

**IMPLEMENTATION
of the**

**NATIONAL
INTELLIGENT TRANSPORTATION SYSTEMS
PROGRAM**

A Report to Congress

1994-1995

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Intelligent Transportation Systems (ITS), formerly Intelligent Vehicle-Highway Systems (IVHS), provide the tools to help us address current surface transportation problems, as well as anticipate and address future demands through an intermodal, strategic approach to transportation. ITS applies current and emerging technologies in such fields as information processing, communications, control, and electronics to surface transportation needs. While ITS technologies alone cannot solve our transportation problems, they can enable us to rethink our approach to solutions, and make current activities more efficient and cost-effective. Effectively integrated and deployed, ITS technologies offer a number of benefits including more efficient use of our infrastructure and energy resources, and significant improvements in safety, mobility, accessibility, and productivity.

Adapted from the National Intelligent Transportation Systems (ITS) Program Plan, March 1995.

Foreword

This report is being forwarded to Congress pursuant to Section 6054 (c) of the *Intermodal Surface Transportation Efficiency Act of 1991* (ISTEA). To obtain the Department of Transportation's (DOT) assessment of progress in the implementation of the national Intelligent Transportation Systems or ITS (formerly IVHS) program, that section of the ISTEA requests the Secretary to:

(a) 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; (b) specify cost-sharing arrangements made, including the scope and nature of Federal investment, in any research, development, or implementation project under the program; (c) assess nontechnical problems and constraints identified as a result of each such implementation project; and (d) include, if appropriate, recommendations of the Secretary for legislation or modifications to the IVHS Strategic Plan.

The first *Implementation Report*, transmitted to Congress in June 1994, described the achievements of DOT in the ITS arena, including early activities predating official establishment of the IVHS program in 1991. **This Report conveys program status since the June 1994 Report, including accomplishments, challenges and associated implications for future direction, and assumes an understanding of information presented in that Report.**

Reader's Guide to this Report

Below is an explanation of where the reader can find material responsive to each element of the ISTEA requirement to report various aspects of the ITS program.

- (a) **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;**

Part I of this report (under section A, *Program Update*, and section B, *Program Accomplishments*) outlines the high level achievements of the Federal ITS program to date; Part II reports on specific progress made within each ITS program area. A companion document to this Report, *Assessment of ITS Benefits--Early Results*, as well as Exhibit 4 (*ITS Benefits Data*) and Appendix III (*Examples of Early Deployments*) to this Report, list some of the actual measured and observed results of applying ITS technologies and systems toward the goals cited in ISTEA.

Section A3 of Part I outlines formal efforts underway for systematically monitoring and evaluating the achievement of the ISTEA goals set for the program.

- (b) **specify cost-sharing arrangements made, including the scope and nature of Federal investment, in any research, development, or implementation project under the program;**

Appendix I (*ITS Operational Tests, 1991-1995*), Appendix II (*Research and Development Projects with Cost-Share Arrangements*), Appendix V (*Early Deployment Studies*), and Appendix VI (*Priority Corridors*) specify the Federal and non-Federal contributions to corresponding programs.

- (c) **assess nontechnical problems and constraints identified as a result of each such implementation project;**

Discussion of the Department's approach to addressing non-technical barriers and constraints to ITS implementation is discussed in section C of Part I (*Where do We Go From Here?*), under *Mainstreaming*.

- (d) **include, if appropriate, recommendations of the Secretary for legislation or modifications to the IVHS Strategic Plan.**

Part I of this Report (in section C, *Where do We Go From Here?*) offers six main approaches to advancing the goals of this program.

Related Reports

The following reports provide more information on the ITS program, and may be obtained from the U.S. DOT Joint Program Office for ITS, or from ITS America.

