *Phoenix Freeway Management System* · *Las Vegas Area Computer Traffic System*	. Traffic Control . Incident Management	. Islands of ATMS deployment . Limited deployment of video cameras . Manual monitoring . Primarily public sector influence
Travel Information · *MetroTraffic* · *ShadowTraffic* In-Vehicle Route Guidance · *Oldsmobile Guidestar* PC-based Software · *City Streets*	. Pre-Trip Travel Information . En-Route Driver Information . Route Guidance . Traveler Information Services	· Radio and TV broadcasts in most markets . Limited deployment of route guidance . Primarily private sector Influence
AVL/AVI · *Various Transit Systems* · *Various Commercial Vehicle Operators* · *Various Emergency Management Services*	· Public Transportation Management · Commercial Fleet Management · Emergency Vehicle Management	. Limited AVL applications/ scheduling software . Limited AVI deployment . Public and private sector Influence
Electronic Toll Collection · *Illinois State Toll Highway Authority* · *Oklahoma PZKEPASS*	. Electronic Payment Services	. Limited/isolated deploymen . Public and private sector influence
Electronic Clearance · *HELP, Inc.* · *Advantage Z-75 (Operational Test)*	. Commercial Vehicle Electronic Clearance	. Limited deployment . Public and private sector influence
Collision Avoidance Systems . *VORAD/ Greyhound Bus Lines*	. Longitudinal Collision Avoidance . Lateral Collision Avoidance	. Limited deployment . Primarily private sector influence

3.1 5-Year Vision

A vision illustrating ITS deployment in 5-years is provided in Figure 6-3. In this timeframe, a significant feature that emerges is the sharing of information among agencies and between the public and private sectors. In the center of the figure, the traffic, freeway, transit, and emergency management systems are linked together to exchange information.

Transportation data is collected from various sources using several surveillance techniques by the public sector and private service providers, is fused into a rich data base. This data is disseminated by the private sector to the general public and other transportation organizations. The data is accessible on cable television, radio, telephone and on-line computer services in the home, office, at interactive kiosks and in-vehicle. The National Information Infrastructure (NII) is evolving and is used to disseminate ITS data.

In this timeframe, the private sector recognizes that there are market opportunities to provide transportation information, therefore, it invests in product and service development. The public sector receives traffic surveillance data either from investments in sensing infrastructure or from private sector services. Cellular phone and AVI deployments are extensive and expanding providing a mobile communications system and data collection method for data reception and wireless traffic surveillance or probes. A key feature is that information systems are sharing data from multiple databases. Data items are being fused together to provide more accurate and comprehensive transportation information.

Data sharing is accelerating within the CVO industry which is illustrated at the top of Figure 6-3. State databases are linked together to exchange regulatory and safety information which further automates the verification of credentials and vehicle safety monitoring. In addition, driver condition monitoring technologies are applied to improve fleet safety performance. AVI and WIM technologies are in operation on most major trucking corridors and international border crossings. AVL systems using GPS and satellite communications are becoming common in truck and bus fleets which enhances the efficiency of freight, distribution, and fleet management systems.

Electronic toll collection systems are deployed at an accelerated pace due to user acceptance and cost savings to toll authorities, the general public, and CVO. Various in-vehicle products are offered by automobile manufacturers. Intelligent cruise control systems that enhance safety by maintaining a steady distance between vehicles by adjusting throttle and braking functions are deployed. Autonomous route guidance is readily available to the consumer. The increasing accessibility of traffic data allows dynamic route guidance to be deployed in some areas of the country. "Mayday," or panic button security systems and services, are deployed in many urban areas.

As the map of the United States in the lower right corner of Figure 6-3 illustrates, the 5-year timeframe deployments are regional or in pockets across the country despite the major

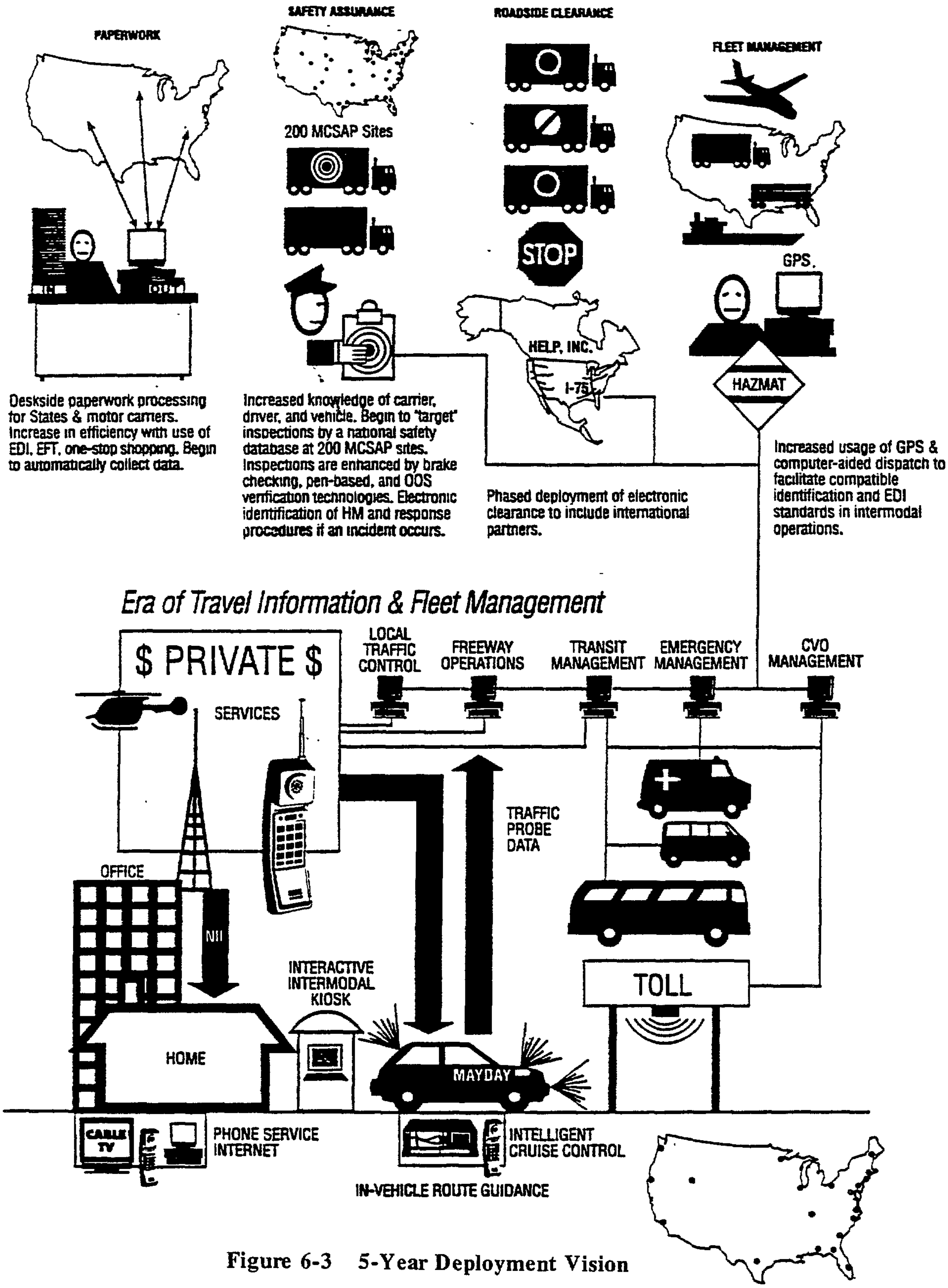


Figure 6-3 5-Year Deployment Vision

advances noted. (Note that the U.S. map is for illustrative purposes only and is not intended to depict actual deployment areas.) Institutional coordination is increasing, and new partnerships are forming between the public and private sectors. Arrangements are being made to exchange and sell public and private sector-collected data. The technologies are available to implement congestion pricing in some areas, however some institutional issues remain and must be addressed. Toll collection and traffic management begin to share information and comprehensive travel information increases the mode choices available to the traveler.

3.2 10-Year Vision

A vision of ITS deployment in 10 years is presented in Figure 6-4. Data sharing is wide spread and is integrated among the transportation agencies and services which provide intermodal coordination for passenger and freight movement. Public and private sector organizations have cooperative agreements regarding the collection and selling of transportation data. An ideal situation may be that the public sector collects transportation data from its surveillance and management infrastructure and the private sector disseminates that information to the users through its communications products and services. This relationship exploits the strengths of each sector to provide the user with the best information possible. The data that is collected and fused together forms rich databases of transportation information which provide the basis for sophisticated traffic management systems. Adaptive traffic control is possible over a larger area. Mode choice options are readily available to the user which facilitates congestion pricing. Communications, navigation, and electronic payment systems are combined into single in-vehicle systems which increase the availability of integrated transportation data and services to the user. Universal electronic payment cards, or “smart cards,” are used for toll, transit fare, parking, and non-transportation financial transactions. In-vehicle ITS applications are standard items on most vehicle models.

Electronic clearance is operational nationwide and on international trucking corridors. An integrated network and database of electronic clearance and safety information provides uniformity to the CVO community both nationally and internationally. Automated vehicle and driver safety monitoring is implemented on all commercial vehicles. Fleet and freight management systems exchange data which increases the efficiency of intermodal distribution operations. Integration and efficiency issues have caused regulatory reform. Cooperative partnerships exist between all States and the CVO community facilitating effective changes from traditional practices.

Enhanced vehicle control systems are marketed for most vehicles. The evolution of intelligent cruise control expands to lateral warning and control systems that provide collision avoidance features. Deployment of vehicle-to-vehicle communications systems makes intersection collision avoidance systems possible.

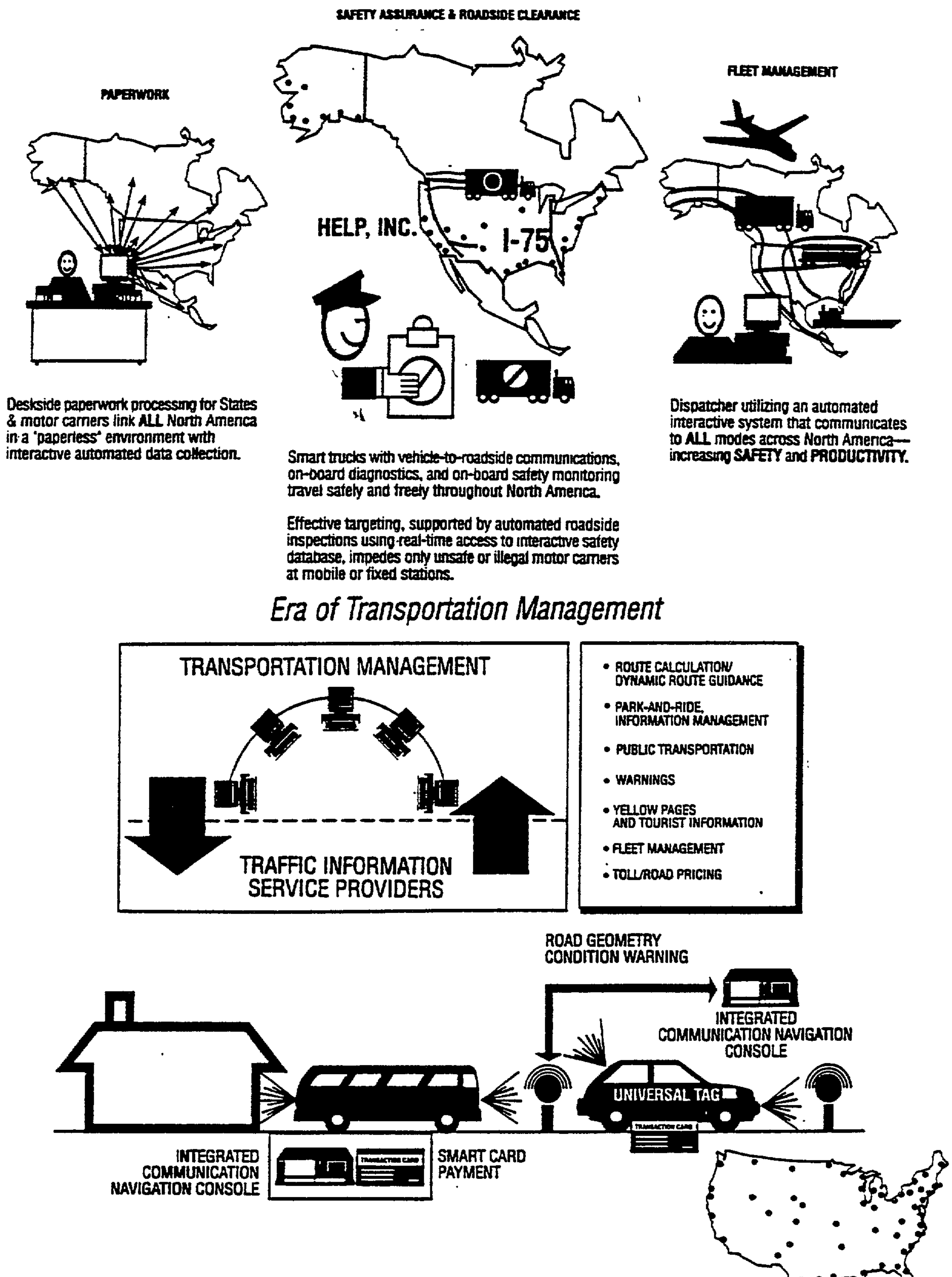


Figure 6-4 10-Year Deployment Vision

In-vehicle route guidance, CVO applications, and information systems are being deployed uniformly across the country. However, traffic surveillance and control systems are deployed with regional emphasis. The integration of transportation data continues to grow and involve more neighboring agencies and private sector organizations. As data integration increases, the regional effectivity of these systems will evolve into national coverage. The emergence of enhanced vehicle control systems sets in place basic systems required for the Automated Highway System (AHS).

3.3 20-Year and Beyond Deployment Vision

The deployment vision beyond the 20-year timeframe involves the evolution of transportation data collection, dissemination, and traffic management. National coverage of most systems is possible. The major change during this timeframe is the deployment of AHS. The evolution of ITS through the 5- and lo-year timeframes lays the groundwork for AHS. Data collection, sharing, and dissemination systems and enhanced vehicle control systems are the basic elements of AHS. The way in which these systems develop and the acceptance they gain from the users shapes AHS evolution. AHS is not the end state of ITS; it is a part of ITS along with all of the systems that are deployed before it. Similar to previous system deployments, AHS is deployed initially on a regional basis in areas where it is most effective. Overall, ITS is deployed in an evolutionary process. Each deployment builds on the deployments that have preceded it.

4.0 CHARACTERIZATION OF PUBLIC AND PRIVATE INVOLVEMENT

The deployment vision illustrated in the preceding paragraphs could be achieved in several ways, one of them being different levels of involvement by the public and private sectors. Many issues will affect ITS deployment, including, public and market policies, technology developments, and institutional concerns. The manner in which these issues are resolved or shaped will directly impact how quickly ITS benefits can be realized through system deployments and how extensive deployment will be across the nation. The key participants involved in ITS are the public and private sectors. They significantly influence the resolution of issues, the formation of policy, and the generation and expenditure of funding. In the following paragraphs, the public and private sector participants in ITS will be characterized to frame an analysis of how these participants can affect particular issues of ITS deployment.

4.1 Public Sector

The public sector is represented by the Federal, State, and local governments. The Federal government provides guidelines, policies, and funding to the State and local governments for the construction and maintenance of transportation facilities including ITS. It is responsible for the national ITS perspective and for encouraging compatible system development. The tools available for the Federal government to make this happen are funding, policy generation, and legislation.

The State and local governments are responsible for the construction, operation, and maintenance of the transportation systems in their jurisdictions. They receive substantial funding from the Federal government to supplement State and local resources and are required, in some cases, to follow applicable Federal policies and guidelines. However, their principal concern is meeting the needs of their own jurisdictions. In terms of ITS, State and local governments are responsible for the deployment of public sector infrastructure in their areas.

The public sector level of involvement in ITS can be characterized by a continuum with two extremes being assertive and non-assertive. In order to simplify the following discussion, the Federal government portion of the public sector and the State and local government portion of the public sector will be discussed as separate entities. The Federal government provides an important variable. The actions of the Federal government, such as regular funding, funding incentives, regulatory initiatives, or other measures will have a direct impact on how the State and local governments approach ITS deployment. The State and local governments can each impact ITS deployment by their actions regarding the application of regular federal funding to ITS deployment projects, the generation of State and local funding for ITS deployments, and the coordination of deployments with neighboring jurisdictions. It is important to note that each State and local government has different operating environments, such as rural, urban, population density, geographic location and climate to name a few. They also differ in their ITS involvement and interest. For these reasons it is necessary, in some cases, to generalize their characteristics for this discussion. The following paragraphs describe how the extremes of public sector involvement can affect ITS deployment.

Involvement of the Federal government in ITS today can be characterized as non-assertive due to its limited amount of influence upon how the State and local governments spend their Federal dollars with regard to ITS. The Federal government primarily provides funding to the State and local governments for ITS research, operational testing, and planning programs. The Federal government encourages the use of ITS applications but does not require or fund ITS deployment directly. Decisions about whether to invest in ITS and which user services should be provided are left to the State and local planning processes. Some State and local governments are very assertive and are pursuing ITS vigorously. They have implemented studies and planning efforts that will make ITS a reality in their jurisdictions. Other State and local governments are not interested in ITS and do not see the need for it in their communities.

In an assertive public sector role, the Federal government could take a leadership role in the development of ITS on a national basis. In addition to encouraging compliance with the national ITS architecture, it could develop a definitive strategy to facilitate and provide incentives for the nationwide deployment of ITS. Federal-aid incentives could be used to encourage compliance with such a strategy and with the architecture. This would encourage the deployment of nationally compatible systems. At the present time, ISTEA does not require this type of involvement by the Federal government. At the State and local levels, an increased public sector role would imply that all States and local governments would be actively pursuing ITS applications where it was appropriate. The use of certain Federal funding mechanisms, such as incentives, would accelerate ITS deployment in some State and local areas. It is important to remember that the capacity of the State and local governments to deploy ITS is not just a matter of funding and policy, but includes skills availability and training, involvement of the academic community in research, and institutional capacity. If all State and local governments were to become active in ITS on their own, a nationally compatible system would require cooperation at the State and local levels and adherence to standards and the architecture. The Federal government is an effective variable in the public sector in establishing a nationally compatible system. Its level of involvement will affect how ITS is developed and deployed throughout the country.

4.2 Private Sector

The private sector in ITS consists of product and service providers, and private industries, such as CVO, that use ITS as a tool to increase the efficiency of their operations. Because the private sector is diverse and pursues many different opportunities, they move at different paces to develop their products and services. As a whole, the private sector is guided primarily by market forces. Product and service providers develop and sell their offerings to satisfy the demand of the market. Other parts of the private sector can respond to their non-ITS markets by providing their products and services at a lower cost due to efficiencies gained through ITS applications.

Similar to the public sector case, the private sector level of involvement in ITS can be characterized as a continuum with two extremes: reactive and proactive. The underlying motivation for the private sector change from a reactive role to a proactive role is increased confidence in the market potential of ITS. The following paragraphs describe how the private sector's level of involvement can affect ITS deployment.

The private sector's involvement in ITS today is one of exploration and understanding of the market. While there are some companies that are aggressively pursuing ITS product development, many companies are skeptical about the actual market potential of ITS. This skepticism provides the major variable component for the private sector characterization. If the private sector is skeptical about the market, it will not take substantial risks or make large investments in product and service development. It is reactive or responsive to market demands and opportunities as they appear but does not lead the market with investment. If the government provides funding to an ITS project, the government has essentially modified the existing market, and the private sector will respond to the new market accordingly.

At the other end of the spectrum, if the private sector is proactive because it believes in the large potential and opportunity of ITS, it will invest heavily in the development of ITS products and services. It will develop the market rather than waiting for the market to develop on its own. The private sector is more likely to take substantial risks based on the belief that the market is solid and has enormous potential for return on investment. It looks for opportunities to offer traditionally public sector services, such as electronic toll collection and traffic surveillance, through privatization.

4.3 Involvement Schemes

The varying levels of involvement of the public and private sectors are shown graphically in Figure 6-5. The public sector involvement level is shown on the vertical axis and the private sector involvement level is shown on the horizontal axis. This figure can be used to discuss the varying degrees of involvement of the two sectors and to speculate on the outcome of certain ITS issues. The quadrants formed by the axes represent involvement schemes, and they are numbered 1 through 4. These schemes will be used to analyze how ITS issues can be affected by differing involvement from the public and private sector participants. They have been presented in this manner to frame or bound a discussion or debate. In reality, the involvement of the public and private sectors in ITS will be somewhere on the continuum between the extremes. A single involvement scheme, such as an assertive public sector and proactive private sector, will not satisfy all issues. Since ITS involves so many different interests and participants, cooperation and compromise is the successful approach for moving forward.

5.0 ITS ISSUES

This section assumes an objective of achieving the evolutionary deployment vision set forth in Section 3.0 and projects the outcomes of each involvement scheme of public and private sectors for certain important issues. This section is intended to promote discussion on the most appropriate path to take. Some issues may be resolved better with a more assertive public sector, while others should be left to be resolved with the existing market forces. Most likely, a single involvement scheme will be unable to address all ITS issues in an optimal manner.

The following paragraphs identify selected ITS issues. This is a representative sample and is not intended to be a complete list of issues. Each issue is analyzed with respect to the impacts of the four involvement schemes. In this way, the influence of each involvement scheme on each issue can be described.

5.1 Issue: Sources of Funding - Operation and Maintenance Funding

Federal funding supplements State and local resources that are used to operate and maintain traditional transportation systems. Many State and local governments do not have the skills, training equipment, or funding to operate and maintain ITS in their current organizations. Providing the skill and equipment resources for ITS requires additional training and funding. This issue is analyzed below for each involvement scheme.

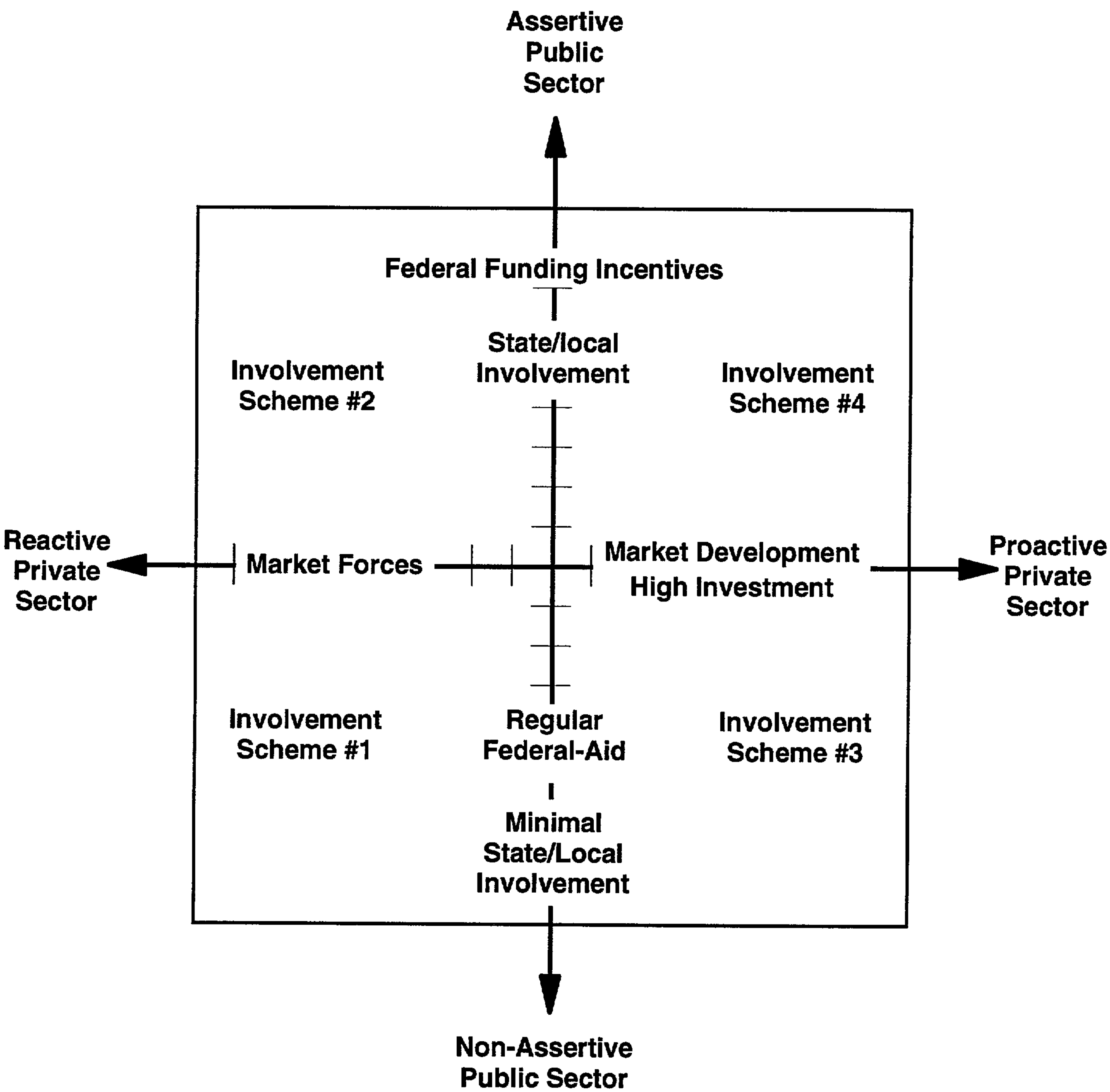


Figure 6-5 ITS Participant Involvement Schemes

1. Reactive Private/Non-Assertive Public - State and local operations and maintenance resources would be limited. Funding proposals would compete with other, traditional transportation demands in the regular Federal-Aid process. State and local ITS deployments would be low, reducing the demand on operation and maintenance resources.

2. Reactive Private/Assertive Public - Federal funding incentives would make more operations and maintenance resources possible at the State and local levels. This funding source would minimize competition with other, traditional transportation demands. Public sector ITS deployments would be high, increasing the demand on operation and maintenance resources.

3. Proactive Private/Non-Assertive Public - State and local operations and maintenance funding would be restrictive to ITS deployment. Privatization of traditionally public sector systems would be increased with a proactive private sector. Private sector funding would cover system operation and maintenance for those privatized systems. State and local ITS deployments would be low, reducing the demand on operation and maintenance resources at those levels.

4. Proactive Private/Assertive Public - Operations and maintenance resources would be available from Federal incentive funding, State and local funding, and private sector sources. This would minimize competition with other traditional transportation demands. State and local ITS deployments would be high, increasing the demand on operations and maintenance resources. Through public/private partnerships, privatization, and State and local government commitment, these demands can be met.

A more assertive public sector role would provide more Federal funding to the State and local governments to operate and maintain ITS, but possibly at the expense of other traditional transportation funding sources if the budgets remain consistent with today's. A proactive private sector can help offset some of the operations and maintenance costs through the privatization of public systems. The optimal approach for this issue is within involvement scheme 4 where there is strong support from the public sector in terms of Federal funding incentives and State and local ITS support. In addition, where there are areas that do not have State and local support, the private sector could provide operations and maintenance capabilities through privatization.

5.2 Issue: Extent of Deployment

The extent to which ITS is deployed, both in the types and numbers of systems deployed across the country, will be greatly influenced by the degree of involvement by the public and private sectors. Each sector will influence different areas of deployment, such as traffic management systems, traveler information systems, Commercial Vehicle Operations (CVO), or Emergency Management Systems (EMS). This issue is analyzed below for each involvement scheme.

1. Reactive Private/Non-Assertive Public - Deployment would be regional and uncoordinated. Pockets of deployment would center around the most active State and local governments. The Federal government would encourage State and local governments to comply with the national ITS architecture but would have no compliance mechanism. Deployment of infrastructure systems would be very slow. Some State and local governments would be deploying, however compliance with the national ITS architecture would not be consistent. Private sector deployments would be slow where significant infrastructure is required. The lack of a uniform ITS infrastructure would impede the development of infrastructure-dependent products and services. Market forces would determine what products and services sell in each region. National compatibility would be minimal.

2. Reactive Private/Assertive Public - State and local infrastructure deployment would be somewhat balanced and nationally uniform for incident management, traveler information, traffic control, public transportation, and emergency services. State CVO databases would be linked to share data. Public transit and multimodal options would be emphasized. Demand management would be possible. Federal funding incentives would be targeted for ITS deployment. These incentives would be tied to compliance with the national ITS architecture. The Federal government would facilitate the adoption of standards. Private sector markets would be expanded by the increase in infrastructure system deployments causing the private sector to react with more product development.

3. Proactive Private/Non-Assertive Public - In-vehicle and infrastructure-independent systems would be extensively deployed. Privatization would be common. The CVO community would be well-equipped and compatible with participating States. Strong advertising and market development would expand the private sector market. The private sector would facilitate industry standards development. State and local systems would purchase transportation data from the private sector. Transportation management, including public transportation, would not be extensively deployed.

4. Proactive Private/Assertive Public - Deployment would be rapid and robust with compatibility and architecture compliance. Standards development and adoption would be accelerated. State and local systems would collect traffic data, and the private sector would disseminate it. Services are functional and deployed in most parts of the country. Federal funding incentives would augment State and local funds for infrastructure deployments. Large investments are made by the private and public sectors.

A proactive private sector and assertive public sector approach, scheme 4, would result in uniform and extensive ITS deployment, but at the highest cost. The outcome desired from this issue requires that a decision be made concerning the available amount of money and the base of deployment that is needed. Assertive State and local governments could provide more extensive transportation data collection, while a proactive private sector could produce extensive data dissemination capabilities.

5.3 Issue: Achievement of Public Goals

The achievement of public goals (e.g., improving safety, system efficiency, intermodal connectivity, and achieving national uniformity) is influenced mostly by the level of involvement by the public sector. National goals are influenced by the Federal government and regional goals are influenced by the State and local governments. The achievement of public goals impacts the support of the general public for the ITS program. This issue is analyzed below for each involvement scheme.

1. Reactive Private/Non-Assertive Public - Emphasis on public transportation and intermodal connections would not be realized. Only a limited number of areas would achieve sufficiently broad deployment to fulfill significant public goals. Rural services would be very slow to develop. The attainment of regional and local goals through ITS deployment would be realized only in assertive State and local areas. The Federal government would encourage the deployment of ITS to attain national goals and funding would come from Regular Federal-Aid. The private sector would only address the attainment of public goals where it involved the market opportunity, such as the individual traveler.

2. Reactive Private/Assertive Public - State and local deployment would be driven by the need to meet public goals. Since the private sector addresses the individual traveler and consumer, those users may not be addressed in an effective manner due to delayed response of the private sector. National goals achievement would be assisted through the implementation of Federal funding incentives. Public transportation, intermodal connections, public safety, and rural services would be addressed by the State and local governments.

3. Proactive Private/Non-Assertive Public - Some national goals would be achieved if they align with individual traveler and consumer needs. The private sector would aggressively pursue the individual traveler and consumer needs and goals due to the market opportunities. Where privatization of public services was available, those areas would realize increased public goals attainment in public transit and safety. Public transportation, intermodal connections, public safety, and rural services may not have sufficient markets to develop public goals adequately. The attainment of regional goals would be limited to the more assertive State and local areas.

4. Proactive Private/Assertive Public - A robust market would promote maximum deployment which would focus on public goals. National and regional goals would be achieved through Federal funding incentives and assertive deployment pursuits by the State and local governments. The recognition and attention to market opportunities by the private sector would also support the achievement of national and regional goals.

National and regional public goals will be achieved more quickly with increased involvement by the public sector. Involvement schemes 2 or 4 will address this issue most favorably. The

State and local governments will have the largest impact on public goals since they will be the primary deployers of ITS. National goals achievement would be assisted through the implementation of Federal funding incentives. Public transportation, intermodal connections, public safety, and rural services would be addressed by the public sector. The impacts of the private sector will be most noticed in the areas of individual traveler and consumer products. They will address the public goals of safety and efficiency.

5.4 Issue: Market Stimulation

Stimulation of a strong domestic ITS industry that is able to compete effectively in a global marketplace can be influenced by different levels of public and private involvement. The public sector can modify the market with funding and deployment, while the private sector can accelerate the market through investment and development.

1. Reactive Private/Non-Assertive Public - National market stimulation would be slow. Regional infrastructure and in-vehicle systems markets would be proportional to the involvement of the State and local governments in ITS and the needs of the communities. The private sector would respond to market demands. Electronic payment and CVO would develop competitive markets. The U.S. ITS industry would be slow to address the global market.

2. Reactive Private/Assertive Public - National market stimulation would be high for public sector systems such as traffic management and public transit, and emergency management. State and local infrastructure would modify the market and attract the private sector. Private sector products and services would increase following public sector stimulation. The U.S. ITS industry would address infrastructure systems in the global market.

3. Proactive Private/Non-Assertive Public - National market stimulation would be high for in-vehicle and infrastructure-independent products and services. Existing infrastructure systems, such as cellular, would exploit the ITS market. State and local systems would be overshadowed by the surveillance capabilities implemented by the private sector. The public sector would expand the private sector market opportunities by purchasing transportation information from private sector providers. There would be a broad range of internationally competitive in-vehicle and infrastructure-independent products and services.

4. Proactive Private/Assertive Public - National market stimulation would be high in all areas of ITS. State and local infrastructure systems would be nationally compatible and uniform in distribution. Private sector products and services would be robust and ultimately depend on the consumer's view of value for the price. There would be a broad range of internationally competitive products and services.

Involvement schemes 2, 3, and 4 provide increased market stimulation. Increased Federal funding can increase the deployment of infrastructure systems by State and local governments.

These deployments modify the market to promote additional private sector development for infrastructure-dependent products and services. In schemes 3 and 4 the private sector invests heavily to develop the markets for its products and services. Public sector funding could be used to begin infrastructure deployments. As these systems become established across the country, the private sector will become more involved with products and services to deliver information and capabilities to the user. The global market is addressed uniformly in scheme 3 and 4 since competition for in-vehicle systems in the global arena requires a very strong private sector involvement.

5.5 Issue: Interagency Cooperation

Strong alliances must be built to share travel information, coordinate activities, and involve the private sector in developing effective, innovative information distribution outlets. This issue is analyzed below for each involvement scheme.

1. Reactive Private/Non-Assertive Public - Interagency cooperation exists only in State and local communities that are active in ITS. Deployment in this situation is mostly regional and not interoperable. There are no incentives to cooperate.

2. Reactive Private/Assertive Public - Interagency cooperation is high on State and local government systems. The Federal government would provide funding incentives to promote interagency cooperation. The private sector cooperates in a supporting role. State and local agencies would form alliances to share data and provide complementary services.

3. Proactive Private/Non-Assertive Public - Interagency cooperation may be stimulated by the private sector on a regional basis. Increased activity and privatization would force the private sector to seek cooperative arrangements with some State and local agencies.

4. Proactive Private/Assertive Public - Interagency cooperation would be stimulated by both sectors. This would facilitate the deployment of richer databases and more accurate and timely data for travelers and emergency services.

Interagency cooperation is mainly affected by State and local government involvement. Participation by State and local agencies in either involvement schemes 2 or 4 would facilitate optimal cooperation. State and local priorities could be placed on coordination activities.

5.6 Issue: Privacy

This issue focuses on how policy concerning privacy is developed. Privacy concerns could slow deployment significantly due to lack of consumer confidence, acceptance, and participation. Privacy issues could hinder development of many systems such as traffic surveillance using probes and AVI. This issue is analyzed below for each involvement scheme.

1. Reactive Private/Non-Assertive Public - Privacy concerns would be raised primarily at the State and local levels. These concerns would focus on the retention of data by the public agencies. A voluntary privacy policy would be adopted within the private sector.

2. Reactive Private/Assertive Public - Privacy concerns would emerge at the local, State and national levels. These concerns would focus on public collection and retention of personal data. National privacy and data security policies would be adopted.

3. Proactive Private/Non-Assertive Public - Significant privacy concerns would be raised about private sector use and resale of personal data. These issues would slow user acceptance of certain systems. Private sector companies would be innovative in securing data and develop internal enforcement mechanisms, however this would have minimal impact overall.

4. Proactive Private/Assertive Public - National ITS policy and data security policy compliance would be required as condition of some Federal funding. State and local governments would levy national and regional privacy and data security policy requirements on public sector procured systems. The private sector would comply with national policy and establish internal enforcement mechanisms.

This issue surfaces the general public's concern of personal data retention in computer databases. The general public has historically trusted Federal, State, and local privacy guidelines more than those of the private sector. They do not see the private sector as being able to accomplish privacy policy on its own. The privacy issue is also very important to the commercial operator who must protect competitive information. Involvement schemes 2 or 4 will provide the general public with the most acceptable range of participation by the public and private sectors.

5.7 Issue: Deployment Cost

The source of deployment funding will vary according to the public and private sector levels of involvement and will affect how deployment costs will be distributed. This issue is analyzed below for each involvement scheme.

1. Reactive Private/Non-Assertive Public - Deployment costs would come from limited Federal-aid sources. State and local agencies would be forced to deploy with the funds that are used to construct and maintain their entire transportation system. The private sector would only deploy in areas for which there is low risk and substantial return on investment. Consumer products may not be affordable for everyone.

2. Reactive Private/Assertive Public - Federal funding incentives could be available for those communities wishing to deploy ITS. Increased funding with minimal direction to the State and local governments maximizes the flexibility that the States and locals have to implement ITS. The private sector would address the increased activity in the public sector market, but some consumer products and services may not be affordable for everyone.

3. Proactive Private/Non-Assertive Public - State and local deployments are funded through regular Federal-aid sources. The private sector would invest heavily in ITS and, through privatization and data collection alternatives, it would provide some public sector systems. Consumer products and services profits would be reinvested in improvements and enhancements.

4. Proactive Private/Assertive Public - State and local deployment costs would come from Federal, State and local sources. Federal funding incentives could be available for the communities that want to deploy ITS. The private sector would invest heavily in ITS and enter into cost-sharing agreements with State and local governments.

Involvement scheme 3 provides the least financial burden for Federal, State, and local funding. Private sector investment is recovered through the sale of products and services in the market place. Deployment costs are distributed equitably among those who purchase products and services.

5.8 Issue: Relationship of ITS to Other/Non-Transportation Services

ITS will make non-transportation services such as health care, education, and recreation readily available to users. ITS also has a relationship to other services as an outlet for transportation information. For example, the existing communications infrastructure provides communications capabilities to the transportation system. This issue is analyzed below for each involvement scheme.

1. Reactive Private/Non-Assertive Public - Other services do not see the potential in ITS and, at most, would see it as a small subset of their market.

2. Reactive Private/Assertive Public - State and local governments would look for ways to exploit existing infrastructure to lower costs of ITS deployment. Where outlets are not available, the public sector would invest in their development. The private sector would respond to public sector investment.

3. Proactive Private/Non-Assertive Public - Private sector industries, such as communications, would see the opportunities in ITS and begin working closely with State and local agencies for ways to expand the communications infrastructure to best suit ITS needs and the needs of other markets. This would result in the expansion of both markets.

4. Proactive Private/Assertive Public - State and local government and the private sector would work closely to apply existing infrastructure in non-transportation services to ITS. This would result in the expansion of both markets.

Involvement scheme 3 would provide the most efficient use of existing infrastructure to ITS through a proactive private sector. This would catalyze the expansion of both ITS and the non-transportation market.

5.9 Issue: Effect on State and Local Choice

State and local governments bear the responsibility to the general public to meet local transportation needs. Flexibility and control in meeting those needs with ITS deployment is highest when they are provided adequate funding and not limited by Federal restrictions. This issue is analyzed below for each involvement scheme.

1. Reactive Private/Non-Assertive Public - The use of regular Federal-Aid funds provides the State and local governments with flexibility.

2. Reactive Private/Assertive Public - The Federal government could offer Federal funding incentives to State and local governments. The influence this has on State and local choice depends on the extent of restrictions placed on the incentives and the extent to which they can fund deployment with State and local funds. If restrictions are few and funding availability is high, State and local choice is maximized.

3. Proactive Private/Non-Assertive Public - Private sector deployment relieves some of the burden on State and local agencies for deployment costs. The State and local governments preserve their choice in the use of regular Federal-Aid funds. However, State and local agencies may have little leverage over privately-operated systems. The proactive private sector maximizes the choices available to the State and local governments.

4. Proactive Private/Assertive Public - Federal funding incentives could restrict State and local decisions. Privatization may narrow the public sector influence.

State and local choice is maximized in involvement schemes 1 and 3. Scheme 3 actually provides more choices since the private sector is producing more products and services to choose from, and alliances between the public and private sectors can be formed to share costs. Assertive State and local governments who decrease their reliance on Federal funds and increase the generation of State and local funds along with private sector partnerships will have the maximum flexibility possible.

6.0 CONCLUSION

There are both favorable and unfavorable outcomes when the various involvement schemes are applied to the issues in section 5. For example, the extent of deployment could be positively affected by the increased involvement of both the public and private sectors. A proactive private sector could stimulate a national market for in-vehicle and infrastructure-independent products and services, while State and local infrastructure systems, such as transportation management and public transportation management, benefit from an assertive public sector. State and local choice is maximized by increased Federal funds and decreased Federal requirements. The vertical and horizontal axes in Figure 6-5 represent an continuum of involvement for the public and private sectors. While the endpoints represent the extremes for each sector's involvement, there are many intermediate levels that are more realistic. The actual roles will be less clearly-defined than the extremes and will represent a consensus approach for ITS. From the previous discussion of the roles and issues, no single involvement scheme emerged to satisfy all of the issues simultaneously. However, the extremes for each role frame the discussion or debate that needs to take place concerning ITS deployment and the roles of the public and private sectors.

The involvement of each of the participants in ITS impacts deployment on both a national and a local level. The funding allocations required for each one of the schemes will be different. The public sector's approach will dictate the amount of Federal, State and local funding needed. If the Federal government uses Federal incentives, that funding will be taken from other sources to be applied to specific areas of interest, unless new sources of revenue are instituted. The more assertive the State and local governments become, the more public money it will take to fund the program. The private sector will invest more money as it becomes more proactive. Investments must be made considering the short and long term returns. Investments are also made on the basis of whether the deployment of a system today leads to the deployment and increased profit of a new system in the future.

With this basic understanding of the public and private sector roles and a vision of how ITS could be deployed, it would be helpful to reach some degree of consensus on how ITS should proceed. A fundamental theme of the vision presented in Section 3 is the importance of transportation data to private sector products and services, public sector systems, and the individual traveler. The collection, exchange, and dissemination of transportation data is the basis for many ITS services. It forms a "core infrastructure" around many of the user services function. The development of that core infrastructure in the near-term will assist the development of other services. To accomplish this goal, infrastructure is required to collect the data, communications facilities are required to make the data available to multiple systems, and products and services are required to present the data to the user. As discussed in Section 5, issues concerning infrastructure deployment, such as operation and maintenance funding, extent of deployment, market stimulation, and interagency cooperation all benefit from increased or more assertive involvement by the Federal, State, and local governments. Federal involvement through funding, encouragement, and leadership will stimulate the development of a core infrastructure that will provide the basis for ITS market expansion. Assertive State and local involvement in the deployment of ITS, specifically core infrastructure systems, will make the expansion of the ITS market a reality. A more proactive private sector will positively impact the development and dissemination of transportation data through the use of existing and new communications infrastructure and product and service deployments.

6.1 Recommendations for ITS Deployment

A clear national interest exists in:

- Realizing the benefits of enhanced transportation management, traveler services, safety, and productivity.

- Establishing the U.S. ITS market early to gain a competitive global advantage for the domestic ITS industry.

To further this national interest, it is recommended:

- That the U.S. DOT be more assertive initially in facilitating the deployment of ITS information and communications infrastructure, leveraging off of private sector facilities and services wherever feasible -- a first step could include establishing and stimulating the communications and information infrastructure needed to deliver many of the ITS services,

- That the private sector retain primary responsibility for the development and commercialization of transportation information delivery and in-vehicle systems, and

- That ITS America continue as the focal point of the public-private partnerships needed for nationwide implementation of the ITS program.

To accomplish this, the following roles are recommended.