- C ***Assessment of ITS Benefits--Early Results (August 1995)***, publication no. FHWA-JPO-96-001 -- accompanies this Report to Congress
- C ***The United States Department of Transportation Automated Highway System Program Report to Congress (September 1995)***, FHWA and NHTSA Report to Congress pursuant to Senate Report 103-150, *Department of Transportation and Related Agencies Appropriations Bill for 1994*; delivered in October 1995.
- C ***Providing Carrier-, Driver-, and Vehicle-Specific Information to the Roadside (May 1995)***, FHWA Report to Congress pursuant to Senate Report 103-310, *Department of Transportation and Related Agencies Appropriations Bill for 1995*; delivered in September 1995.
- C ***How the Intelligent Transportation Systems Research and Development Program Integrates with the Operational Test Program (May 1995)***, FHWA Report to Congress pursuant to Senate Report 103-310, *Department of Transportation and Related Agencies Appropriations Bill for 1995*; delivered in September 1995.
- C ***National ITS Program Plan: Volumes I and II (and Synopsis), First Edition (March 1995)*** -- outlines an approach to achieving the goals of the ITS program over the next 20 years, and offers guidance to aid public and private investment decisions; jointly produced by U.S. DOT and ITS America
- C ***Department of Transportation's Intelligent Transportation Systems Projects (January 1995)***, publication no. FHWA-JPO-95-001 -- a complete listing of all projects, tests, and studies receiving Federal ITS funds, from 1991 to the present; updated annually
- C ***U.S. Department of Transportation's Implementation of the National Intelligent Vehicle Highway Systems (IVHS) Program Plan: Report to Congress (June 1994)***, publication, no. FHWA-SA-94-082 -- annual report to Congress as required by ISTEA
- C ***Nontechnical Constraints and Barriers to Implementation of Intelligent Vehicle Highway Systems: a Report to Congress (June 1994)*** -- coordinated by the Office of the Secretary of Transportation, in response to an ISTEA requirement
- C ***Department of Transportation's IVHS Strategic Plan: Report to Congress (December 1992)***, publication no. FHWA-SA-93-009 -- U.S. DOT's first annual report pursuant to the ISTEA requirement
- C ***Strategic Plan for Intelligent Vehicle-Highway Systems in the United States (May 1992)***, publication no. IVHS-AMER-92-3 -- prepared by ITS America

I. Program Overview and Accomplishments

A. Introduction: Program Update, Management and Evaluation

When the Congress wrote ISTEA just over four years ago, it acknowledged that the Nation had reached the goals set for the Interstate era. It called for advancement into the next generation of surface transportation via a new level of research and exploration in pavements, design techniques and **Intelligent Transportation Systems (ITS)**.

In response to this charter, DOT launched a multi-faceted ITS Program involving research and limited field trials of promising technologies and systems. Over the last four years, the program has grown, matured, and found unified leadership and direction. We believe the foundation has now been laid for achieving the goals envisioned for ITS in ISTEA through the nationwide deployment of the first generation of Intelligent Transportation Systems in the United States. The program is now entering a new phase marked by two distinct horizons:

Near Term: For the next five years, the Department will focus on facilitating the national deployment of available public infrastructure--systems that many jurisdictions are already beginning to deploy--that can save lives and increase the capacity and efficiency of highway, transit and emergency response systems. Private sector investment and market development is predicated on the existence of a critical mass of such infrastructure.

The national challenge is to ensure consistency in architecture and standards development so that initial deployments form a foundation for the evolution of more sophisticated future systems. Establishment of standards should circumvent haphazard, regionally and modally fragmented, non-interoperable deployment that could seriously deter market development and preclude the achievement of long term ITS benefits.

Recognizing that public benefit comes only through actual commercialization of safety-effective products, the Department will adopt roles that complement the product-based interests of industry while representing the public interest in safety enhancement. We will achieve this goal in the near-term by building government/ industry cooperative relationships; conducting in-service evaluations of near-market crash avoidance products; and encouraging development of technology in our longer term research efforts.

The portion of the ITS program that supports near term deployment includes: *architecture, standards, operational tests, model deployment, technology transfer* and *training efforts*.

Long Term: Efforts focused on long term needs involve supporting the research, development and testing of more sophisticated technologies that show promise of deployability over the next 10 to 20 years. This part of the program includes efforts in advancing *crash avoidance technology*, the *next generation of traffic management techniques*, and *automated highway research*. We expect much of the operational test program's focus to shift from testing nearly market-ready technology toward testing technologies and systems derived from the Department's long term research efforts.

In the remainder of Section A, we report on the ITS Program's management, expenditure history, and new efforts in evaluating Program effectiveness and monitoring progress.

In Section B, we outline six major accomplishments that have laid a solid foundation for a program of national deployment. Section C presents a road map for the next phase of the program. The final section articulates a series of emerging issues that we believe will dominate our policy discussion over the next few years.