Federal Role: To support the timely deployment of the information/communications infrastructure necessary to foster a range of ITS information services, the U.S. DOT will need to:

- Stimulate and help fund the design, development, and deployment of major elements of the information/communications infrastructure,

- Facilitate the development and coordination of travel and transportation management data bases, and

- Catalyze the necessary public and private institutional relationships.

The U.S. DOT should carry out these objectives by a system of funding incentives rather than regulatory mandates. Where appropriate, new Federal funds should be identified to seed the development and deployment of infrastructure utilizing or in partnership with the private sector wherever feasible. Consideration should be given to the use of private money and regular ISTEA funds on a matching basis.

To aid in achieving these objectives, it is also appropriate for the U.S. DOT to:

- Play an active role with public/private partnerships in defining and securing communications spectrum,

- Facilitate, with public/private partnerships, the near-term development of key communications and interface standards in such areas as traveler information, electronic clearance, and electronic toll collection deployment, for example.

The U.S. DOT should continue to invest in long term research, such as AHS, as well as intermediate development and operational testing in partnership with the private sector. The U.S. DOT should also continue to develop the partnership with the private sector both directly and through ITS America.

State and Local Government Role: The role of the State and local governments is to determine the needs of their communities and deploy information/communications infrastructure to satisfy those needs. To fulfill this role, they should make short and long range plans for the deployment of ITS in their jurisdictions and be aware of the ITS solutions available for their specific transportation problems. The State and local governments should work closely with the U.S. DOT, the private sector, and ITS America to coordinate deployments to achieve national compatibility.

Private Sector Role: The primary role of the private sector is to build and commercialize ITS products and services and to market them to consumers, industry, and the public sector. To fulfill this role, the private sector needs to invest and engage in a variety of activities including research and development, market research, pilot tests, deployments, and system evaluations. However, the decision for members of the private sector to take these actions is not centralized. It consists of hundreds of individual decisions based on the perception of feasibility, marketability and the level of acceptable risk. The private sector must be prepared to take substantial risks in deploying both infrastructure systems and products, since many will be available in advance of well-developed infrastructure and markets.

A well-balanced public sector role, in deploying the fundamental infrastructure needed to support in-vehicle, traveler, and other end-user information products, is vital in encouraging private sector decisions. The public sector role must be vigorous enough to stimulate private sector participation, but not so assertive as to preempt the private sector role. Close cooperation between the private and public sectors is indispensable for achieving this balance.

ITS America Role: The ITS community, along with Congress through ISTEA, recognizes that ITS will be developed and deployed most effectively through partnerships among the public sector, the private sector, and academia. ITS America is the embodiment of this partnership and is playing a crucial role in bringing the participants together to work cooperatively in the creation of a national ITS program.

ITS America has a continuing role in bringing new interests and constituencies into the ITS process, broadening the base of ITS involvement through its technical committees and State chapters, disseminating information through electronic and other means, and building international relationships. ITS America is key in guiding and building the consensus for the national ITS architecture and for coordinating the development of standards and protocols. It plays an important role in building support and providing education about ITS through its outreach program. ITS America's involvement in consensus building has focused attention on technical and non-technical issues as well as promoting intermodalism. ITS America represents a consensus forum through which the ITS community and the U.S. DOT can communicate ideas and concerns.

The recommendations and issues presented in this chapter must be considered and discussed by the ITS community, including the U.S. DOT. A strategy for deployment and the most effective involvement of the participants must be implemented. ITS deployments will continue to take place. Without a consensus direction of how ITS should proceed and without actions to steer its course, ITS deployment is left to forces that may not yield a nationally compatible ITS system.

CHAPTER VII - DEPLOYMENT CONSIDERATIONS

1.0 INTRODUCTION

The successful deployment of ITS products and systems hinges on surmounting both technical and nontechnical challenges. Dedicated efforts will be required to facilitate the negotiation of these challenges. The information intensive nature of ITS requires fundamental changes in the institutional aspects of how transportation business has been conducted for many years. The Congress recognized the importance of nontechnical issues by requiring the U.S. DOT to submit a report assessing these challenges confronting deployment. To fulfill this requirement, the U.S. DOT implemented a research program evaluating a whole range of institutional considerations associated with facilitating deployment. Addressing institutional issues as a routine aspect of most ITS deployments will be an on-going and concerted effort. While this effort drives development of solutions to nontechnical problems, the research communities in the private sector, academia, and Federal government agencies will dedicate their efforts to surmounting technological hurdles impeding deployment of ITS applications and products which satisfy needs of local communities and have strong market acceptance. Compelling as they may be, challenges to deployment will be overcome in stages. Some problems will be posed in the near-term and some will exert their influences throughout the evolutionary deployment period.

The objective of this Deployment Considerations chapter is to address some of the near- and long-term challenges and to offer recommended approaches for their resolution. This chapter initially addresses some near-term activities for dealing with barriers that inhibit the achievement of the five-year vision presented in Chapter VI, Deployment. This is followed by a discussion of major categories of long-term issues confronting deployment with recommendations for program element definition and initial year funding.

2.0 THE NEAR-TERM CHALLENGES - MAKING A DIFFERENCE SOON

Facilitating ITS deployment in accordance with the vision described in Chapter VI, Deployment requires recognition of the challenges and barriers. The five-year vision presents an opportunity to implement solutions to the barriers that exist in that timeframe and measure their success in the near-term. The environment for achieving the five-year vision of ITS deployment will be essentially the same as it is today. ISTEA will remain in effect until 1997. Current Federally funded programs will continue at levels determined on an annual basis. Measures to facilitate ITS deployment will be shaped from the experiences gathered from on-going activities. As these lessons are learned, they will point to new approaches, some of which are discussed in Chapter VI. In the five-year timeframe, deployment decisions will continue to be made in a distributed or local manner. Near-term deployment will be influenced by modest, but sound, program adjustments. From the experiences of current deployment and the vision of deployment in the five-year timeframe, the following deployment challenges have been identified:

There is *inadequate sensor infrastructure* in place to support robust data collection.
The *lack* of nationally *accepted standards* is inhibiting development and marketing of certain products and systems.
Market uncertainty is fostering caution in private sector product developers and service providers.
Operations and maintenance requirements and funding for ITS are not accommodated in existing planning and budget processes in some transportation agencies.
Privacy is a concern for participants in programs which require vehicle tracking.
Liability concerns arise from introducing in-vehicle systems which could either distract drivers or assume some control over the vehicle.
Partnerships are encountering difficulties.

The following paragraphs address each of these challenges and present recommendations to resolve them.

2.1 Issue: Sensor Infrastructure

The national sensor infrastructure deployment base is neither adequately robust nor available to support system applications dependent on real-time traffic information. Several metropolitan areas have made significant investments in loop detectors and closed circuit television cameras, with supporting microwave capabilities. Some operational tests feature vehicle probes. The potential for expanding the sensor infrastructure to enable dynamic route guidance or to enhance traffic control and incident management is limited by cost and technology constraints. A related technical hurdle in the case of dynamic route guidance is filtering relevant traffic data for directed transmission to individual receivers. Under ISTEA, local and regional jurisdictions installing and operating the sensor infrastructure must take the initiative to invest based on a cost/benefit analysis. Their priorities, as well as the priorities of legislative assemblies and elected officials, may lie in other areas and they may be sensitive to the associated ITS operations and maintenance costs. Expanding the sensor infrastructure must be “sold” to local and regional decision-makers as a beneficial investment.

Program Recommendation: Sensor Infrastructure - 1

Currently, there are six operational tests, in varying stages of maturity, which are centered on the installation and use of sensor-based systems for traffic management and traveler information: ADVANCE; Borman Expressway Advanced Traffic Management Systems; “Capital’‘-Washington, D.C. Area Operational Test; Connecticut Freeway Advanced Traffic Management Systems; DIRECT; and FAST-TRAC. A Federal government initiative should be explored which assembles a “lessons learned/benefits analysis” presentation on these test experiences to date. The FHWA field organizations should offer this presentation to State and local transportation organizations and municipal planning organizations at appropriate times in their planning cycles. In jurisdictions with an expressed desire to expand traffic management/traveler information capabilities, these levels of government should be provided access to as much public domain information in this area as is practical.

Program Recommendation: Sensor Infrastructure - 2

ITS America should convene the privately operated, nationally based traffic advisory enterprises (Metro-Traffic and Shadow Traffic) to explore means by which their advisories could be converted to media more compatible with traffic management center operations such as digital communications. If traffic data could be transmitted in digital media to subscribers supported by associated billing capabilities (inherent in cellular operations, for example), privatized infrastructure might increase rapidly.

2.2 Issue: Lack of Nationally Accepted Standards

Near-term, nationally accepted standards are needed to reduce product and system development risk. The National ITS Architecture Development Program will help identify required ITS standards and protocols when it is completed in mid-1996. However, several required standards have already been identified and can be developed prior to the adoption of a national architecture to facilitate near-term deployment. Some of these standards are being developed now. The following program initiatives are recommended:

Program Recommendations: Standards - 1

Development should be expedited for standards that are independent of a national ITS architecture and that can support near-term ITS deployment. Examples of such standards include: electronic payment and automatic vehicle location (such as for public transportation and commercial fleet applications), map databases, and traffic management system interface protocols. Standards for electronic payment should be coordinated with other interested parties such as the financial industry.

Program Recommendation: Standards - 2

Using the results of Phase 1 of the National ITS Architecture Development Program, the architectures should be examined to determine which additional standards and protocols are required. These additional standards and protocol requirements should be prioritized and then developed accordingly. The review and prioritization process should be repeated when the national architecture is adopted at the conclusion of Phase 2 in mid-1996.

Program Recommendation: Standards - 3

Development of the enhanced 9-l-l standard to assist emergency response services in locating emergencies should be expedited if the standard is determined to be architecture-independent. The enhanced 9-l-l standard should be developed in conjunction with the 9-l-l community.

Early development of an enhanced 9-l-l standard will posture emergency response services for wide deployment.

2.3 Issue: Market Uncertainty

The Volpe National Transportation Systems Center (VNTSC) is developing electronic toll collection (ETC) user acceptance case studies. Data emerging from these case studies should be disseminated widely throughout the ETC community. On a regional basis, this information will provide States, MPOs and private sector service providers a comprehensive understanding of ETC users' willingness to pay. Providing this type of information to deploying entities is critical because, among the several factors generating market uncertainty, two appear most compelling:

- the perception that the service will be expensive, and
- the lack of validated information to establish the value of the service in the marketplace.

The increasing number of ETC projects, either in operation or in planning, suggests that the service is meeting with increased acceptance. New York, Illinois, Kansas, Oklahoma, Florida, Texas, Virginia, and Washington, among others, have or are planning ETC projects usually in some partnership-consortia arrangement.

Experiences from several operational tests deploying other systems have been documented in the IVHS Institutional Issues and Case Studies report prepared by Science Applications International Corporation (SAIC) for VNTSC. In this report, some measures have been identified as applicable for ETC projects. The following recommendations draw upon the case study experiences. This issue of Market Uncertainty is also covered as a long-term challenge in Paragraph 3.7 of this chapter.

Program Recommendation: Market Uncertainty - 1

Organizations/partnerships or consortia approaching the deployment of ETC should include representatives of the user community (as defined in the particular deployment area) in their planning, testing, and evaluation phases. Establishing communication channels at the local government level to reach citizens provides early and reliable insights into the acceptance of ETC at projected, full deployment price levels.

Program Recommendation: Market Uncertainty - 2

In public/private partnerships, the public sector participants should take an active role in assisting the private sector participants with marketing efforts. In the Westchester Commuter Central (WCC) project, Westchester County experienced significant success through active public sector involvement in assisting private sector partners.

Program Recommendation: Market Uncertainty - 3

The ITS America/U.S. DOT outreach program should lend strong emphasis on the successes and benefits of ETC projects underway. The successes and benefits should be balanced with representative sample costs.

2.4 Issue: Operations and Maintenance

Systems delivering incident management and traffic management are maintenance-intensive and require dedicated operational facilities and staffing. The challenge associated with supporting operations and maintenance is centered on identifying funding sources and developing rewarding career fields in the private and public sectors for long-term sustainment. Deployments which have successfully coped with establishing and sustaining operations and maintenance programs have followed thorough planning procedures. The early recognition of the need and commitment to raise and allocate dedicated funding, have been key elements in successful deployments. In Chapter VI, Deployment, a scenario is presented in which the Federal government takes an active role in guiding and funding ITS deployments and activities. A highly beneficial Federal investment possibility in this environment could be funding targeted at operations and maintenance activities.

Program Recommendation: Operations and Maintenance

The tailored outreach recommendation outlined in Paragraph 3.1 advocates a multi-disciplinary team interacting with transportation planners. Consideration would be given to operations and maintenance issues addressing sustainment of newly installed facilities. The ITS Early Deployment Planning Program, while not heavily focused in this area, identifies operations and maintenance as a consideration.

2.5 Issue: Privacy

Privacy is an issue of concern in almost every ITS deployment where information is recorded. In this discussion, the areas of AVI and AVL provide the most illustrative examples. Program recommendations to mitigate privacy concerns associated with expanding AVI and AVL systems are derived from experiences in several operational tests where the privacy impediment was confronted. HELP/Crescent, TravTek, ADVANCE and TRANSCOM/TRANSMIT all included technologies that enabled the identification, location and speed of the individual vehicles being tracked. This concern, sometimes referred to as the “Big Brother” issue, was perceived by truckers participating in HELP/Crescent to enable the Federal government to initiate a national-level weight/distance tax using AVI. This tax, which is based on a combination of weight and distance traveled, is unpopular with trucking companies and delayed the project’s ability to recruit carriers to participate in the program. On a different level, individual truckers who were interviewed felt that transponders would allow truck company management to track their movements and impose sanctions or penalties.

TravTek and *ADVANCE* experienced similar challenges in recruiting volunteer drivers from the public at large. The system operation and evaluation aspects of *ADVANCE* required tracking drivers over several years, versus a maximum of two months for TravTek. While TravTek did not experience serious recruitment problems, there are some residual concerns among *ADVANCE* participants, even though they are not tracked in real time as is the case in TravTek.

Those participating in TRANSCOM/TRANSMIT expressed a general concern about the perception that government could, at any time, know the whereabouts of any vehicle using the system and track vehicle speed for enforcement purposes.

Against this background of recent operational test experiences, the following summary describes the mitigation strategies employed to address the privacy concerns. This summary is in the form of program recommendations which are offered from the sole perspective of overcoming the privacy challenge in deploying ITS systems and without any intent to promote the obstruction of traffic law enforcement.

Operational test mitigation strategy summarv: The most effective means of protecting driver identity is in the design of in-vehicle units and the way in which a system is operated. Both the *ADVANCE* and TravTek partnership participants ensured that volunteers from the general public were made aware that their locations would be tracked. In both cases, databases containing the names of participants were separated from databases containing the operational information (i.e., how the systems were used, etc.). In the case of TRANSMIT, authorities defused privacy issues before they surfaced. TRANSMIT uses a random number system, therefore, it does not track or maintain vehicle identification records. Project authorities have adopted a policy not to release vehicle speed/travel time information to enforcement authorities. Prior to implementation, TRANSCOM will promote a public information campaign to explain clearly what government can and will not do with the data it gathers.

Program Recommendation: Privacy - 1

It is recommended that partnerships deploying AVI and AVL systems sponsor a study to determine and gain consensus for an optimal approach for protecting driver identity. A key element of the study should be the feasibility/advisability of implementing management systems which compartmentalize databases to preclude revealing driver identity.

Program Recommendation: Privacy - 2

It is recommended that prior to system implementation, the issue of the release of vehicle speed data to enforcement authorities be addressed and decided by deployment partners, and a comprehensive public/participant education/awareness program be implemented.

2.6 Issue: Liability

Liability has been identified as an impediment to expanding collision avoidance deployments as well as some in-vehicle navigation displays. The components of ITS, such as new technology, innovative approaches to problems, and exposure to the public, collectively raise concerns about liability. The liability concerns include system components which could distract drivers, provide incorrect or illegal directions, overload drivers with information, or fail to operate as advertised. The operational test experiences involving liability, though informative, are of limited value. The test partnerships "worked around" the problem by having participants sign informed consent forms which spell out the risks to the driver as a result of participation in a test. These forms also advise participants of the right to drop out at any time without penalty.

The most obvious mitigation strategy for liability concerns is to design safety into systems. For example, TravTek, the General Motors' driver display interface design precluded the driver from manipulating the screen while the vehicle was in motion. When the engine was started, the display would flash a disclaimer that the system was experimental and that safe driving was the driver's responsibility.

Data collected from operational test experience was obtained from project management personnel. In all cases these managers had no knowledge of the legal foundation for determining liability. The following program recommendations are presented to establish an information base from which a clearer picture may be defined.

Program Recommendation: Liability - 1

It is recommended that the Federal government conduct a review of the legal foundations of liability for in-vehicle systems and provide a report. The objective of this report is solely to provide interested stakeholders with an understanding of the factors incurring liability.

Program Recommendation: Liability - 2

It is recommended that ITS America conduct exploratory discussions with automobile insurance association representatives to determine the industry's position with regard to insuring drivers with ITS devices.

2.7 Issue: Partnerships

Shortcomings in partnership arrangements have been singled out as impeding the expansion of future electronic clearance as a central CVO service. In developing program recommendations to mitigate this challenge, case studies conducted on the HELP/Crescent and Advantage I-75 operational tests were used. Advantage I-75 is a CVO project established as an international public-private partnership. It provides a test-bed for deploying advanced technologies designed to increase transport efficiency along I-75. The Heavy Vehicle Electronic License Plate (HELP) Program was a multi-state, international research effort to develop an integrated heavy vehicle monitoring system using AVI, automated vehicle classification (AVC) and weigh-in-motion (WIM) technologies. Advantage I-75 is in the installation and pre-testing phase, while the HELP/Crescent operational field test was concluded in September 1993. The HELP operational deployment continues under the auspices of HELP, Incorporated. A summary of partnership problems evident in both projects include the following:

- Lack of trust among partners.
- Poor communications between partners.

Lack of trust in the CVO projects originated from a trucking industry perception that their public sector counterparts were principally motivated by developing the use of technologies for implementing weight/distance taxation. This problem was aggravated, possibly unintentionally, by the exclusion of the trucking industry as a fully vested partner in the design of CVO initiatives. Finally, there is a traditional “regulated” vs “regulator” relationship between the two partners. In this area of ITS, the users are regulated by the public sector while concurrently playing the key role in transportation. National and State trucking associations, though not always in harmony, exert significant influence. These organizations were cited by the case studies as not being included as full partners in the CVO projects.

Poor communications are cited in the case studies as being prevalent during some phase of the CVO projects. One major reason noted is the large number of organizational players involved. Single representatives from the States managed the interests of multiple State organizations without being able to coordinate across all appropriate State agencies. This was evident in defining goals and responsibilities in the conduct of project phases.

The following measures were implemented to improve these partnership areas:

- Lack of trust between the public and private sector participants in both CVO projects was significantly improved by involving the trucking industry in the design of the systems.
- Communications have been enhanced by public sector measures to accommodate the interests of all meeting participants. States with multiple representatives at ITS meetings can feed their concerns to a single State representative who integrates a State position on

issues. Some State departments of transportation have created an ITS program office to serve as the focal point for ITS matters. This has been beneficial to State DOTS, but not necessarily to other State agencies whose positions are not represented frequently by DOT ITS focal points.

In light of this experience base, the following program recommendations are made to improve the potential for near-term CVO deployment.

Program Recommendation: Partnerships - 1

It is recommended that private-public partnerships undertaking CVO deployments involve appropriate trucking industry associations at the beginning of the project, and solicit their participation in system design, deployment, and operation.

Program Recommendation: Partnerships - 2

It is recommended that State DOTS undertaking CVO projects designate a single focal point office for ITS activities and empower that office to coordinate across State agency lines.

3.0 LONG-TERM CHALLENGES - AN OVERVIEW

While acknowledging the merit of measures which can accelerate near-term deployment activities, it is important to retain a long-term perspective in pursuing the vision of ITS in to the next century. Some deployment challenges will endure throughout the evolution of ITS deployment.

There are a number of issue categories which have been identified as crucial to the successful expansion of ITS applications to transportation problems. The following sections are summaries of the categories with associated major issues and recommended program approaches designed to promote resolution. Applicable on-going initiatives whose results will contribute to resolving these issues are also identified. The programmatic specifics associated with the program recommendations (i.e., funding, program definition, etc.) are not included, but the timing for recommended actions is addressed. The programmatic details will be added to the NPP when:

- an approved recommendation is integrated into the budget formulation process at the U.S. DOT, or
- the appropriate non-Federal organization has accepted an activity recommendation and developed implementation details.

The issue categories identified as mainstays of the deployment support program throughout the evolution of ITS are:

- Organizational and Cultural Change
- Partnerships
- Procurement
- Environmental Considerations
- Legal Implications
- Outreach
- Market Uncertainty and Risk
- Societal Issues

The organizational scheme in this section outlines the *Zssue,* defines the *Dimensions of the Challenge,* presents a *Summary Assessment* of needed activities and potentially productive measures, and follows up with the *Approach* which describes, in most cases, *Activities* Underway and makes *Program Recommendations.*

3.1 Organizational and Cultural Change

Issue: Many experienced transportation professionals view technology-based solutions to transportation problems with skepticism based on their experiences with early systems. Higher priority is often placed on capital investments that add capacity or maintain existing infrastructure, rather than on systems that require commitment to operations and maintenance. Technology-based solutions, in many cases, are not routinely considered in State/local planning processes.

3.1.1 Dimensions of the Challenge

A significant number of transportation professionals who hold decision-making authority have been influenced by frustrating experiences with earlier high-technology system deployments. Some systems implemented in the last twenty years were not supported by adequate planning, were under-funded for sustaining operations and maintenance, and proved to be maintenance-intensive embarrassments driven by unreliable software programs. The consideration of technology-based solutions to transportation problems is not universally embedded in State and local government transportation planning processes. For some, ITS-based applications are not viewed as contributing to reliable, time-tested solutions to current transportation problems.

3.1.2 Summary Assessment

At this point in the program, there is, in some areas, lack of clear definition about program boundaries. Many interpret the ITS program as being comprised only of operational tests and corridor projects funded by ITS appropriations. There is a compelling need among those in the process of planning near-term, state-of-the-art system deployments with routine funding sources to know whether or not ITS applications hold the potential for integration into an evolving national ITS architecture. Since ITS will evolve through the varied efforts of multiple stakeholders, there is no single, programmatic vision that describes the capabilities of the technology and how they might impact on the unique needs of a community. These conditions make moving ITS into the "mainstream" more difficult. ITS will become accepted more readily if it is not viewed as a distinct, separate entity attempting to break into the routine of transportation planning. ITS is not, and was never intended to be, a stand-alone solution to traffic, incident or public transit management. ITS facilitates the resolutions of transportation problems by harnessing technology. While ITS requires the adaptation of many practices, it must be brought into the mainstream of those practices. In their most effective form, ITS considerations will be fully integrated into metropolitan planning processes, environmental assessment processes and State/regional planning.

3.1.3 Approach

Activities Underway

- The ITS Institutional and Legal Issues Program employs operational test case studies to assess institutional issues and legal impediments associated with deployments.

Program Recommendations

- An outreach initiative should be tailored to the community of transportation professionals who conduct planning and make the recommendations for new investment at the State and local levels. The proposal advocates sending multi-disciplinary teams to State and local level sites to interact with planners. The interaction would solicit local needs and present lessons learned in the operational test and corridor program activities. Potential ITS-based solutions, having demonstrated positive results in satisfying similar needs, would be identified. Evolutionary planning would be outlined and, at a minimum, the consideration ***of ITS applications*** would be embedded in planning processes. It is recommended that a pilot **program** be established in 1996.

- Development of an "expert system" is proposed to coincide with the adoption of a national ITS architecture in 1996. This software program would be provided to planners in communities which may not have the opportunity to interact with multi-disciplinary contact teams. It would allow a transportation planner to load the system with local metrics and develop architecturally-compatible potential applications to community needs.

3.2 Partnerships

Issue: Traditional transportation construction/acquisition models involve a single jurisdiction. ITS deployments will be multi-jurisdictional and regional. Partnerships among public sector entities, between the two sectors, and among private sector organizations will be crucial to success. The fundamental differences in motivation between the public and private sectors pose a challenge to the development of effective partnerships and frequently create difficulties in accurately defining the obstacles to potentially effective partnership arrangements. This a long-term ITS challenge which will influence deployment planning at different levels of intensity across the nation for the foreseeable future.

3.2.1 Dimensions of the Challenge

Traditional roles and responsibilities will experience significant change during the evolution of ITS. The high potential for privatization, or joint operation of functions historically associated with government, is one dimension of the challenge facing the acceptance of partnerships. Private sector participation brings great potential benefit in the form of technical expertise, marketing experience, and opportunities to reduce public funding requirements. The implementation of successful partnerships is highly dependent on the mutual recognition that the two sectors operate with fundamentally different motivations and measures of success. A significant challenge for successful deployment will be harnessing the different operating styles and driving motivations behind common ITS goals.

3.2.2 Summary Assessment

Effectively facilitating future partnership arrangements requires an understanding of the sources of friction and conflict which may detract from cooperation. The most productive sources of this information are the operational test bed and early deployment activities. The thrust of program initiatives undertaken to support future partnership ventures should evaluate, document, and disseminate the lessons collected through those experiences. This process should produce a body of guidelines for establishing and sustaining subsequent partnership endeavors.

3.2.3 Approach

Activities Underway

- There is a concerted effort sponsored by the ITS Institutional and Legal Issues Program to prepare case studies and spin off “lessons learned” reports which use operational test and other deployment experiences as a test bed for identifying partnership problem areas.

- The ITS Public/Private Partnership Regional Workshop Program is conducting six regional workshops to develop a baseline of supporting documentation on public/private partnerships and their roles in ITS deployment activities.

- Projects such as the I-95 Corridor Coalition, which brings together 12 State DOTS with 11 independent transportation and toll authorities and 3 Federal agencies, present a rich opportunity to explore the means for improving coordination and communications in support of better serving the travel needs of the communities in the corridor.

Program Recommendations

- An annotated user's guide documenting critical information to be used by State and local agencies as an aid in developing institutional arrangements is recommended. It is recommended for funding in FY 96.

3.3 Procurement

Issue: Traditional procurement methods are not compatible with ITS procurements. ITS applications, in general, will require a systems design approach and cross-jurisdictional cooperation in order to optimize effectiveness. High technology procurements crossing jurisdictional lines pose problems for both public sector organizations and private sector providers. Public sector organizations must follow inflexible procurement regulations. Private sector providers are confronted with adhering to a complex maze of procedures changing across the boundaries of the proposed procurement. This is a mid- to long-term challenge which will impact heavily on regional deployments.

3.3.1 Dimensions of the Challenge

The deployment of ITS systems across jurisdictional boundaries requires coordination. Government agencies and competing product and service providers will be confronted with potentially conflicting regulations and requirements. The coordination efforts will be time-intensive and will create uncertainty for all participants. In many State and local jurisdictions, the experience level in acquiring high technology systems is still maturing. Defining specifications, establishing selection criteria, and working around potentially counter-productive low bid-compliance regulations may contribute to confusion, frustration and, thus, delay. While specific points of contention will vary with each case, some have the potential for recurring on a frequent basis. Examples include, but are not limited to the following:

- Product and system providers may develop a concern for the protection of ***intellectual property rights*** in cases where the public sector customer demands proprietary information be placed in the public domain. Procedures and policies ensuring protection of title to inventions are essential to fostering technological innovation.

- Compliance with ***cost accounting/certification and auditing requirements,*** at any level of government, may have significant impact. Direct Federal procurements are subject to Federal requirements which may obligate vendors to implement new accounting systems and acquire knowledge of specialized procedures. By contrast, ITS procurements funded under Federal grants and cooperative agreements conducted by State and local government entities incur greatly simplified Federal requirements.

- ***Organizational conflict of interest limitations*** may constrain the selection of firms as both designers and builders of ITS applications. While State and local procurements are not governed by Federal Acquisition Regulation (FAR) provisions, some States may have their own regulatory requirements that impose the same prohibitions. While these limitations are appropriate in many situations, technology procurements offer a compelling need for reconsideration of this area.

3.3.2 Summary Assessment

Simplifying and streamlining procurement procedures are critical for facilitating deployment of ITS. The number of participating governmental jurisdictions precludes an all-encompassing solution. Since procurement regulation is, by definition, a government function, managers at each level of government will have to develop means of facilitating ITS procurement actions. A reasonable goal in the Federal arena is to search for flexibility in the FARs with regard to technology acquisitions. States should conduct joint reviews with adjoining States and jurisdictions involved in regional deployments. This process should become embedded in planning processes for any multi-jurisdictional deployment. The crucial element for success is to consider procurement challenges early in the planning cycle.

3.3.3 Approach

Program Recommendations

- A joint State-Federal program is recommended to study Federal and State procurement regulations with the objective of streamlining Federal regulatory requirements.

- A cooperative program between the Federal government and the States is recommended to identify proposed revisions in State procurement guidelines. Special areas of interest in procurement reform should examine:

  - Intellectual property rights.
  - Cost accounting/cost certification and auditing requirements.
  - Procurement compliance costs.
  - Organizational conflict of interest limitations.

Both program elements are recommended for definition in FY 96 and resourcing in FY 97.

3.4 Environmental Considerations

Issue: There is no clearly-defined understanding of how ITS deployments will/may affect mandated environmental requirements. This challenge will be a continuing feature of deployment planning for infrastructure-based user services. It is a long-term consideration for ITS which holds the potential for significant impact on deployment rates.

3.4.1 Dimensions of the Challenge

When deployed in mutually-supporting combinations, ITS applications can make significant contributions to energy conservation and the attainment of environmental quality goals. Assessing the impact of ITS deployment on the environment is dependent on knowledge of the specific systems selected, the features of the environment in which deployment is being considered, and how deploying entities will choose to meet their unique needs. There is no consistent formula for arriving at definitive conclusions about the environmental impacts of deployment. In principle, ITS technologies hold the potential to reduce vehicle emissions and support the Clean Air Act.

3.4.2 Summary Assessment

A major contributing factor to the development of deployment strategies which will support environmental goals is additional research.

3.4.3 Approach

Program Recommendations

- A series of research and data collection projects is recommended to develop user guidelines to support deploying entities in both the public and private sectors. These projects would leverage operational tests, to the extent possible, and the ITS Early Deployment Planning Program. Essential elements of research and modeling would focus on:

  - Analyzing travel behavior patterns.
  - Modeling vehicle emissions under several modes of vehicle operation. Recommended for funding in FY 96.

- Research and data collection initiatives should be coordinated with two on-going U.S. DOT model development efforts: The Benefits Framework Project and The Travel Model Improvement Program.

3.5 Legal Implications

Issue: ITS deployments have a high probability of confronting a wide range of legal implications. Each deployment situation will be different and will be addressed or, if necessary, litigated individually. There is a compelling need to compile and document the precedents and decisions of common legal experiences and approaches used in ITS deployments.

3.5.1 Dimensions of the Challenge

Some legal issues, frequently identified as possible constraints to ITS system deployment, have recently been reconsidered. Tort liability in traffic management and traveler information services, according to several involved participants, is now viewed as a manageable risk under existing law. Intellectual property issues (briefly discussed in Paragraph 3.3 "Procurement") covering patents, copyrights, trademarks and trade secrets continue to be a potential source of time-consuming concerns. Many of these concerns will arise from the adoption of uniform national standards, the acquisition of technologies by State and local governments, and the commercial exploitation of data gathered through ITS applications.

Tort liability, while a matter of decreasing concern in traffic management and traveler information, is a key issue in automated vehicle control systems. The nature of these systems introduces the possibility of shifting accident liability from vehicle operators to vehicle/component manufacturers and automated highway operators. As the automated highway system develops, liability should be examined.

Some regulatory requirements may inhibit implementing certain ITS applications. A prominent example resides in State safety regulations prohibiting in-vehicle video display screens. Hazardous materials incident response may be constrained by regulations governing the dissemination of hazardous load tracking information.

Privatization of traditionally public sector roles (discussed in Paragraphs 3.2 "Partnerships" and 3.3 "Procurement") introduces legal questions regarding States' prerogatives to delegate government enforcement authority to private sector organizations and to grant exclusive franchises.

Delegation of authority emerges in another context. The inherent need for close coordination and joint funding among multiple jurisdictions in ITS operations introduces issues of State agencies delegating vested authority (for various functions) to regional entities or consortia.

Privacy issues have been identified in the context of:

- surveillance technology implementation;
- electronic payment services;
- public posting of ride-sharing information; and
- commercial vehicle operations.

3.5.2 Summary Assessment

Each of the potential issues addressed in paragraph 3.5.1, may have to be addressed in the course of ITS implementation. In cases where Federal law is suspected of presenting a deployment-related constraint, the applicable code can be researched, and summary opinions can be made available. In many cases, State law will present a potential impediment. This suggests that ITS partnerships/consortia should address issues on a case-by-case basis in the affected regions. The task of conducting a comprehensive survey of State law for a large number of States appears prohibitive.

3.5.3 Approach

Activities Underway

- Several U.S. DOT/ITS America-sponsored conferences, courses of study and projects are in progress to focus on liability and contracting issues:

  - The Liability Conference convenes experts in liability and ITS to reach consensus on identifying high/low risk deployment activities.
  - "The Legal Constraints and Fair Access Issues Related to Franchising in-Ground Communications Technologies Along Highway Rights of Way" Project is determining approaches for franchising rights to installing communications infrastructure.

Program Recommendation

- A series of research initiatives is recommended to develop policy guidelines on intellectual property and identify high risk liability issues. Program definition is recommended for FY 95 and should include the near-term program recommendation cited in Paragraph 2.6 of this chapter (please see Program Recommendation: Liability - 1). Initial program implementation is recommended for funding in FY 96.

3.6 Outreach

Issue: On a nation-wide basis, there are differing levels of understanding and awareness of ITS. Education of a wide range of stakeholders is critical to the successful acceptance of ITS products and services. In some cases outreach seeks to foster general awareness of ITS, while in other instances, outreach is issue-specific. Target audiences can be segmented, and each requires a uniquely designed educational/outreach approach. Note: This section will not address the "tailored outreach" proposal recommended in Paragraph 3.1.3 of "Organizational and Cultural Change".

3.6.1 Dimensions of the Challenge

ITS projects and product deployments are becoming more visible. The near-term planning horizon for ITS, 3-to-5 years, is critical in several respects: a national ITS architecture will be adopted, and public support will be sought for deployment decisions addressed at the State, regional (MPO), and local government levels. In the current environment, awareness of products, services, and potential benefits is not uniform. At many State and local level organizations, decision-makers who could play a major role in proliferating ITS applications have only a vague understanding of available ITS options for supplementing highway construction. Many members of Congress are under-informed about the potential of ITS.

3.6.2 Summary Assessment

The Federal Government and ITS America in Fiscal Year 1995 confront a critically important year for increasing public awareness and developing an education program. Fiscal Year 1996 will bring key events such as the adoption of a national ITS architecture and the acceleration of standards-setting. These risk reduction measures may not fulfill their potential on the ITS program without development of some momentum in public anticipation and demand for services. ***Awareness*** is needed to maintain a level of understanding about technologies and benefits among the consumer public. An ***education*** program is needed to keep specific groups of people informed of ITS activities. These groups include State, MPO, and local government-appointed and elected officials who deal with transportation issues, private sector stakeholders, and opinion-makers.

3.6.3 Approach

Program Recommendations

- A joint U.S. DOT/ITS America outreach program should be developed which leverages and expands activities currently underway. The ITS America Speakers' Bureau and the development of speakers' kits offer a baseline from which a series of target-specific presentation packages can be developed. The recommended audience segments include:

  - the transportation consumer;
  - educators and students at levels from secondary school through university;
  - the trucking community;
  - elected and appointed officials; and
  - public transportation officials in the disciplines of design, administration, planning, operations and maintenance.

- Program definition for a National Strategic Communications Plan for Intelligent Transportation Systems is recommended for Fiscal Year 1995 with funding of selected initiatives to begin in second quarter Fiscal Year 1995. (This Plan is currently under development by ITS America).

3.7 Market Uncertainty and Risk

Issue: The market for ITS products is clouded by uncertainty. Potential private sector providers need risk assessment to support investment strategies. Public sector authorities require an understanding of potential public acceptance of ITS to support deployment planning.

3.7.1 Dimensions of the Challenge

Potential private sector providers seek an understanding of the commercial potential for their products and services. The potential for return on investment is not clearly quantifiable and the time-phasing of market development is also undefined. A common concern is the inability to predict when publicly-funded infrastructure will be in place to interact with in-vehicle systems. This uncertainty has a retarding effect on privately-funded research and development.

3.7.2 Summary Assessment

Market uncertainty adds a new dimension to the public/private partnership working to advance ITS. Traditional government reluctance towards involvement in private sector business decisions and market operations (other than in a regulatory mode) can inhibit progress. The government's major contribution to reducing risk is creating favorable conditions for setting standards by conducting the national ITS architecture program and fulfilling the Congressional mandate to ensure national compatibility.

3.7.3 Approach

Activities Underway

- VNTSC is preparing a series of case studies on user acceptance issues in automated vehicle location, electronic toll collection/smart cards, and cellular telephones.
- VNTSC is developing guidelines for the evaluation of user acceptance issues in operational tests and deployments.

Program Recommendations

- An immediate analysis of the four national ITS architecture contract teams' cost analyses and market penetration estimates is recommended. These items are delivered to the Government as Phase 1 products. This analytical summary should be made available to interested parties through either ITS America or FHWA.
- The development of a joint U.S. DOT/ITS America-sponsored research effort directed at developing an on-going assessment of market acceptance for each user service "bundle" is recommended. Program definition, to include allocation of research task sponsorship to ITS America and the U.S. DOT is recommended for completion in Fiscal Year 1995. The program is recommended for funding in Fiscal Year 1996, concurrently with the adoption of a national ITS architecture.

3.8 Societal Issues

Issue: Widespread deployment of ITS systems and products is likely to be accompanied by societal implications not yet fully understood. A thorough understanding of societal issues offers the opportunity for the deployment of ITS technology to result in significant social benefits. Equity of access to ITS services and benefits, impacts on seniors and the disabled with special needs, and effects on pedestrians and on community livability, are important societal considerations. These kinds of societal considerations are crucial factors influencing public acceptance and the potential for successful deployment of ITS technologies.

By assessing societal implications early in the process of ITS development and deployment and integrating societal, institutional, and technical prospectives, it may be possible to maximize its potential to improve quality of life, make its benefits widely and equitably available, and avoid unnecessary conflict with other societal goals.

3.8.1 Dimensions of the Challenge

The long range implications of widespread ITS deployment are difficult to anticipate. Some members of society are likely to be more impacted than others, but there is no definitive supporting research. There is a compelling need for sound, analytically-based research efforts to attempt to define both the positive and negative effects of deployment on components of society and to seek ways to optimize the benefits.

Issues of concern include:

- <u>Impacts on Elderly and Disabled Individuals</u> By the year 2020, 17 percent of the population will be age 65 or older, and out of these, more than half will be 75 years old or older. The Americans with Disabilities Act made access to public transportation for disabled individuals a national goal. ITS user services may make it possible to compensate for some of the impairments associated with advancing age or physical disabilities that reduce safe driving skills and interfere with safe and convenient use of public transportation.

- <u>Impact on Communities</u> The familiar goals of ITS are to harness advanced technologies to reduce congestion, enhance mobility, and improve safety and the environment. Yet, combined with other advanced technologies, ITS may have positive benefits not yet imagined for improving transportation in American communities. There also is a need to better understand how improvements in mobility can be joined with policies to better manage the growth in transportation demand. Travel demand is linked to social attitudes toward the use of different transportation modes, social policy with regard to land use, public concern for safe and healthy environments, and other complex societal factors. ITS public and private sector participants should foster discussion of these issues, which may vary from one community to another.

- Equity in Distribution of Benefits and Costs Assuming ITS is supported in part by an infrastructure paid for by public funds, the benefits and costs of ITS must be equitably distributed throughout society. ITS services must not be available only to those who can afford sophisticated technology and must not widen the gap between social, geographic, and economic groups. Though equity in deployment is difficult to define and may not be fully achievable, study of ITS users' ability to use, to benefit, and to pay must be conducted to guide ITS policy making.

- Impacts on the Vulnerable Road User Pedestrians and bicyclists comprise a substantial portion of roadway users. Their vulnerability is reflected in their representing about 15% of the deaths in the U.S. from traffic accidents. Positive and negative effects of ITS technology on this group need to be addressed.

- Access and Intermodalism The nation is moving toward the provision of an intermodal transportation system that will be available to all users for all purpose. ITS deployment offers tremendous opportunity to increase the mobility of the access-disadvantaged portion of the U.S. population.

3.8.2 Summary Assessment

There is a wide range of societal issues that must be assessed to optimize the impact on society of the deployment of ITS technology. The range of user services has the potential to impact virtually every segment of society, especially the young, the aged, the disabled, and users as well as non-users of the technology. Questions of who pays and who benefits need to be addressed. Analysis focused on access of different people to employment, education, and health care are pivotal societal issues. Analytical methods need to be appropriately applied to the consideration of these societal issues to add scientific rigor in the planning and evaluation of ITS deployment.

Actions already taken, such as the ADA, offer opportunities to more fully meet the needs of all members of society.

3.8.3 Approach

Program Recommendation

Initially, the program focus is at the national level, followed by regional (large metropolitan areas, corridor communities, mid-sized cities, rural communities) and local assessments. Program definition is recommended for completion in Fiscal Year 1995, with final program elements being shaped by the attributes of the national ITS architecture adopted in mid-1996. Funding is recommended to start in Fiscal Year 1996.

Two specific areas need to be addressed:

- Bringing into the ITS planning and evaluation process representatives of the various stakeholder groups to identify societal issues, needs, and opportunities consistent with ITS outreach policies.

- Designing a jointly sponsored/funded Federal Government/ITS data collection/research program to develop a predictive assessment of the impacts of ITS deployment.

Activities Underway

The SITF has several activities underway including a symposium on Alterative Futures and a seminar/workshop on Analytical Methodologies to address societal issues. USDOT is sponsoring related research through Volpe on ITS Societal Implications: Current Knowledge and Research Needs, and George Mason University is designing and will conduct a national workshop on societal implications with invited papers.

4.0 CONCLUSION

Widespread application of ITS technologies as a solution to transportation problems should not be taken for granted as a natural evolution. As logical and appealing as harnessing technology appears during the years in which ITS evolves, there will be forces which may individually or collectively retard deployment. Several categories of challenges and some of the associated issues confronting ITS in the long-term have been identified. Recommended program activities are intended to start efforts requiring some level of sustainment during the evolution of ITS. These efforts may, or may not, yield immediate results. Appendix E contains a schedule of key deployment support activities associated with time-phased program recommendations.

The challenges and barriers that could, potentially, impede ITS deployment must be dealt with throughout the ITS program. The near-term barriers present an opportunity to institute resolutions that will make the 5-year vision presented in Chapter VI, Deployment, possible. Programs enacted to address these near-term issues will form the foundation for some of the long-term recommendations identified in Section 3 of this chapter. The resolution of the challenges and barriers presented in this chapter is critical to the successful deployment of ITS.

CHAPTER VIII - PROGRAM ASSESSMENT

1.0 INTRODUCTION

The purpose of program assessment is to provide composite and on-going information on how well the ITS program is performing relative to key ITS goals and objectives. As such, program assessment is also a principal feedback mechanism for measuring performance of the National ITS Program Plan (NPP) and providing information to update future NPPs. Program assessment also serves as a major source of data to the ITS America formal Program Advice Memorandum (PAM) and to the U.S. DOT Annual Implementation Report to Congress. It also provides a common reference for the public and private sectors to contribute to and use assessment data as they plan and deploy ITS services and products.

As this is the first edition of the NPP, this chapter focuses on the overall approach and implementation plans for ITS program assessment. It provides a direction for ensuing program assessment activities to inform the national ITS program. Subsequent updates of the NPP will contain reports on progress toward achieving the evaluation objectives discussed below.

This chapter describes the key features of the program assessment process, the assessment of objectives and measures, the implementation of assessment activities, the outputs of program assessment, and the roles and responsibilities of parties involved in the assessment process.