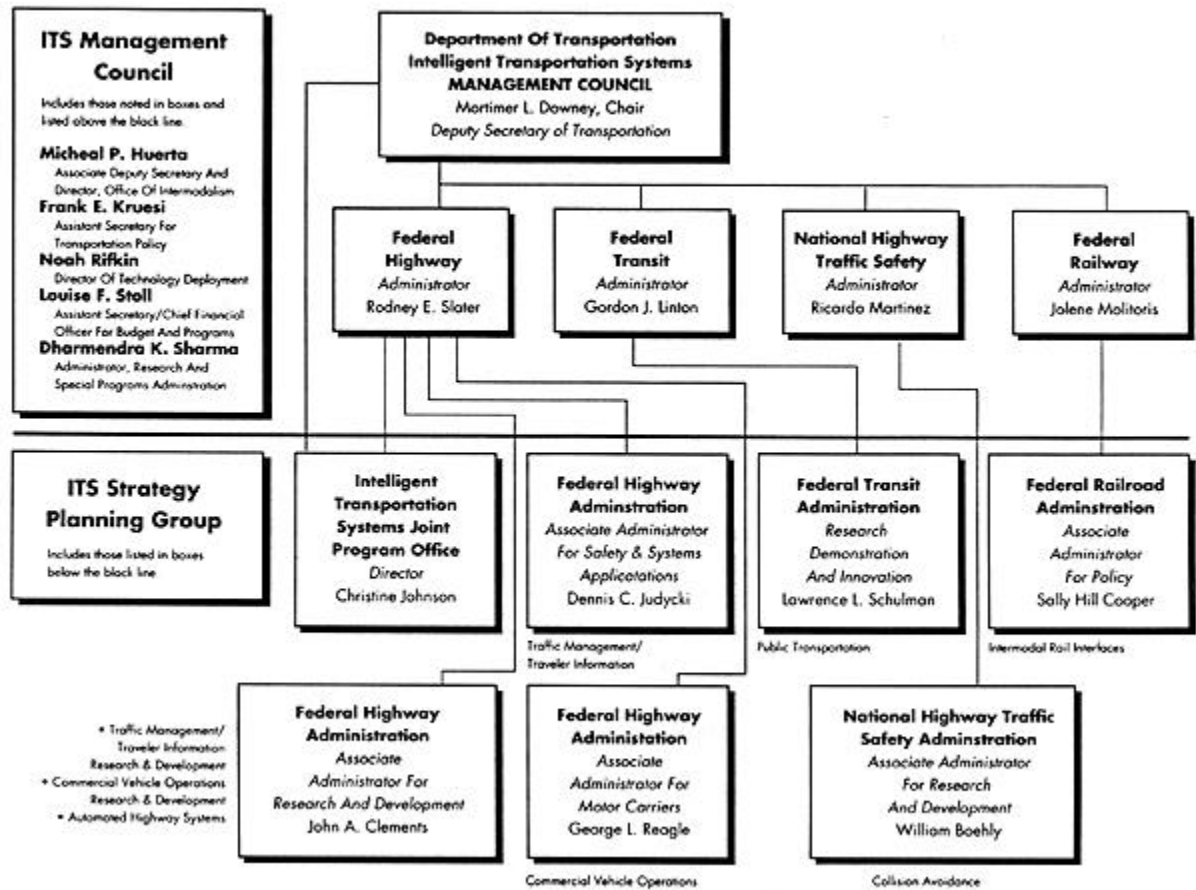
1. Program Management

The Joint Program Office (JPO) for ITS manages the ITS program for U.S. DOT. The JPO has liaisons with the modal Administrations, and receives policy guidance directly from the ITS Management Council chaired by the Deputy Secretary of Transportation.

The JPO recently coordinated the development of a set of **road maps** that mark milestones and critical paths for achieving key program objectives. Representatives of the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), and the Federal Transit Administration (FTA) worked closely with JPO to develop these maps which now serve as the bases for budgeting and program evaluation. Exhibit 1 on page 3 breaks down the JPO's management structure; Exhibit 2 outlines JPO program goals.

Exhibit 1. Joint Program Office Management

Department of Transportation Intelligent Transportation Systems Coordination



(as of 12/95 ITS-JPO)

JPO is housed within FHWA and receives policy guidance from the ITS Management Council, chaired by Deputy Secretary of Transportation, Mortimer L. Downey.

Exhibit 2. ITS Program Goals

1. Widespread implementation of intelligent vehicle-highway systems to enhance the capacity, efficiency, and safety of the Federal-aid highway system, and to serve as an alternative to additional capacity of the Federal-aid highway system.
2. Enhance, through more efficient use of the Federal-aid highway system, the efforts of several states to attain air quality goals established pursuant to the Clean Air Act.
3. Enhance safe and efficient operation of the Nation's highway systems, particularly system aspects that will increase safety. Identify system aspects that may degrade safety.
4. Develop and promote an intelligent vehicle-highway system and an intelligent vehicle-highway systems industry in the United States.
5. Reduce societal, economic, and environmental costs associated with traffic congestion.
6. Enhance U.S. industrial and economic competitiveness and productivity.

- 7. Develop a technology base for intelligent vehicle-highway systems and establish the capability to perform demonstration experiments, using existing national laboratory capabilities where appropriate.**
- 8. Facilitate the transfer of transportation technology from national laboratories to the private sector.**

JPO works toward the achievement of eight program goals, as delineated in ISTEA.