2.0 ASSESSMENT FEATURES

The framework of the ITS Program Assessment are provided in Figure 8- 1. This diagram also highlights the following principles and features of program assessment.

- Linkage to ITS Goals and Objectives Program Assessment provides a link between the national ITS goals and objectives and the national ITS program performance. Key milestone achievements as well as transportation system impacts will be tracked. It also calls attention to the need to view the ITS goals and objectives in a broader legislative context, such as the use of ITS for intermodal access (as consistent with ISTEA) and for improved air quality (as consistent with the Clean Air Act (CAA) Amendment).

- Composite View of ITS Activities The NPP covers a broad range of activities including research and development, mode-specific and multimodal ITS development, user service integration, operational tests, system architecture development, and deployment support. The program assessment process synthesizes overall progress of the program along six dimensions: Milestone Achievement, Effects, Funding and Costs, Acceptance and Deployment, Industry Implications, and International Comparison. A seventh parameter, Other Issues, allows for assessment activities in addition to the six principal categories.

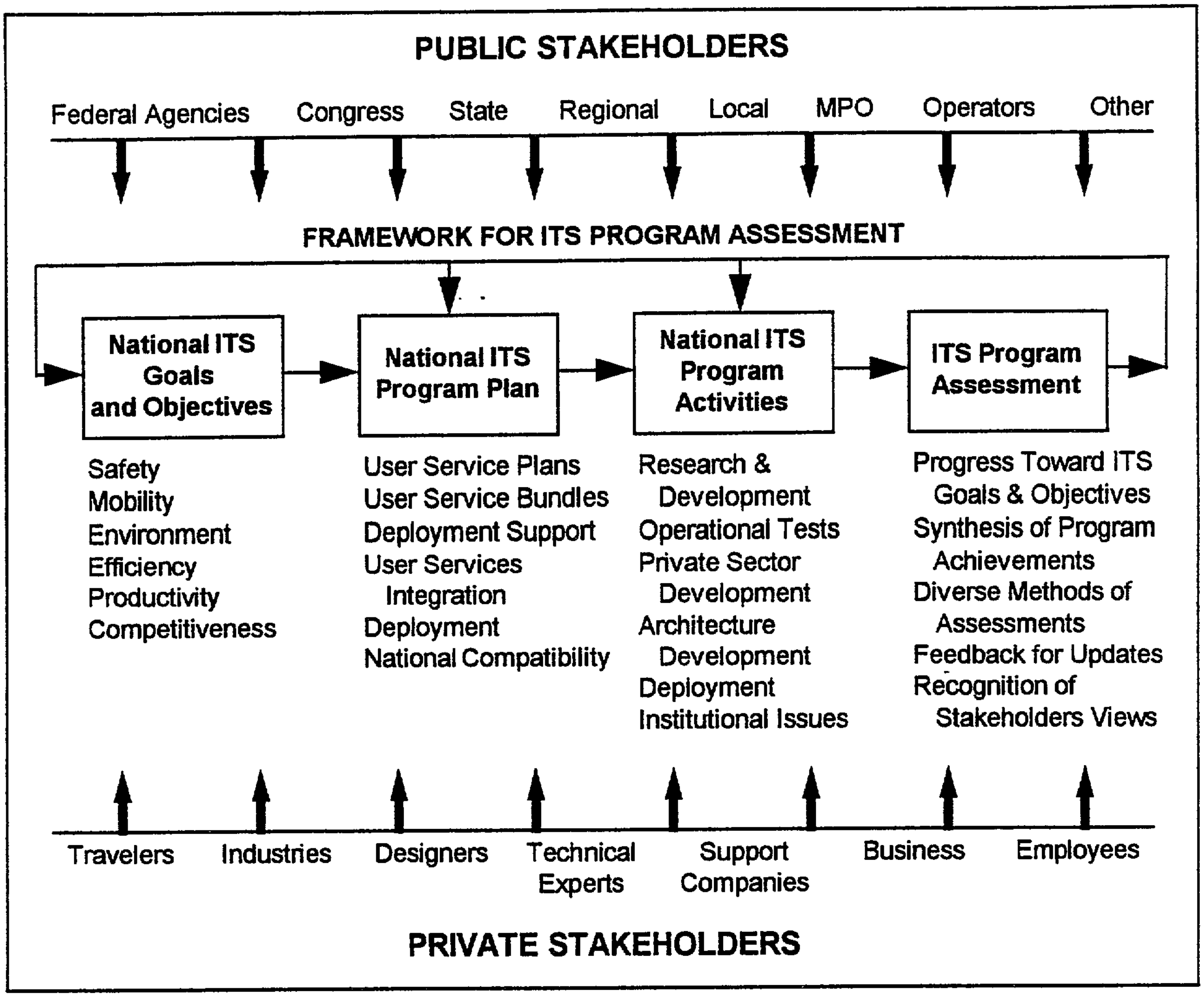


Figure 8-1 Framework for Program Assessment

- Use of Diverse Assessment Methods The program assessment process uses a variety of methods and data sources, including several on-going activities, such as field test evaluations, and several new activities, such as milestone monitoring. The methods represent a range of approaches toward ascertaining progress and use both public and private sector experiences with ITS products and services.

- Dynamic Feedback on ITS Program The program assessment process is a feedback mechanism that permits updates and refinements to the NPP and the national ITS goals and objectives. This feedback process recognizes the dynamic and changing nature of the public and private activities related to ITS.

- Explicit Recognition of Public and Private Stakeholders As illustrated in Figure 8-1, an important source of input into the program assessment process are the various ITS stakeholders, including both public and private sectors. The program assessment process makes use of stakeholder input at each stage and produces outcomes that can be used by stakeholders in their own decision-making processes.

3.0 ASSESSMENT APPROACH

Due to the range and complexity of ITS activities, it is necessary to assess a variety of parameters. The seven areas below comprise the initial evaluation parameters for the national ITS program.

- Milestone Progress
- Effects
- Funding and Costs
- Acceptance and Deployment
- System Implications
- International Comparisons
- Other Key Issues

An overview of the program assessment plan based on these seven evaluation parameters, is provided in Figure 8-2.

3.1 Evaluation Scope

This section provides a description of the scope of each of the seven evaluation objectives.

- Milestone Progress A key area for assessing early success of the ITS program is its ability to make progress on key program milestones. The NPP has provided useful milestones for each of the user services. The challenge to program assessment and the national ITS planning process is to ensure the milestones established are crucial for program progress. Milestones that represent key building blocks in the development of ITS should be refined and tracked closely. These milestones will be user service-specific, such as completion of a system design for a national electronic clearance system, as well as cross-cutting, such as completion of the national ITS architecture development program.

- Effects Determining the effects of ITS services and projects, including benefits and negative impacts, is a main objective of the national ITS program. Consequently, monitoring of this objective is a necessary evaluation target, and one that is required for the implementation reports to Congress. The U.S. DOT Annual Implementation Report to Congress contains the U.S. DOT's assessment of the ITS implementation progress. ISTEA requires that the reports "analyze the possible and actual accomplishments of intelligent vehicle-highway systems projects in achieving congestion, safety, environmental, and energy conservation goals and objectives of the program". Additionally, benefits of economic productivity would also be important to monitor due to the commercial and economic expectations of the national ITS program.

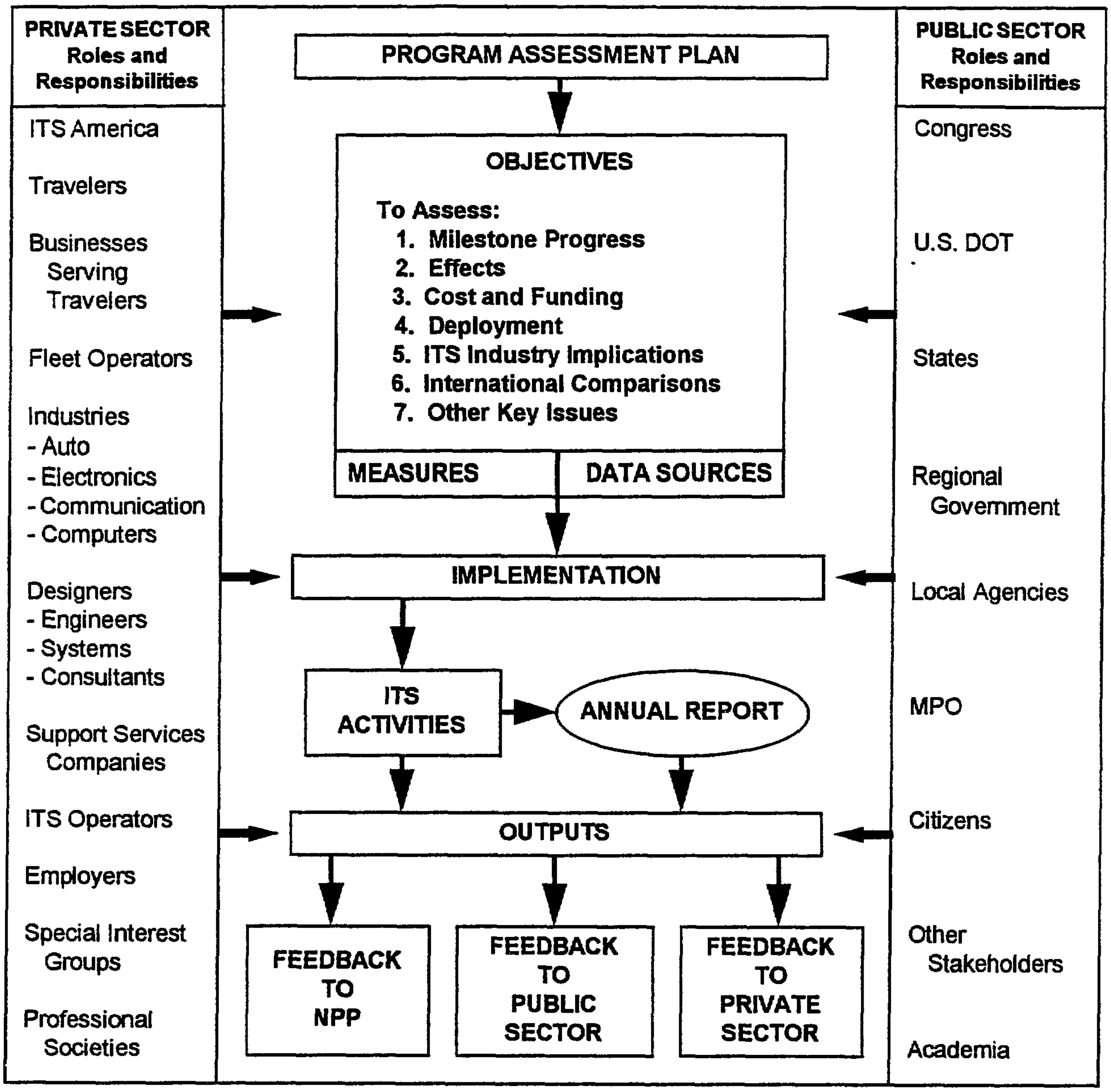


Figure 8-2 Assessment Overview

The program assessment process considers both the positive and negative effects of ITS services and products. Where possible, indirect benefits would be considered, such as ITS effects on transportation system performance, including positive effects on level of service as well as negative effects on travel demand. The assessment should also track the contributions of ITS products and services to the achievement of transportation system goals, such as those articulated by ISTEA, CAA Amendment, and the Americans with Disabilities Act (ADA).

- Funding and Costs The tracking of realized and potential funding and costs of ITS products and services has implications for a variety of stakeholders. At the national level, reports of funding would provide a useful indicator of national program support allowing for international comparisons to be made. Actual, committed and anticipated funding at the state and local level, as well as the private sector, is also a critical index of support.

  The ITS deployment costs will be estimated at several points during the development of a new ITS product or service. Cost-pricing relationships, principally performed by the private sector, yield important information on the value of ITS goods and services. Public costs are centrally important and are within the public domain, therefore, cost estimation reports from experiences around the country will be provided. These reports could include the cost to construct, operate, or maintain portions of ITS services. Further, the relationship of costs to benefits will be tracked.

  The congressional implementation report also requires monitoring of cost-sharing arrangements involving the federal government, which will be tracked as part of the overall funding and cost monitoring effort.

- Acceptance and Deployment Public acceptance of ITS products and services will be critical to the implementation of the NPP and, therefore, is an important element in program assessment. Both public and private systems will need to achieve the level of user acceptance that will allow the program to unfold as expected and planned. Lessons from other areas where technology transfer has been publicly accepted need to be incorporated into these activities and new, innovative techniques will also be required.

  The extent and rate of ITS deployment are central measures of the progress the public and private sectors are making in implementing ITS services and products, and by implication, the progress towards potential tangible benefits. Data on existing and developing markets for ITS services will assist the private sector in understanding how market demand is evolving. Indices of ITS infrastructure deployment would provide a similar understanding for the public sector on the way in which local agencies are choosing to support ITS.

  Non-technical constraints, such as institutional and societal issues can adversely affect the rate of deployment. Progress toward resolving these issues would be a part of the assessment process.

- Implications for U.S. Industries As the ITS program evolves, it will offer many opportunities for applying new technologies to surface transportation. Over time, the ITS program will have significant implications for U.S. industries in terms of job creation, new businesses, revenues from ITS products and services, and private sector investments. One important aspect of program assessment will be these affects on U.S. industries. Although most changes will occur in transportation-related industries, important implications in other industries will occur as well. For example, effects of ITS on the emerging "information highway" industries will be considered.

- International Assessment A comparison of the national ITS program relative to international developments is another useful factor in program assessment. Items to compare include levels of public funding, private sector roles, user service orientations, and deployment rates.

- Other Assessment Issues In addition to the six previously mentioned evaluation parameters, other assessment issues will undoubtedly arise and they will be included in the program assessment. For example, the progress toward institutional gains and national compatibility will be considered under this seventh evaluation parameter.

3.2 Evaluation Measures

Each evaluation parameter in Section 3.1 has corresponding measures which can be used to track program performance. Evaluation parameter measures are described in Table 8-3.

Table 8-3 Evaluation Measures

Evaluation Parameter	Evaluation Subparameter	Measures of Performance
Milestone Progress	Strategic Milestones	Measures of attainment for significant user service milestones
	Crosscutting Milestones	Measures of attainment for systems architecture development, operational test completion, etc. that involve multiple user services
Effects	Synthesis of Benefits and Disbenefits	Measures of impact from operational tests and related modeling studies; specific benefit measures include: reduction in fatalities and injuries (safety), increase in level of service and HOV and transit usage (mobility), reduction in harmful emissions and energy consumption (environment), and reduction in user costs (productivity)
	Transportation System Impacts	System-wide impacts on performance, impact on achievement of clean air mandates, increase in accessibility for disabled groups

Table 8-3 Evaluation Measures

Evaluation Parameter	Evaluation Subparameter	Measures of Performance
Funding and costs	Program support	Funding levels by Federal, State, and local organizations, and measures of private sector support
	Cost Effectiveness	Measures on the relationship of incurred or projected costs to realized or expected benefits; reports on significant cost-sharing arrangements
Acceptance and Deployment	Public Acceptance	Levels of public acceptance as determined by surveys and marketing studies being done through various stakeholder groups in both the public and private sectors
	Deployment Planning	Level of deployment support and planning being conducted across the country, including, but not limited to, major metropolitan areas
	Deployment Implementation	Levels of deployment for ITS products and services supported by public and private entities across the county including significant public support and infrastructure market penetration information on private sector services
	Deployment support	Reports on institutional and societal innovations and constraints realized during deployment of ITS services and products
Industry Effects	U.S. ITS Industry Development	Number of jobs in ITS, market share of U.S. firms in the user services, revenue of U.S. firms from ITS products and services, new products on the market
	Other Industry Development	Deployments within specific context of private sector developments, such as emerging multi-media deployments
International	Comparative Performance	Comparative measures of U.S. Industry performance relative to international development, including areas such as market share, national support, etc.
	Cooperative Performance	Assessments of progress on international standard-setting, joint research programs, and strategic alliances

Table 8-3 Evaluation Measures

Evaluation Parameter	Evaluation Subpammeter	Measures of Performance
Other Issues	Institutional Gains	New public-private partnerships, streamlining of procurement, progress in outreach, etc.
	National Compatibility	User service standards requirements, progress on system architecture development

3.3 Information Sources

Information sources for the evaluation parameters and their corresponding measures must be identified. The program assessment process will leverage the variety of ITS evaluation activities already underway. This information will be supplemented with other information, as appropriate, in several phases. The implications of this approach are two-fold.

- A reliance on the development of quality data through other activities.
- Other efforts have to be augmented to serve the needs of national assessment.

The program assessment objectives and the data sources which could produce information relevant to the objectives are shown in Figure 8-4. The existing and new information sources are described in the following paragraphs.

3.3.1 Existing Sources

On-going evaluation efforts which are relevant to ITS program assessment include: operational test evaluations, modeling studies, data repository establishment, national ITS architecture development, and studies.

- Operational Test Evaluations The operational tests are significant activities with implications for assessment of milestones, benefits, and costs. The evaluation of these tests will provide important assessment information. For example, the Federal Transit Administration's APTS program is conducting a series of evaluation studies based on a coordinated evaluation model. These results will provide useful data on multi-modal services and benefits realized through their implementation. General guidelines for conducting ITS operational test evaluations are being prepared. These operational tests and their evaluations will provide valuable information for program assessment, however, the required range and quality of data is unknown and needs to be established. As new activities in this area are commissioned, they can also be designed to fill in gaps in existing data sources.

OBJECTIVES	DATA SOURCES								
	EXISTING					NEW			
	Op Test Evaluations	Modeling Studies	Data Repository	ITS Architecture	Recent Studies	Milestone Data	Private Sector	Public Sector	Special Studies
Progress Toward Milestones and Accomplishments	O		O	O		●			
Effects of ITS Services and Products	●	O	●	O			O		
Costs of ITS Services and Products	O			O			●	●	
Acceptance and Deployment	●		O		O		●	●	O
Impact on ITS Industries					O		O		●
International Comparisons					●		O		●
Other: e.g. Standards	●			●	O		O		●

KEY: ● Primary Data Source O Supplemental Data Source

Figure 8-4 Program Assessment Matrix

- Modeling Studies Modeling and simulations are required because field measurements can be expensive and some impacts of ITS may be difficult to measure directly, such as regional ozone impact. Program assessment will consider and utilize the findings of major modeling efforts underway, such as those at the Volpe National Transportation Systems Center (VNTSC). However, there are limitations of these exercises to adequately address the diversity of ITS services. The assessment will encourage the development of more robust models which will allow for including such variables as regional planning, air quality assessments, and potential safety benefits.

- Data Repository An ITS data repository will help integrate field tests and modeling results. The repository should be structured so that data collection and synthesis facilitate the use of the data for program assessment reporting.

- National ITS Architecture The results from the ITS architecture program have implications for the entire ITS program. The ITS architecture program will produce data that will be useful for program assessment. For example, the architecture program will study the possible impacts of various architecture implementations on selected benefit areas, such as numbers of accidents. The architecture program will also address various deployment scenarios and how each affects the achievement of benefits. Synthesizing and reporting these results within the context of program assessment can aid in setting expectations on benefits.

3.3.2 New Data Sources

Supplemental sources of assessment data that need to be developed are described below.

- Milestone Data Currently, there are no available mechanisms for tracking progress toward key ITS program milestones. A formal mechanism for tracking priority ITS milestones needs to be established to supplement existing program assessment data.

- Private Sector Data Given the integral role of the private sector in the ITS program, a mechanism for tracking its performance on a variety of the assessment dimensions should be established. Because of the diffuse nature of the private sector, a comprehensive accounting of benefits, market penetration, costs, and trends will be difficult. However, private sector data is necessary for the program assessment to encompass both public and private performance. ITS AMERICA could draw upon its public and private sector membership to compile and organize industry data on private sector achievements.

- State and Local Public Sector Activities An increasing amount of data will be needed from public sector sources, such as state, regional, and local transportation authorities to assess deployment and its impacts on intended benefits, costs, and system implications. This information should be obtained in a cost-effective manner that keeps additional administrative paperwork to a minimum.

- Special Studies As the program assessment process is implemented, special studies will be required to provide assessment data not available otherwise.

4.0 IMPLEMENTATION PLAN FOR ASSESSMENT ACTIVITIES

An assessment workshop hosted by ITS America will be held periodically as a mechanism for gathering and evaluating progress and performance information. A report on results of the workshop will provide a reference for updating the NPP, for use by ITS AMERICA in developing its program advice to the U.S. DOT, and by the U.S. DOT in the Implementation Report to Congress. The assessment report will also provide many other interested parties with information to aid decision-making. In future years, as evaluation results become available, the workshop will provide a useful way for synthesizing these findings.

5.0 OUTPUTS OF PROGRAM ASSESSMENTS

5.1 Assessment Reports

The assessment process is structured so that a draft of the assessment report can be generated largely from the workshop and the papers and studies presented therein. This product will then be used by the various stakeholders as described previously.

5.2 Implications for NPP Process

The program assessment process is one feedback mechanism by which the NPP is modified and updated. The periodic assessments should contain information that would be useful in identifying specific recommendations for the NPP. The unique contribution of the program assessment process will be its attention toward obtaining credible and independent data on program achievements that can be used by stakeholders in their assessment of priorities.

5.3 Implications for Public and Private Sector Investment Decisions

The program assessment findings will have implications for public and private sector investment decisions. Specifically, the program assessment document will be a reference document to inform the public and private sectors on how the program is developing, much like the U.S. DOT's Conditions and Status Report. The program assessment will provide data with which the public and private sectors will evaluate assumptions and premises used to justify additional ITS implementation.

6.0 ROLES AND RESPONSIBILITIES

A successful assessment of the national ITS program will require the cooperation and support of the various ITS stakeholder groups, including the U.S. DOT, ITS America, and other public and private sector organizations. The roles and responsibilities of each of these participants are evolving as the ITS program moves forward, and they will continue to evolve over time. However, it is important that roles and responsibilities be identified early to ensure that a comprehensive program assessment is performed.

6.1 The U.S. Department of Transportation

Because the U.S. DOT is responsible for managing the Federal ITS program, it has the overall responsibility, access to information, and potential resources to manage and conduct key elements of the program assessment. Moreover, the U.S. DOT has the responsibility to produce an Annual Implementation Report to Congress. Within U.S. DOT, establishment of the Joint Program Office for ITS enhances coordination throughout the department.

6.2 ITS America

As an advisory committee with broad based private industry, as well as public sector membership, ITS America is well-positioned to compile and organize industry data that could provide independent evaluations of private sector achievements. Information on the nature and magnitude of existing and potential ITS markets could be included. These data will be instrumental in assessing progress of the overall national ITS program. ITS America could make recommendations in the following areas:

- Program Definition/Content
- Program Development
- Program Integration
- Deployment Planning
- Program Advocacy
- Resourcing the Program
- Program Evaluation

ITS America's committee on Benefits, Evaluation and Costs will play a vital role in helping to develop the information necessary for an assessment of the program. This committee will host the assessment workshops.

6.3 Other Public and Private Sector Organizations

Mechanisms should be developed by both the U.S. DOT and ITS America to ensure that state and local agencies, private firms, public interest and other organizations, the academic community, and private individuals can comment on the ITS program assessment. For example, draft assessment reports should be released to interested parties for comment.

7.0 CONCLUSION

ITS Program Assessment evaluates how well the ITS program is performing relative to the ITS goals and objectives. Program assessment results will be used as a source of data for the ITS America formal PAM, the U.S. DOT Annual Implementation Report to Congress, and the NPP. Also, program assessment data will be valuable to public and private sector stakeholders who are making investment decisions on future ITS deployments. Parameters used to assess performance include progress toward milestones, funding levels, costs, public acceptance, extent and rate of deployment, U.S. industry implications, and international comparisons. Some sources of assessment data are in place today, such as operational test evaluations, modeling results, and the national ITS architecture program. Other sources of information will need to be developed such as milestone data and data from public and private sectors. Program assessment is designed to be a complete and on-going mechanism for measuring the progress of the ITS program toward achieving its goals.

APPENDICES

APPENDIX A
PROGRAM PLAN REVIEWERS AND CONTRIBUTORS

Reviewers

Well over two hundred individuals and organizations participated in the review of the Plan. In some cases, reviewers offered general suggestions, in other cases, they offered major sections of text to be inserted into the Plan. Their participation was invaluable in producing the document as it appears today. The participants we were able to identify by name are listed below. If anyone was inadvertently left off this list, please accept our thanks for participating and our apologies for not properly acknowledging your effort.

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APPENDIX B - OPERATIONAL TESTS

Since operational tests will provide critical learning experiences, and in many cases, validation of predictions about service performance features, it is essential that potential deployment options be considered with an appreciation of available operational test results. Table B-l lists a sample of on-going operational tests including the evaluation purposes and the user services implemented. The experience base derived from operational tests will provide the ITS community with valuable data on technologies and public-private partnership arrangements. Public and private sector planners should review evaluation reports from the tests yielding results of interest. Reference the U.S. DOT's Intelligent Transportation Systems (ITS) Projects report for the latest, complete compilation of Operational Test activities and status.

Table B -1 Examples of Operational Tests

Operational Test	Test Purpose	User Services Implemented
Mobile Communication Test	Evaluate mobile surveillance & communication equipment for managing short-duration situations	. En-Route Driver Inform ation . Incident Management
Delaware Smart DART	Test collection of fares using a smart card on transit	. Electronic Payment Services
California Adaptive Signal Control	Evaluate effectiveness of video traffic detectors & SCOOT	. Incident Management · Traffic Control
Smart Call Box	Test addition of traffic sensors to call box network	. Incident Management
TravInfo	Test providing traffic information to private service providers	. Pre-Trip Travel Inform ation . En-Route Driver Information . En-Route Transit Inform ation
On-board Automated Mileage Test	Test automated recording of travel miles for tax purposes using GPS & map matching with on-board computers	. Commercial Vehicle Administrative Processes
"Capital" DC Metro Area Surveillance Test	Test accuracy and value of passive surveillance using cellular phone data	. Incident Management

Table B -1 Examples of Operational Tests

Operational Test	Test Purpose	User Services Implemented
Genesis	Tests provision of highway & transit data via PCDs	. Pre-Trip Travel Inform ation . En-Route Driver Inform ation · En-Route Transit Inform ation
Integrated Ramp Metering/Adaptive Signal Control	Evaluate integration of ramp metering & signal control	. En-Route Driver Inform ation . Incident Management . Traffic Control
Denver, CO Information Display	Evaluate display of transit information to transit locations & companies	Pre-Trip Travel Inform ation . En-Route Transit Inform ation . Public Transportation Management
California Infrastructure Communications	Test spread spectrum radio as a communication infrastructure	· None
San Antonio	Evaluate fiber-based communication with surveillance, signal control & message displays	. Incident Management · Traffic Control
Minnesota Travlink	Evaluate use of traffic & transit information	Pre-Trip Travel Inform ation
Dynamic Truck Speed Warning	Test dynamic messages to display safe truck speeds	En-Route Driver Inform ation
New York City Travel Inform ation	Evaluate vehicle location applications to transit information systems	. En-Route Transit Inform ation . Public Transportation Management
Idaho Storm Warning System	Test ability of visibility sensors & variable message signs to warn drivers of poor visibility conditions	. En-Route Driver Inform ation
Rappahannock Ride Share System	Test Dynamic Route Guidance using multiple sources of Traffic Information	. Ride Matching & Reservation

Table B -1 Examples of Operational Tests

Operational Test	Test Purpose	User Services Implemented
ADVANCE	Evaluate usefulness of probe data for feedback into mute guidance	. Route Guidance . Traveler Services Inform ation
Travtek	Test dynamic mute **guidance** using multiple traffic data sources	. Route Guidance . Traveler Services Inform ation
FAST TRAC	Test large network of integrated traffic control devices & driver information devices	. Traffic Control . En-Route Driver Inform ation
TRANSCAL	Evaluate the benefits of transmitting inter-regional traveler information using various fixed and mobile user devices	. Pre-Trip Travel Inform ation . En-Route Driver Inform ation
DIRECT	Test techniques to provide information to travelers via audio	. Pre-Trip Travel Inform ation . En-Route Driver Inform ation

APPENDIX C - MAPPING OF USER SERVICES TO ITS GOALS

The user services were developed to address the ITS goals and objectives. The ITS goals were originally provided in ISTEA and have been refined in the strategic plans of the U.S. DOT and ITS America. These goals and objectives are discussed in Volume I, Chapter II.

Table C-l maps each user service to its related goals, objectives, and actions supporting the objectives. The labels across the top list the user services grouped by user service bundle. A shaded cell indicates that the user service represented in the column of the shaded cell relates to impemention of the action listed in its row. A blackened cell indicates that the user service in its column relates to one or more action supporting the objective in that row.

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	1.1 En-Route Driver Information	1.2 Route Guidance	1.3 Traveler Services Information	1.4 Traffic Control	1.5 Incident Management	1.6 Emissions Testing & Mitigation
		TRAVEL AND TRANSPORTATION MANAGEMENT						
A		**Improve Safety**						
1		Reduce the frequency of accidents	■	■		■	■	
	a	Improve on-board vehicle system monitoring						
	b	Reduce the number of impaired drivers						
	c	Enhance driver performance	▒	▒				
	e	Enhance vehicle control capability						
	f	Improve traffic safety law enforcement						
	g	Smooth traffic flows	▒	▒		▒	▒	
2		Reduce severity of accidents, including fatalities, injuries...	■	■		■	■	
	a	Enhance driver performance	▒	▒				
	b	Enhance vehicle control capability						
	c	Improve EMS/roadway services responsiveness		▒		▒	▒	
	d	Improve passenger protection (restraint)						
B		**Improve Service Level (Efficiency)**						
1		Increase capacity of the transportation system	■	■	■	■	■	
	a	Increase average vehicle occupancy						
	b	Increase vehicle capacity of highways				▒		
	c	Match demand to available highway system capacity	▒	▒			▒	
	d	Increase driver navigational effectiveness	▒	▒	▒			
2		Reduce congestion due to incidents	■	■		■	■	
	a	Improve the ability to respond to HAZMAT incidents					▒	
	b	Improve incident management				▒	▒	
	c	Improve incident information to drivers	▒	▒				
3		Improve transportation customer service	■	■		■		
	a	Improve transit information	▒					
	b	Improve transit schedule adherence				▒		
	c	Improve transit responsiveness				▒		
	d	Improve service request responsiveness						
	e	Improve convenience of transportation payment						

Legend

Objective related to user service	■
Action related to user service	▒

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	TRAVEL AND TRANSPORTATION MANAGEMENT					
			1.1 *En-Route Driver Information*	1.2 *Route Guidance*	1.3 *Traveler Services Information*	1.4 *Traffic Control*	1.5 *Incident Management*	1.6 *Emissions Testing & Mitigation*
C	**Reduced Energy and Environmental Impact**							
1	Reduce harmful emissions per unit of travel		■	■	■	■	■	■
	a	Reduce vehicle miles traveled	░	░	░			
	b	Reduce emissions due to congestion	░	░		░	░	
	c	Improve pollution source identification						░
	d	Smooth traffic flows	░	░		░	░	
2	Reduce energy consumption per unit of travel		■	■	■	■	■	
	a	Reduce vehicle miles traveled	░	░	░			
	b	Smooth traffic flows	░	░		░	░	
	c	Reduce fuel wasted in congestion	░	░		░	░	
3	Reduce new right-of-way requirements		■	■	■	■	■	
	a	Reduce vehicle miles traveled	░	░	░			
D	**Enhance Productivity**							
1	Reduce costs incurred by fleet operators, operating agnc...							
	a	Reduce costs of regulating vehicles						
	b	Reduce cost of fee collection						
	c	Improve equity of fee collection						
	d	Improve vehicle and staff utilization						
2	Reduce travel time		■	■		■	■	
	a	Reduce time lost in intermodal interchange						
	b	Reduce delays of regulating vehicles						
	c	Reduce delay associated with congestion	░	░		░	░	
	d	Reduce time wasted due to navigational inefficiency	░	░				
3	Improve transportation system mngmnt and planning					■		
	a	Reduce cost of data collection				░		
	b	Improve quality of data collection				░		

Legend

Objective related to user service	■
Action related to user service	░

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	TRAVEL AND TRANSPORTATION MANAGEMENT 1.1 *En-Route Driver Information*	1.2 *Route Guidance*	1.3 *Traveler Services Information*	1.4 *Traffic Control*	1.5 *Incident Management*	1.6 *Emissions Testing & Mitigation*
E		**Improve Mobility**						
1		Enhance traveler security			■			
	a	Improve availability of communications devices			▒			
	b	Reduce vehicle theft						
	c	Increase monitoring of transportation facilities						
2		Reduce travel stress	■	■		■	■	
	a	Improve traffic information	▒	▒				
	b	Smooth traffic flows	▒	▒		▒	▒	
	c	Improve travel time predictability	▒	▒			▒	
3		Improve accessibility to transportation	■	■				
	a	Improve transportation affordability						
	b	Improve quality of travel options information	▒					
	c	Improve availability of alternate modes						
	d	Improve driver performance		▒				

Legend

Objective related to user service	■
Action related to user service	▒

Table C-1 Mapping of User Services to ITS Goals

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	TRAVEL DEMAND MANAGEMENT			PUBLIC TRANSPORTATION OPERATIONS				ELECTRONIC PAYMENT
			2.1 *Pre-trip Travel Information*	2.2 *Ride Matching & Reservation*	2.3 *Demand Management & Operations*	3.1 *Public Transportation Management*	3.2 *En-Route Transit Information*	3.3 *Personalized Public Transit*	3.4 *Public Travel Security*	4.1 *Electronic Payment Services*
A		**Improve Safety**								
1		Reduce the frequency of accidents	■		■					■
	a	Improve on-board vehicle system monitoring								
	b	Reduce the number of impaired drivers								
	c	Enhance driver performance								
	e	Enhance vehicle control capability								
	f	Improve traffic safety law enforcement								
	g	Smooth traffic flows	░		░					░
2		Reduce severity of accidents, including fatalities, injuries...								
	a	Enhance driver performance								
	b	Enhance vehicle control capability								
	c	Improve EMS/roadway services responsiveness								
	d	Improve passenger protection (restraint)								
B		**Improve Service Level (Efficiency)**								
1		Increase capacity of the transportation system	■	■	■	■	■	■		■
	a	Increase average vehicle occupancy	░	░	░	░	░	░		
	b	Increase vehicle capacity of highways								░
	c	Match demand to available highway system capacity	░							
	d	Increase driver navigational effectiveness	░							
2		Reduce congestion due to incidents	■							
	a	Improve the ability to respond to HAZMAT incidents								
	b	Improve incident management								
	c	Improve incident information to drivers	░							
3		Improve transportation customer service	■	■		■	■	■		■
	a	Improve transit information	░	░			░			
	b	Improve transit schedule adherence				░				
	c	Improve transit responsiveness				░		░		
	d	Improve service request responsiveness				░		░		
	e	Improve convenience of transportation payment								░

Legend

Objective related to user service	■
Action related to user service	░

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	TRAVEL DEMAND MANAGEMENT			PUBLIC TRANSPORTATION OPERATIONS				ELECTRONIC PAYMENT
			2.1 *Pre-trip Travel Information*	2.2 *Ride Matching & Reservation*	2.3 *Demand Management & Operations*	3.1 *Public Transportation Management*	3.2 *En-Route Transit Information*	3.3 *Personalized Public Transit*	3.4 *Public Travel Security*	4.1 *Electronic Payment Services*
C		**Reduced Energy and Environmental Impact**								
1		Reduce harmful emissions per unit of travel	■	■	■	■	■	■		■
	a	Reduce vehicle miles traveled	▒	▒	▒	▒	▒	▒		
	b	Reduce emissions due to congestion	▒	▒	▒	▒	▒	▒	▒	▒
	c	Improve pollution source identification								
	d	Smooth traffic flows	▒		▒					▒
2		Reduce energy consumption per unit of travel	■	■	■	■	■	■	■	■
	a	Reduce vehicle miles traveled	▒	▒	▒	▒	▒	▒		
	b	Smooth traffic flows	▒		▒					▒
	c	Reduce fuel wasted in congestion	▒	▒	▒	▒	▒	▒	▒	▒
3		Reduce new right-of-way requirements	■	■	■	■	■	■	■	
	a	Reduce vehicle miles traveled		▒	▒	▒	▒	▒		
D		**Enhance Productivity**								
1		Reduce costs incurred by fleet operators, operating agnc...				■				■
	a	Reduce costs of regulating vehicles								
	b	Reduce cost of fee collection								▒
	c	Improve equity of fee collection								▒
	d	Improve vehicle and staff utilization				▒				
2		Reduce travel time	■	■	■	■	■	■	■	■
	a	Reduce time lost in intermodal interchange	▒	▒		▒	▒	▒		▒
	b	Reduce delays of regulating vehicles								
	c	Reduce delay associated with congestion	▒	▒	▒	▒	▒	▒	▒	▒
	d	Reduce time wasted due to navigational inefficiency	▒							
3		Improve transportation system mngmnt and planning				■				
	a	Reduce cost of data collection				▒				
	b	Improve quality of data collection				▒				

Legend
- ■ Objective related to user service
- ▒ Action related to user service

Table C-1 Mapping of User Services to ITS Goals

MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	TRAVEL DEMAND MANAGEMENT 2.1 *Pre-trip Travel Information*	 2.2 *Ride Matching & Reservation*	 2.3 *Demand Management & Operations*	PUBLIC TRANSPORTATION OPERATIONS 3.1 *Public Transportation Management*	 3.2 *En-Route Transit Information*	 3.3 *Personalized Public Transit*	 3.4 *Public Travel Security*	ELECTRONIC PAYMENT 4.1 *Electronic Payment Services*
E Improve Mobility								
1 Enhance traveler security							■	
a Improve availability of communications devices							░	
b Reduce vehicle theft								
c Increase monitoring of transportation facilities							░	
2 Reduce travel stress	■	■	■	■	■			■
a Improve traffic information	░				░			
b Smooth traffic flows	░		░					░
c Improve travel time predictability	░	░		░	░			
3 Improve accessibility to transportation	■	■	■	■	■	■		■
a Improve transportation affordability								░
b Improve quality of travel options information	░	░	░		░			
c Improve availability of alternate modes		░		░	░	░		
d Improve driver performance								

Legend
Objective related to user service ■
Action related to user service ░

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	COMMERCIAL VEHICLE OPERATIONS						EMERGENCY MANAGEMENT	
			5.1 *Commercial Vehicle Electronic Clearance*	5.2 *Automated Roadside Safety Insp*	5.3 *On-Board Safety Monitoring*	5.4 *Commercial Veh. Administrative Processes*	5.5 *Hazardous Mat Incident Response*	5.6 *Commercial Fleet Management*	6.1 *Emergency Notification & Personal Sec*	6.2 *Emergency Vehicle Management*
A	**Improve Safety**									
1	Reduce the frequency of accidents		■	■	■					
	a	Improve on-board vehicle system monitoring		░	░					
	b	Reduce the number of impaired drivers			░					
	c	Enhance driver performance			░					
	e	Enhance vehicle control capability			░					
	f	Improve traffic safety law enforcement	░	░	░					
	g	Smooth traffic flows	░							
2	Reduce severity of accidents, including fatalities, injuries...						■		■	■
	a	Enhance driver performance								
	b	Enhance vehicle control capability								
	c	Improve EMS/roadway services responsiveness					░		░	░
	d	Improve passenger protection (restraint)								
B	**Improve Service Level (Efficiency)**									
1	Increase capacity of the transportation system		■					■		
	a	Increase average vehicle occupancy								
	b	Increase vehicle capacity of highways	░							
	c	Match demand to available highway system capacity						░		
	d	Increase driver navigational effectiveness						░		
2	Reduce congestion due to incidents						■	■	■	■
	a	Improve the ability to respond to HAZMAT incidents					░	░		
	b	Improve incident management					░		░	░
	c	Improve incident information to drivers								
3	Improve transportation customer service							■		
	a	Improve transit information								
	b	Improve transit schedule adherence								
	c	Improve transit responsiveness								
	d	Improve service request responsiveness						░		
	e	Improve convenience of transportation payment								

Legend
- Objective related to user service ■
- Action related to user service ░

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	COMMERCIAL VEHICLE OPERATIONS 5.1 *Commercial Vehicle Electronic Clearance*	5.2 *Automated Roadside Safety Insp*	5.3 *On-Board Safety Monitoring*	5.4 *Commercial Veh. Administrative Processes*	5.5 *Hazardous Mat Incident Response*	5.6 *Commercial Fleet Management*	EMERGENCY MANAGEMENT 6.1 *Emergency Notification & Personal Sec*	6.2 *Emergency Vehicle Management*
C		Reduced Energy and Environmental Impact								
1		Reduce harmful emissions per unit of travel	■	■				■		
	a	Reduce vehicle miles traveled						▒		
	b	Reduce emissions due to congestion	▒					▒		
	c	Improve pollution source identification		▒						
	d	Smooth traffic flows	▒							
2		Reduce energy consumption per unit of travel	■					■		
	a	Reduce vehicle miles traveled						▒		
	b	Smooth traffic flows	▒							
	c	Reduce fuel wasted in congestion	▒					▒		
3		Reduce new right-of-way requirements	■					■		
	a	Reduce vehicle miles traveled						▒		
D		Enhance Productivity								
1		Reduce costs incurred by fleet operators, operating agnc...	■	■		■		■		
	a	Reduce costs of regulating vehicles	▒	▒		▒				
	b	Reduce cost of fee collection				▒				
	c	Improve equity of fee collection				▒				
	d	Improve vehicle and staff utilization						▒		
2		Reduce travel time	■	■				■		
	a	Reduce time lost in intermodal interchange						▒		
	b	Reduce delays of regulating vehicles	▒	▒						
	c	Reduce delay associated with congestion	▒					▒		
	d	Reduce time wasted due to navigational inefficiency						▒		
3		Improve transportation system mngmnt and planning	■							
	a	Reduce cost of data collection	▒							
	b	Improve quality of data collection	▒							

Legend
- Objective related to user service: ■
- Action related to user service: ▒

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	COMMERCIAL VEHICLE OPERATIONS						EMERGENCY MANAGEMENT	
			5.1 *Commercial Vehicle Electronic Clearance*	5.2 *Automated Roadside Safety Insp*	5.3 *On-Board Safety Monitoring*	5.4 *Commercial Veh. Administrative Processes*	5.5 *Hazardous Mat Incident Response*	5.6 *Commercial Fleet Management*	6.1 *Emergency Notification & Personal Sec*	6.2 *Emergency Vehicle Management*
E		**Improve Mobility**								
1		**Enhance traveler security**							■	
	a	Improve availability of communications devices							▒	
	b	Reduce vehicle theft							▒	
	c	Increase monitoring of transportation facilities							▒	
2		**Reduce travel stress**	■					■		
	a	Improve traffic information								
	b	Smooth traffic flows	▒							
	c	Improve travel time predictability	▒					▒		
3		**Improve accessibility to transportation**								
	a	Improve transportation affordability								
	b	Improve quality of travel options information								
	c	Improve availability of alternate modes								
	d	Improve driver performance								

Legend

Objective related to user service ■

Action related to user service ▒

Table C-1 Mapping of User Services to ITS Goals

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS 7.1 Longitudinal Collision Avoidance	7.2 Lateral Collision Avoidance	7.3 Intersection Collision Avoidance	7.4 Vision Enhancement for Crash Avoidance	7.5 Safety Readiness	7.6 Pre-Crash Restraint Deployment	7.7 Automated Highway System
A	Improve Safety								
1		Reduce the frequency of accidents	■	■	■	■	■		■
	a	Improve on-board vehicle system monitoring					▒		
	b	Reduce the number of impaired drivers					▒		
	c	Enhance driver performance	▒	▒	▒	▒	▒		▒
	e	Enhance vehicle control capability	▒	▒			▒		▒
	f	Improve traffic safety law enforcement							
	g	Smooth traffic flows							▒
2		Reduce severity of accidents, including fatalities, injuries...	■	■	■	■	■	■	■
	a	Enhance driver performance	▒	▒	▒	▒	▒		▒
	b	Enhance vehicle control capability	▒	▒			▒		▒
	c	Improve EMS/roadway services responsiveness							
	d	Improve passenger protection (restraint)						▒	
B	Improve Service Level (Efficiency)								
1		Increase capacity of the transportation system	■						■
	a	Increase average vehicle occupancy							
	b	Increase vehicle capacity of highways	▒						▒
	c	Match demand to available highway system capacity							
	d	Increase driver navigational effectiveness							
2		Reduce congestion due to incidents							
	a	Improve the ability to respond to HAZMAT incidents							
	b	Improve incident management							
	c	Improve incident information to drivers							
3		Improve transportation customer service							
	a	Improve transit information							
	b	Improve transit schedule adherence							
	c	Improve transit responsiveness							
	d	Improve service request responsiveness							
	e	Improve convenience of transportation payment							

Legend
Objective related to user service ■
Action related to user service ▒

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS 7.1 *Longitudinal Collision Avoidance*	7.2 *Lateral Collision Avoidance*	7.3 *Intersection Collision Avoidance*	7.4 *Vision Enhancement for Crash Avoidance*	7.5 *Safety Readiness*	7.6 *Pre-Crash Restraint Deployment*	7.7 *Automated Highway System*
C		Reduced Energy and Environmental Impact							
1		Reduce harmful emissions per unit of travel							■
	a	Reduce vehicle miles traveled							
	b	Reduce emissions due to congestion							
	c	Improve pollution source identification							
	d	Smooth traffic flows							▒
2		Reduce energy consumption per unit of travel							■
	a	Reduce vehicle miles traveled							
	b	Smooth traffic flows							▒
	c	Reduce fuel wasted in congestion							
3		Reduce new right-of-way requirements		■					■
	a	Reduce vehicle miles traveled							
D		Enhance Productivity							
1		Reduce costs incurred by fleet operators, operating agnc...							
	a	Reduce costs of regulating vehicles							
	b	Reduce cost of fee collection							
	c	Improve equity of fee collection							
	d	Improve vehicle and s'^ff utilization							
2		Reduce travel time							■
	a	Reduce time lost in intermodal interchange							
	b	Reduce delays of regulating vehicles							
	c	Reduce delay associated with congestion							▒
	d	Reduce time wasted due to navigational inefficiency							
3		Improve transportation system mngmnt and planning							
	a	Reduce cost of data collection							
	b	Improve quality of data collection							

Legend
- ■ Objective related to user service
- ▒ Action related to user service

Table C-1 Mapping of User Services to ITS Goals

		MAPPING OF USER SERVICES TO IVHS STRATEGIC GOALS	ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS 7.1 *Longitudinal Collision Avoidance*	7.2 *Lateral Collision Avoidance*	7.3 *Intersection Collision Avoidance*	7.4 *Vision Enhancement for Crash Avoidance*	7.5 *Safety Readiness*	7.6 *Pre-Crash Restraint Deployment*	7.7 *Automated Highway System*
E	Improve Mobility								
1	Enhance traveler security								
	a	Improve availability of communications devices							
	b	Reduce vehicle theft							
	c	Increase monitoring of transportation facilities							
2	Reduce travel stress								■
	a	Improve traffic information							
	b	Smooth traffic flows							░
	c	Improve travel time predictability							░
3	Improve accessibility to transportation		■	■	■	■			■
	a	Improve transportation affordability							
	b	Improve quality of travel options information							
	c	Improve availability of alternate modes							
	d	Improve driver performance	░	░	░	░			░

Legend

Objective related to user service	■
Action related to user service	░

Table C-1 Mapping of User Services to ITS Goals

APPENDIX D - ITS RF SPECTRUM REQUIREMENTS MATRIX

The ITS AMERICA Telecommunications Committee completed a preliminary assessment of the Radio Frequency (RF) spectrum requirements for ITS. The Committee identified ITS applications and their corresponding communications functions, frequency, and bandwidth requirements. Some of the supporting communications technologies such as FM subcarrier, wireline, cellular, etc. are provided as remarks. The Telecommunications Committee will update the matrix when the RF spectrum requirements for the National ITS Architecture Development Program, the Automated Highway System, and additional ITS applications are identified. For traceability to the rest of the National Program Plan (NPP), ITS user services which could be associated with the ITS applications have been added to the Committee's matrix. The user services column is preliminary and will be reviewed in more detail prior to the next edition of the NPP. The RF spectrum requirements matrix is referenced in Chapter IV, National Compatibility and is provided in Table D-l.

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Longitudinal Collision Avoidance	Automated Collision Avoidance	Longitudinal Collision Avoidance (Radar)	>20 GHz	200.000	
• Lateral Collision Avoidance		Lateral Collision Avoidance (Radar)	>10 GHz	20.0	
		Data Link (Coordinate Evasive Actions)	5.8 GHz	0.500	
• All User Services	Automatic Vehicle Identification (AVI)	One-way Communications	902-928 MHz	6.0	*10 frequencies required. Electronic Toll and Traffic Management (ETTM) applications. #
		Two-way Communications	902-928 MHz	6.0	*10 frequencies required. ETTM applications. #
		Two-way Communications	2.4, 5.8 GHz	50.0	ETTM applications * **
• All User Services	Automatic Vehicle Location (AVL)	Two-way Communications	902-928 MHz	8.000	
			150/450/800/900 MHz		

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Traffic Control	CCTV Communications and Control	Two-way Communications	n/a	n/a	Wireline
• Incident Management		Two-way Communications	>1 GHz	10.000	Private microwave bands
• Emissions Testing & Mitigation • Public Transportation Management •Public Travel Security			150/450/800/900 MHz		Slow scan TV/Low frame rate video

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Traffic Control • Incident Management • Public Transportation Management • En-route Transit Information • Hazardous Materials & Incident Response • Automated Highway System	Changeable Message Sign (CMS) Control	One-way Communications	88-108, 150-900 MHz	n/a	FM subcarrier (or wireline)
• Commercial Fleet Management	Dispatching (Commercial)	Two-way Communications	150/450/800/900 MHz	0.025	[Bandwidth per circuit; trunking essential; not unique to ITS.]
			Mobile Satellite Systems (MSS)		

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Incident Management • Hazardous Material Incident Response • Emergency Vehicle Management	Dispatching (Emergency)	Two-way Communications	150/450/800/900 MHz	0.025	[Bandwidth per circuit; trunking essential; not unique to ITS.]
			MSS		
• Public Transportation Management • Personalized Public Transit • Ride Matching & Reservation	Dispatching (Transit)	Two-way Communications	150/450/800/900 MHz	0.025	[Bandwidth per circuit; trunking essential; not unique to ITS.]
			MSS		
• Route Guidance • Traffic Control	Diversion (Emergency)	Two-way Communications	150/450/800/900 MHz	0.025	[Bandwidth per circuit; trunking essential; not unique to ITS.]
			MSS		

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Route Guidance • Traffic Control * Public Transportation Management	Diversion (Transit-Handicap)	Two-way Communications	150/450/800/900 MHz	0.025	[Bandwidth per circuit; trunking essential; not unique to ITS.]
• En-Route Transit Information • Personalized Public Transit			MSS		
• Route Guidance • Traffic Control • Public Transportation Management • En-Route Transit Information	Diversion (Transit-Route Change)	[Covered by other functions.]			

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-route Driver Information • Traffic Control • Incident Management	Diversion (Vehicle)	[Covered by other functions.]			

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Pre-Trip Travel Information • Public Transportation Management • Personalized Public Transit • Commercial Vehicle Electronic Clearance • Hazardous Materials • Incident Response • Commercial Fleet Management • Automated Highway System	Driver/Vehicle Status Reporting	One-way Communications	5.8 GHz, 150-900 MHz	0.005	**
		Two-way Communications	5.8 GHz, 150-900 MHz	0.010	[Acknowledgment required for remote locations].

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Ride Matching & Reservation	Dynamic Ridesharing	[Covered by other functions.]			
• Public Transportation Management • Personalized Public Transit	Electronic Transit Payment	[Covered by other functions.]			
• Emergency Vehicle Management	Electronic Siren	One-way Communications	5.8 GHz, 220 MHz	0.005	**
• Commercial Vehicle Electronic Clearance * Hazardous Materials • Incident Response • Commercial Vehicle Administrative Processes	Electronic Credentials (Commercial)	Two-way Communications	5.8 GHz	0.200	**

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Traffic Control • Ride Matching & Reservation • Public Transportation Management • Personalized Public, Transit • Demand Management & Operations • Commercial Vehicle Electronic Clearance • Commercial Vehicle Administrative Processes * Hazardous Materials • Incident Response • Commercial Fleet Management	Electronic Toll Collection	[Covered by other functions.]			

A tota 6 MHz is required, shared betwee ıe- and two- ste
* Syster rchitecture effort requests 50 MHz ach band.
** Total uirement of 5.8 GHz is 75 MHz.

Tab D ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Traffic Control • Route Guidance • Traveler Services Information • Ride Matching & Reservation • Demand Management & Operations • Public Transportation Management • Personalized Public Transit • Pre-Trip Travel Information • Commercial Vehicle Electronic Clearance • Commercial Vehicle Administrative Processes • Commercial Fleet Management	Fee Collection and Access Control	[Covered by other functions.]			

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Pre-Trip Travel Information • Ride Matching & Reservation	Hand-held Advanced Traveler Information System (ATIS)/Digital Personal Assistant (DPA)	One-way, Two-way Communications	5.8 GHz	0.200	[Also, can be supported by Personal Communications Systems (PCS), cellular, FM subcarrier, Highway Advisory Radio (HAR), etc.] **
• Traffic Control • Route Guidance • Hazardous Materials • Incident Response • Commercial Fleet Management • Emergency Vehicle Management	HAZMAT Access Control	Covered under AVI	5.8 GHz	0.100	**

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
En-Route Driver nformation Route Guidance Traffic Control · Incident Management · Emergency Vehicle Management	ỊAZMAT Warning beacon	;overed Under AVI/AVL, ỊAYDAY	5.8 GHz	0.100	**
· En-Route Driver Information · Intersection Collision Avoidance • Automated Highway System	n-Road and Roadside Detector Reports	Nireline, Radio	150-900 MH		Occassionally rural will reed radio.

A total of 6 MHz is required, shared between one- and two-way systems.
• System architecture effort requests 50 MHz in each band.
•* Total requirement of 5.6 GHz is 75 MHz.

Table D-l ITS RF' Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Route Guidance • Traffic Control • Ride Matching & Reservation • Public Transportation Management • Personalized Public Transit • *Commercial Fleet* Management • Intersection Collision Avoidance • Pre-Crash Restraint Deployment • Automated Highway System	In-Vehicle Signing (IVS)	One-way Communications - RF	5.8 GHz, 220 MHz	0.200	Could be done at 220 MHz in rural area with
		One-way Communications - IR	n/a	n/a	

\# A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Route Guidance • Traffic Control • Incident Management • Public Transportation Management • Personalized Public Transit • Hazardous Materials • Incident Response • Commercial Fleet Management • Emergency Notification & Personal Security • Pre-Crash Restraint Deployment • Automated Highway System	Incident Reporting	Outbound to vehicles	88-108 MHz	n/a	FM Subcarrier - Covered Under IVS, ATIS

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• Incident Management • En-Route Driver Information • Traffic Control •Personalized Public Transit • Hazardous Materials • Incident Response • Automated Highway System	MAYDAY (Automatic) - Airbag Sensor	Two-way Communications	220 MHz	0.005	False alarms and limited effectiveness of one-way systems.
		Two-way Communications	MSS	0.005	Acknowledgement required for non-urban interstate and rural areas.

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Traffic Control • Incident Management • Personalized Public Transit • Commercial Fleet Management • Emergency Notification & Personal Security • Automated Highway System	MAYDAY (Emergency)	[Use same system as automatic MAYDAY.]			

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Route Guidance • Traveler Services Information • Ride Matching & Reservation • Personalized Public Transit • Automated Highway System	Non-emergency Assistance	Two-way Communications			Cellular, PCS

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Route Guidance • Traveler Services Information • Traffic Control • Pre-Trip Travel Information • Demand Management and Operations	Parking Information	[Value-added service]	HAR, 5.8 GHz		Cellular, PCS

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Demand Management & Operations • Public Transportation Management • Personalized Public Transit • Electronic Payment Services • Commercial Fleet Management	Road Pricing	[Covered by Toll Collection, ATIS	HAR, FM		FM subcarrier, Variable Message Sign (VMS) Pre-Trip Travel Information.

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Route Guidance • Traffic Control • Personalized Public Transit • Hazardous Materials • Incident Response • Emergency Vehicle Management • Automated Highway System	Route Guidance (In-Vehicle)	One-Way Communications from Traffic Management Center (TMC))	88-108 MHz	16 kHz	FM subcarrier, [cellular]

A total of 6 MHz is required, shared between one- and two-way systems.
• System architecture effort requests 50 MHz in each band.
•* Total requirement of 5.6 GHz is 75 MHz.

Table D-l ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Route Guidance • Traffic Control • Ride Matching & Reservation • Personalized Public Transit • Hazardous Materials Incident Response • Emergency Vehicle Management * Automated Highway System	Route Guidance (Centralized)	Two-way Communications - RF	5.8 GHz, 150-900 MHz	0.200	Digital cellular. **
		Two-way Communications - IR	optical	n/a	
• Traffic Control • Emergency Vehicle Management	Signal Priority (Emergency & Transit Vehicle)	One-way Communication	5.8 GHz	0.200	**
			IR		

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Traffic Control • Hazardous Materials • Incident Response • Vision Enhancement for Crash Avoidance	Terrain/Hazard Warnings	(See In-Vehicle Signing)	220 MHz	0.200	
• En-Route Driver Information • Traffic Control	Traffic Probing	Outbound Poll to Vehicle	5.8 GHz, 88-108, 220 MHz	n/a	[FM Subcarrier] 2.4 GHz dependent on toll plaza-to-TMC
		Inbound Response from Vehicle	2.4, 5.8 GHz, 220 MHz	0.200	2.4 GHz dependent on toll plaza-to-TMC communications. **
• Traffic Control • Emergency Vehicle Management	Traffic Signal Control	Wireline, Radio	150-900 MHz		

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Traveler Services Information • Pre-Trip Travel Information • Public Transportation Management	Transit Schedule Status Reporting	From Transit Vehicle to Dispatch	5.8 GHz, 150-900 MHz	0.005	
		To Stop Kiosk			Wireline, FM subcarrier
• En-Route Driver Information • Traffic Control • Public Transportation Management • Hazardous Materials • Incident Response	Travel Time Reporting	[Covered by Other Services]			

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Traffic Control • Public Transportation Management • Personalized Public Transit • Commercial Fleet Management • Emergency Vehicle Management • Automated Highway System	Weather/Road Condition Reports	Included Under Route Guidance		n/a	FM subcarrier

\# A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
- En-Route Driver Information - Traveler Services Information - En-Route Transit Information	Value-Added Data				Cellular PCS.
- Traffic Control - Demand Management and Operations - Public Transportation Management	Variable Message Sign Control	See Changeable Message Sign.)	220 MHz	0.005	[Can also be wireline in most areas.]

A total of 6 MHz is required, shared between one- and two-way systems.
. System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-l ITS RF Spectrum Requirements Matrix

User Services	ITS Applications	Communications Function	Frequency Band	Bandwidth [MHz]	Remarks
• En-Route Driver Information • Traffic Control • Emissions Testing & Mitigation • Demand Management & Operations • Commercial Fleet Management	Emissions Monitoring	(To be completed.)			

A total of 6 MHz is required, shared between one- and two-way systems.
* System architecture effort requests 50 MHz in each band.
** Total requirement of 5.8 GHz is 75 MHz.

Table D-1 ITS RF Spectrum Requirements Matrix

APPENDIX E - DEPLOYMENT SUPPORT ACTIVITIES SCHEDULE

Figure E-l illustrates the Deployment Support Activities Schedule. The details of these activities are discussed in Volume I, Chapter VII, Deployment Considerations.

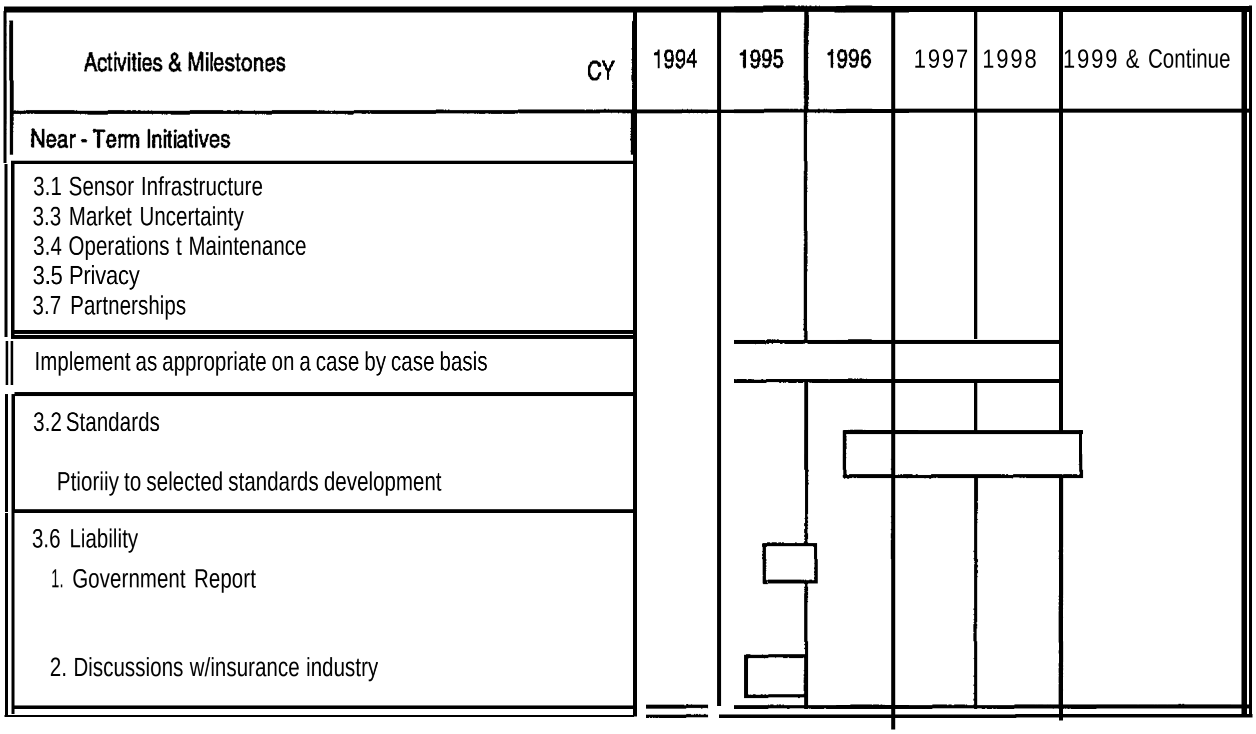

Figure E-l Deployment Support Activities Schedule

Activities & Milestones CY	1994	1995	1996	1997	1998	1999 & Beyond
4.1 Organizational Change						
1. Develop "Tailored Outreach" Proposal.						
2. Establish Pilot Program.						
3. Develop "Expert System".						
4.2 Partnerships						
1. Document Results of Pub/Pvt Partnership Regional Workshops						
2. Document I-95 Corridor Coalition Lessons Learned						
3. Develop "User Guide"						
4. Implement Lessons Learned						
4.3 Procurement						
1. Define Joint State/Federal Study re: FARs.						
2. Conduct Study.						
3. Define Joint State/Federal Coop Program re: State Reg's.						
4. Fund/Conduct Program						
4.4 IVHS & The Environment						
1. Define User Guideline Research Project						
2. Fund/Execute Project						
4.5 Legal Implications						
1. Define Research Project for Policy Guidelines						
2. Fund/ Conduct Project						
3. Implement Lesson Learned re:Liability						

Figure E-1 Deployment Support Activities Schedule (Continued)

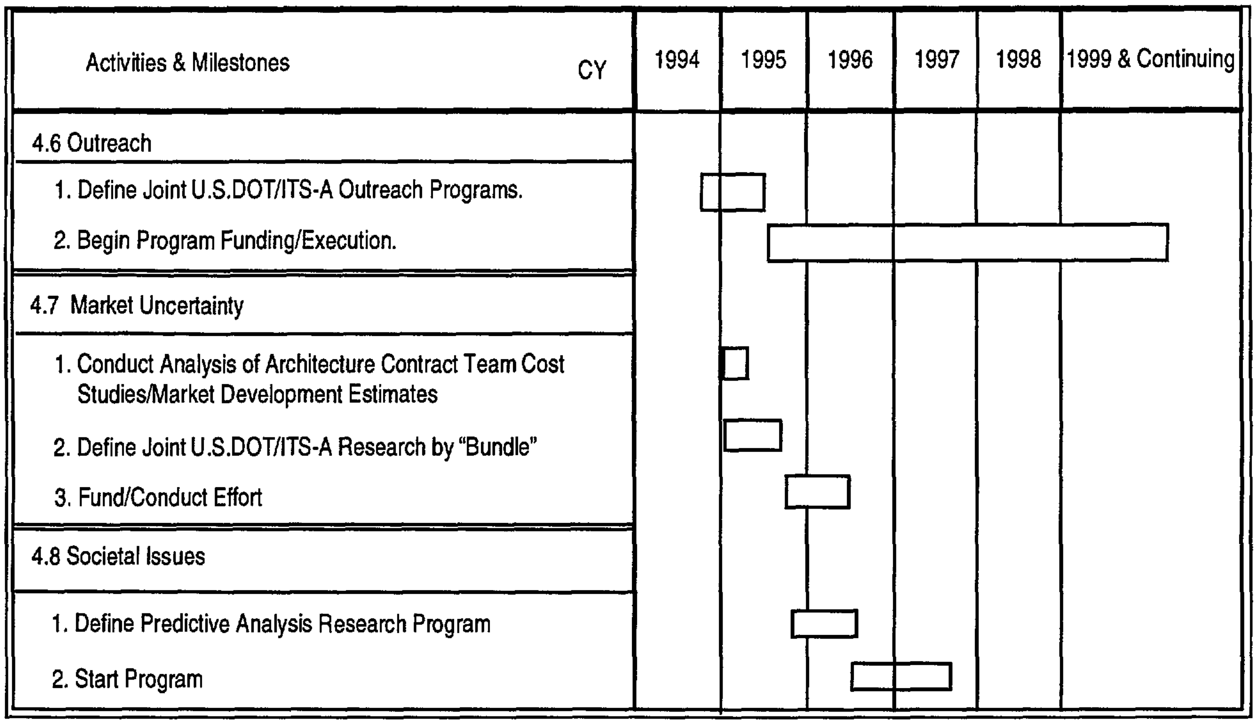

Figure E-1 Deployment Support Activities Schedule (Continued)

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APPENDIX G - GLOSSARY

The following Glossary is in two parts. Part I contains a list of terms, concepts, and acronyms used in discussions of ITS including selected acronyms for project and program names, organizations, ITS technologies and functions. Part II contains a limited list of electronics and communications terms and concepts.

PART I: GENERAL ITS TERMS, CONCEPTS AND ACRONYMS

AAA	American Automobile Association
AASHTO	American Association of State Highway and Transportation Officials
ADIS	Advanced Driver Information Systems; original name for ATIS
ADVANCE	Advanced Driver and Vehicle Advisory Navigation ConcEpt (Chicago area); Largest current IVHS project [5000 cars, $40M, 300 sq. mi.] Driver advisory, in-vehicle guidance, traffic probing, GPS; partnership of Motorola, Illinois DOT, Illinois University Transportation Research Consortium, USDOT
Advantage I-75	Project on interstate from Canada to Miami, uses decentralized traffic management, CVO.
AHAR	Advanced Highway Advisory Radio; a system whereby special radio receivers tune themselves to stations carrying traffic, safety, or other information when necessary.
Ah-Scout	See Euro-Scout.
AMTICS	Advanced Mobile Traffic Info & Control System on local roads sponsored by National Police Agency (see VICS). Japan.
AMTA	American Mobile Telecommunications Association
ANSI	American National Standards Institute; standards for the computer industry
AP	Administrative Processes- Commercial Vehicle Operations
APTA	American Public Transit Association

APTS	Advanced Public Transportation Systems; FHWA/FTA-funded initiatives investigating better use of existing commuter transport methods. [Also a program area.]
APTS	Advanced Public Transportation Systems; also refers to specific FHWA-funded projects to make better use of existing commuter transportation methods.
ARI	Autofahrer Rundfunk Information; German radio service; a 57kHz FM subcarrier signal alerts receiver that selected station carries traffic information; precursor to RDS-TMC
ARI	Autofahrer Rundfunk Information; a German radio system that transmits an FM subcarrier code to equipped receivers indicating if a station carries traffic information.
ARSI	Automated Roadside Safety Inspection for commercial vehicles.
ARIES	Automobiles' Roadside transceiver Infrastructure for Extensive Services. Japan.
ARTBA	American Road and Transportation Builders Association
ASA	American Statistical Association
ASCE	American Society of Civil Engineers
ASG	Automotive Sciences Group
ASTM	American Society for Testing & Materials (manufacturing trade organization)
ARTS	Advanced Rural Transportation Systems
ATA	American Trucking Association
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
ATT	Advanced Transport Telematics; European counterpart to ATIS and related technologies; the focus of DRIVE II (cf)

Autoguide	London area route guidance project, originally based on Euro-Scout system, now under revision
AUVS	Association of [alternatively, Autonomous] Unmanned Vehicle Systems; heavy DoD DARPA, NASA (and related contractor) representation; follows and reports on work being done with autonomous and remotely piloted air, sea, and ground vehicles
AVC	Automatic Vehicle Classification
AVCS	Advanced Vehicle Control Systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
AVM	Automatic Vehicle Monitoring
Bus Info	Displaying bus arrival/destination information at bus stops
CACS	Japan. Comprehensive Automobile Communication System (1973-79), $70 million funded experiment in mobile twoway digital communications for route guidance; led to the founding of JSK (IVHS/A-like association of 57 companies)
CARIN	CAR Info and Navigation system; an in-vehicle navigation aid developed by Philips
CDL	Commercial Driver's License (Nationwide standard trucker identification)
CDLIS	Commercial Driver License Information System (See CVO User Services in Volume II .)
CEC	Commission of the European Community
CEN	EC standards body, similar in function to ANSI
CMSNMS	Changeable (or Variable) Message Signs
COMPASS	Incident Management/Driver Information program; Highway 401 in Ontario, Toronto area

COPDRIVE	Cooperative Driving; a PROMETHEUS project investigating some AVCS-type technologies
CORRIDOR	Cooperation On Regional Road Informatics Demonstrations On Real sites; major DRIVE II ATIS initiative
Crescent	CVO HELP/AVI project in a crescent-shaped corridor from SW Canada thru CA, to Houston TX [$80M/10 yrs.]
CTIA	Cellular Telephone Industry Association
CVO	Commercial Vehicle Operations
DEMETER	Digital Electronic Mapping of European TERritory EUREKA-sponsored, Philips/Bosch project to spec digital map data standards
DE SmrtCmmtr	Ridesharing system in Delaware.
DGPS	Differential GPS (cf.); land station based method for improving GPS accuracy and/or getting around DOD-imposed Selective Availability (S/A) encryption; effort by the Coast Guard to build coastal infrastructure; claims of 1 to 2 cm accuracy
DIRECT	Driver Information Experimenting with Communication Technology; ATIS (HAR, cellular) in downtown Detroit to Metro airport.
DRIVE I	Dedicated Road Infrastructure for Vehicle safety in Europe; EC-supported consortium of European governments, industry, and universities to conduct research aimed at improving highway safety, air quality, and increasing mobility; results will be applied in DRIVE II
DRIVE II	The second, just-beginning phase of DRIVE; after projects are selected for funding, approx. $151 million will be available for 50 or so major operational tests of ATT (Advanced Transport Telematics) throughout Europe for the next several years
EIA	Electronics Industry Association
ENTERPRISE	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency; consortium of states (Arizona,Colorado,Iowa,Minesota) for rapid develop/deployment of IVHS technologies

ERGS	Electronic Route Guidance System; the first attempt, in the 60's/70's, at an in-vehicle router, based on loop communication at every intersection to provide directions to the next node. Every intersection was uniquely coded.
ERTICO	European Road Telematics Implementation Coordination Organization; nascent organization intended to coordinate EC IVHS effort, spanning PROMETHEUS, DRIVE, and the member nation Ministries of Transport
ETSI	European Telecommunications Standards Institute
ETTM	Electronic Toll & Traffic Management (applications area for AVI)
EUREKA	EC (European Technology Ministry) cooperative R&D program to encourage private sector collaboration among 19 countries; runs PROMETHEUS program
EURO-SCOUT	Infrastructure-based route guidance system using infrared beacons; successful operational test completed in Berlin; Seimens/Blaupunkt
FAME	Freeway and Arterial Management Effort (Seattle, WA)
FAST-TRAC	Faster And Safer Travel/Traffic Routing & Advanced Control; traffic mgmt etc. Oakland County, MI.
FCC	Federal Communications Commission; handles CIVILIAN requests for radio spectrum; allocations and allotments
FHWA	Federal Highway Administration (USDOT)
FMCS	Fleet Management & Control Systems
FTA	Federal Transit Administration (USDOT)
GIS	Geographic Information Systems; software/database/display systems containing highly accurate detailed geographic data for a variety of applications; most are based on US Government TIGER files compiled by the Census Bureau and the US Geological Survey
GLONASS	Soviet GPS, constellation unfinished (12 out of 24 satellites are up); many GPS receivers can now pick up GLONASS satellites as well
GMRL	General Motors Research Laboratories

GPS	Global Positioning System, DoD satellite constellation (16 now, eventually 21 & 3 spares) that allows receivers to get a position fix (3 channel receiver necessary to compute lat and long, 4+ gets you altitude also) to a fine (and selectively variable) degree of accuracy (see DGPS)
Guidestar	Twin Cities (Minneapolis-St. Paul, Minnesota) coordinated ATMS, ATIS program
HAR	Highway Advisory Radio; dedicated radio frequencies carrying traffic information; roadside signs direct travelers to tune to the appropriate station; usually 530kHz in US
HAZMAT	Hazardous Materials
HELP	Heavy vehicle Electronic License Plate; CVO component of the Crescent project
HOV	High-Occupancy Vehicle; a designation used to restrict certain lane access to cars with multiple occupants, usually during freeway rush hours
HUD	Head-Up Display; windshield-reflected or other in-vehicle display equipment that allows driver to keep eyes forward
HUFSAM	Highway Users Federation for Safety and Mobility; represents highway (construction) related industries
IBTTA	International Bridge, Tunnel, and Turnpike Association
IEEE	Institute of Electrical and Electronics Engineers
IDEAS	Innovations Deserving Exploratory Analysis Program for IVHS funds small projects that would provide radically different and new approaches to ITS. Managed by TRB.
IGOR	Interactive Guidance On Routes
IMIS	NYSDOT (Long Island) Integrated Motorist Information System, major part of INFORM project
INFOBANQ	Driver info (pretrip) project, USDOT & Texas State Dept. Highways and Public Transport.

INFORM	INformation FOR Motorists (NY State DOT); Long Island highways driver info project; VMS, ramp metering
IRAC	Inter-departmental Radio Advisory Council; handles GOVERNMENT radio spectrum management, division of NTIA (cf.)
ISATA	International Symposium on Automotive Technology & Automation (annual conference in Florence)
IS0	International Standards Organization
ITE	Institute of Transportation Engineers
ITS AMERICA	(or ITS/A) Intelligent Transportation Society of America, group of govt/industry/academic people with international representation to work on standards and issues in North American ITS; now has official Federal Advisory Committee status
ITU	International Telecommunications Union
IVRG	In-Vehicle Route Guidance System
IVSAWS	In-Vehicle Safety Advisory and Warning System; contract with Hughes Electronics to develop radio beacon type warning system for incidents, emergency vehicles, etc.
LISB	Ali-Scout trial, Berlin.
MAGIC	Metropolitan Area Guidance, Information & Control; uses surveillance and HAR, VMS, ramp metering. New Jersey, Rte. 80.
Mobility Mngr	intra-city rideshare matching
Mobility 2000	Original govt/industry/university consortium/committee to define IVHS areas and issues (predecessor of IVHS AMERICA)
MAO	Metropolitan Planning Organization (local urban transportation planning authorities)
NAVSTAR	NAVigation Satellite Timing And Ranging system; another name for GPS (cf)
NCHRP	National Cooperative Highway Research Program; program of TRB-administered/partially funded research projects

NEMA	National Electrical Manufacturers Association (the traffic control/signaling equipment industry)
NHTSA	National Highway Traffic Safety Administration (USDOT)
NIST	National Institute for Standards in Technology
NTIA	National Telecommunications and Information Administration; Dept of Commerce bureau that handles all communication. standards & allocations; parent of IRAC
NTSB	National Transportation Safety Board; Federal independent agency, conducts accident investigations & safety studies, makes recommendations to manufacturers, govt. regulatory agencies, et al.
OBC	On-Board Computer
OECD	Organization for Economic Cooperation and Development
PAMELA	(EC) Pricing and Monitoring Electronically of Autos; AVI/ETTM effort as part of DRIVE in Europe
PANDORA	EC digital road mapping project
PATH	Partners for Advanced Transit and Highways (U. Berkeley, Caltrans); lot of work on AVCS
Pathfinder	In-vehicle guidance/traffic probing project on 12 miles of Santa Monica Freeway, surrounding arterials; sponsored by GM, Caltrans, FHWA, Etak
PEGASUS	People, Goods, and Services Urban System (Texas)
PIARC	Permanent International Association of Road Congresses
POLIS	Promoting Operational Links with Integrated Services; interurban driver info services major operational test project within DRIVE II
PROMETHEUS	PROgraMme for European Traffic with Highest Efficiency & Unprecedented Safety; broad consortium of countries & IVHS projects
RACS	Road-Automobile Communications Systems sponsored by Ministry of Construction (see VICS), Japan

RDS	Radio Data System (Europe); uses FM subcarrier to alert equipped receivers to incoming traffic info
RSPA	Research and Special Programs Administration (USDOT); handles hazmat, statistics, etc.
SAE	Society of Automotive Engineers
SAFER	Safety and Fitness Electronic Records System (See CVO User Services in Volume II.
SCATS	Sydney Coordinated Adaptive Traffic System; Australian integrated automated signaling system for urban traffic management
SCOOT	Split, Cycle, and Offset Optimization Techniques; British traffic signal control system
SHRP	Strategic Highway Research Program; develops/promotes advanced construction/maintenance methods
Sign1 Preempt	Chicago, et. al., using AVL for busses and allowing mass transit to interrupt traffic signals for better schedule reliability
SmartCard	Ann Arbor Mobility Manager
SmartCommuter	CA, TX CATV/radio-based commuter information services
SOCRATES	(EC) System of Cellular Radio for Traffic Efficiency and Safety; uses a single-frequency broadcast to vehicles, multiple access protocol for responses
SOV	Single Occupancy Vehicle; driver with no passengers
s s v s	Super Smart Vehicle System, an AVCS effort. Japan.
STPP	Surface Transportation Policy Project
TFHRC	Turner-Fairbank Highway Research Center (FHWA R&D)
TMC	Traffic Message Channel (with RDS); transmits, on FM subcarriers, digital codes representing standardized traffic info messages to be decoded and displayed (or spoken) in any given language by in-vehicle receiver.

TMI/FOC	Traffic Management Information/Fleet Operation Coordination; Anaheim CA, on/off board integrated information services for truckers
TNRDA	Transit Network Route Decision Aid; Software to assist phone operators in advising urban travelers
TRB	Transportation Research Board
TRIP	The Road Information Program; citizen's group to monitor roadways
TRRL	Transportation Road Research Lab; run by UK government, soon to be privatized
TSC	Transportation Systems Center; see VNTSC
Trafficmaster	London area pager-based navigation aid and positioning service, including 250 IR traffic sensors; 1600+ subscribers
TRANSCOM	Transportation Operations Coordinating Committee; NY/NJ metro area organization striving for poly-institutional unity on IVHS issues , including AVI, ETTM, etc.
TravTek	In-vehicle guidance&routing, yellow pages, traffic info, probing, integrated infrastructure; partnership of GM, AAA, FlaDOT, FHWA, Orlando [$12M, several yrs]. Orlando, FL project
UMTA	Urban Mass Transportation Administration (former USDOT agency, now the Federal Transit Administration)
UMTRI	Univ Michigan Transportation Research Institute
VA "University Corridor"	Adding special IVHS testbed lane to new VA highway (UVA-VaTech); [$95M]
VICS	Vehicle Information & Communications System; integrated successor to AMTICS and RACS; vehicle-roadside communication, in-vehicle navigation & route guidance. Japan.
VIDS	Video Imaging Detection System (federally initiated AVCS machine vision effort)
VNIS	Vehicle Navigation & Information Systems. Annual IEEE sponsored conference.

VNTSC Volpe National Transportation Systems Center; the ‘other’ research wing of FHWA, located in Cambridge, MA

VORAD Vehicle Onboard RADar; for collision avoidance

VRTC Vehicle Research and Test Center, East Liberty OH

WADS Wide Area Detection System; an image processing based vehicle detection algorithm, precursor to VIDS

WARC World Administrative Radio Conference; meets every few years to discuss frequency table issues; ambassadorial and technical delegates

WIM Weigh In Motion

PART II: ELECTRONICS/COMMUNICATIONS TERMS and CONCEPTS

AM Amplitude Modulation; communication method that varies the signal amplitude to represent varying data

ARQ Automatic Repeat Request; an electronic request for retransmission of corrupted data

ASCII American Standard Code for Information Interchange; standard table of 8-bit representations of each letter, number, symbol, etc. for inter-machine communication

ASK Amplitude Shift Keying; digital AM; logic 0 and 1 are represented by two discrete amplitudes of the signal

BW Bandwidth; the range of frequencies needed to transmit a particular signal coherently; the larger the BW, the more information theoretically that can be carried. Limited by transmission medium and method. In general, digital techniques can use less BW than analog for a given message, thus more information per available BW.

BER Bit Error Rate; measure of digital communication. system accuracy (what percentage of bits are screwed up)

BPS Bits per second; basic data communication. rate measurement

C band Portion of the electromagnetic spectrum used primarily for satellite and microwave transmission; 4 to 6 GHz

CAD	Computer Aided Design (engineering), or Computer Aided Dispatching (of emergency/fleet vehicles)
CCD	Charge-Coupled Device; popular TV camera element
CDMA	Code Division Multiple Access; a spread spectrum digital communication. technique, developed by the military to prevent jamming, also allows for greatly increased multichannel transmission ability on a single medium by splitting a particular message up between different frequencies AND time slots
CD-ROM	Compact Disk Read Only Memory
cn	Carrier to Interference ratio; ratio of wanted/unwanted signal levels (also C/N, Carrier to Noise)
Common Carrier	Any authorized supplier of transmission facilities or communication. services to the general US public
Companding	Compressing and expanding a signal's bandwidth for transmission on a limited channel
CPU	Central Processing Unit; heart of a computer, hardware that actually executes instructions
CRC	Cyclic Redundancy Check; data communication. error correction method; extra message bits indicate (# of bits)/(some #), which can be verified on the receiving end
CT2	Second Generation Cordless Telephone; digital wireless phone system proposed and implemented in UK first, adopted with modifications by EC
DAB	Digital Audio Broadcasting; an emerging service, intended primarily for the broadcast of CD-quality music; can be terrestrial or satellite based and can transmit data at high rates as well
dBm	Decibel referenced to 1 milliwatt; relative strength of a signal measured in dB's (10*log base 10) when the signal power is compared in a ratio to one mW.
DBMS	Data Base Management System; software that manages information for multiple users

DBS	Direct Broadcast Satellite; satellite transmission intended to be received direct into home or building television/data systems; typically, only a small (1 m or less in diameter) dish antenna is required for reception.
DECT	Digital European Cordless Telephone; EC cellular, or CT1
Diplexer	A device that prevents the signal transmitted from a transceiver (eg, a cellular radio) from interfering with the receiving section of the transceiver
EHF	Extremely High Frequency; electromagnetic spectrum range of frequencies used for microwave transmission, 30-300GHz
EM1	Electra-Magnetic Interference; physical phenomenon that accompanies all electric and magnetic activity, can result in communication. channel noise and data errors if not guarded against
EPROM	Erasable-Programmable Read-Only Memory; a ROM chip that can be erased by X-ray or UV radiation and reprogrammed
fading	loss of radio signal due to transmission range limitations or multipath effects
FDM/FMA	Frequency Division Multiplexing/Multiple Access; technique that allows simultaneous communication on multiple channels using one physical medium by assigning different frequencies to different communicating parties
Firmware	Logic circuits that reside in ROM, but are software-alterable in certain circumstances
FM	Frequency Modulation; communication. method that represents a varying signal with a constant-amplitude wave that varies in frequency around a base (or carrier) frequency that is much higher than that of the signal
FSK	Frequency Shift Keying; digital FM--most common method for low speed data transmission, uses two different frequencies to represent logic 0 or 1
GHz	Gigahertz; frequency unit equalling 1 billion cycles/sec
GSM	Group Special Mobile; a subcommittee of ETSI that is specifying new pan-European digital cellular system
HF	High Frequency; radio frequency band from 3-30 MHz

ISDN	Integrated Services Digital Network; a recent type of digital telephone service allowing a user to transmit voice and data simultaneously
Ka band	Portion of spectrum in 12 to 30GHz range
Ku band	Portion of spectrum in 10 to 12GHz range, used increasingly for satellite communication
KHz	Kilohertz; frequency unit equalling 1 thousand cycles/sec
L band	A microwave frequency band used for satellite and microwave, in 1GHz range.
LCD	Liquid Crystal Display; e.g., watches, ‘flat’ displays
LED	Light Emitting Diode
MHz	Megahertz; frequency unit equalling 1 million cycles/set
microwave	frequencies above about 890 MHz
MIPS	Million Instructions Per Second; CPU speed performance measuring units
Modem	Modulator/Demodulator; common interface between machines and the communication. link connecting them; converts data to a form easily transmissible over (usually phone) lines
MTBF	Mean Time Between Failures; computing equipment reliability measurement
MTTF/R	Mean Time To Failure/Repair; computing equipment longevity measurement
multipath	A phenomenon in cellular radio propagation wherein obstacle-reflected radio waves interfere with direct waves at the receiver, causing signal loss
OS1	Open Systems Interconnection; 7-layered suggested model for data communication. system configuration, allowing processes to be separated enough to allow independence from a specific hardware platform
PCM	Pulse Code Modulation; a method of digitizing analog data for transmission
PROM	Programmable Read-Only Memory; a chip that stores data that is ‘permanent’ relative to software. ‘Burning in’ (storage) of data happens after manufacture.

ROM	Read-Only Memory; data storage, the contents of which are not meant to be changed (written), only accessed (read).
SCA	Subsidiary Communications Authorization; FCC regulation concerning subcarrier FM transmission (Muzak, RDS, etc.)
SLMR	Special Land Mobile Radio
SMDS	Switched Multimegabit Data Service; carrier-provided, connectionless, broadband, packet-switched data transmission service offering 1.544 mbs, 44.736 mbs, and eventually 155 mbs data rates.
T1 line	Digital transmission channel (provided by carrier services) rated to 1.544 megabits per second; used primarily for short-haul links
T2 line	Digital carrier facility at 6.312 mbps
TDM/TDMA	Time Division Multiplexing/Multiple Access; technique allowing multiple communication. channels on one physical medium by ‘time-sharing’-- chopping a message into pieces and sticking each piece into its channel’s timeslot which occurs cyclically
Teletext	One-way data transmission designed for broadcast of graphics and text, for display on subscriber TV or low-cost terminals
UHF	Ultra High Frequency; frequency range from 300MHz to 3GHz; includes TV channels 14-83 and cellular radio
VI-IF	Very High Frequency; frequency range from 30 to 300MHz, includes most FM radio and TV channels 2-13
VLF	Very Low Frequency; frequency band from 3 to 30 KHz, not very useful for communications because of slow data rate and EM1 from electromechanical devices
vocoder	Voice Coder; a device that converts analog speech signals into digital form and vice versa, reduces the bandwidth needed for voice communication.
VSAT	Very Small Aperature Terminal; an easily accessible satellite communication service, now competing with land-based leased lines