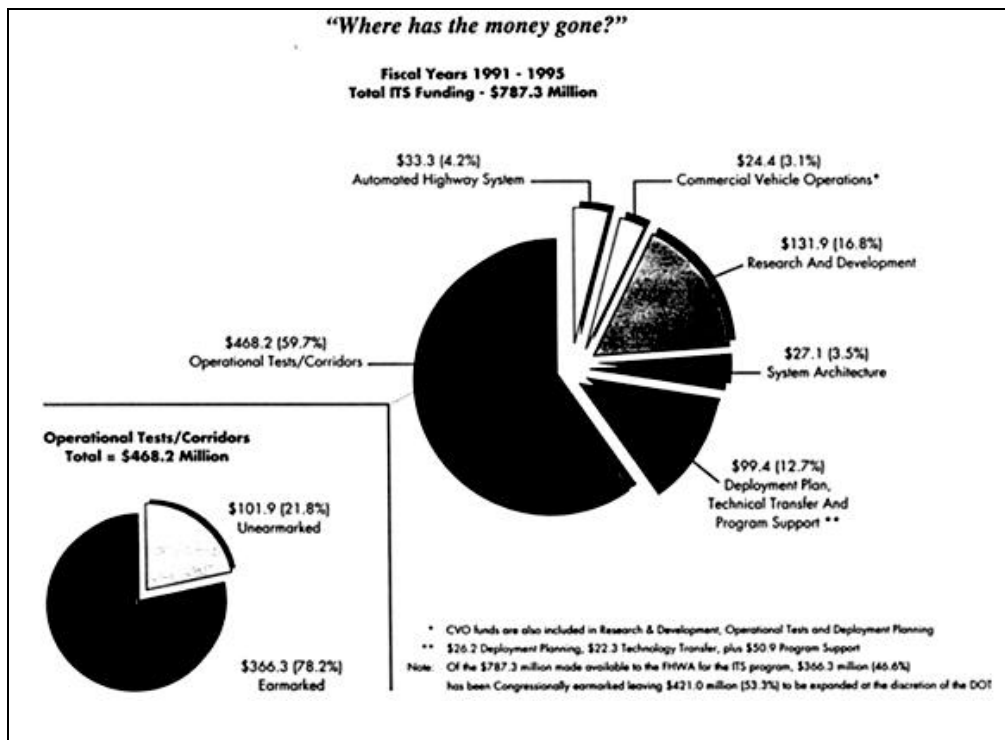
The program is advised by the Intelligent Transportation Society of America (ITS America), which was established in 1991 as a federal utilized advisory committee. ITS America membership hails from all sectors of the surface transportation community: state and local governments, motor vehicle manufacturers, commercial vehicle operators, railroads, telecommunications and commuter technology companies, universities and other research organizations, consulting firms, and public interest groups.

It sponsors workshops, conferences, and symposiums to convene researchers, producers, and ITS service users; it provides a forum for the exchange of ideas on what works, what is useful, and what is not, and to address remaining unfulfilled needs. ITS America has produced a number of reports, including a National Strategic Plan. It has partnered with DOT in developing the Program Plan and gaining consensus on a National Architecture.

2. Program Expenditures

ISTEA authorized a total of \$659 million over 6 years to achieve 8 key goals, as listed in Exhibit 2. As of Fiscal Year 1995, \$433.0 million of ISTEA funds have been authorized for expenditure in the program. This amount was supplemented by \$354.3 million (\$394.6 million appropriated, less \$40.3 million rescinded in FY 1995) in funds from the General Operating Expense budget, for total funding of \$787.3 million through Fiscal Year 1995. We estimate that by the end of 1995, all but about \$11 million will have been obligated. Exhibit 3 breaks down overall ITS fund obligations.

Exhibit 3. AWhere Has the Money Gone?@



ITS spending goes toward Operational Tests/Priority Corridors, the Automated Highway System (AHS), Commercial Vehicle Operations (CVO), Research and Development, System Architecture, and Deployment Planning, Technical Transfer and Program Support.

About 60 percent of the \$776 million total obligated amount was applied to field testing and demonstration projects, as part of either operational tests or the ISTEA Priority Corridors¹ program; 78 percent of that amount (operational tests and corridor projects) was Congressionally directed. Appendix I is a comprehensive breakdown of funding sources (i.e., Federal and other) for the operational test projects only. In many cases, Federal funds have leveraged a very high proportion of local or private funds (see Appendix I).

About 21 percent of ITS funding went to research, including the Automated Highway System (AHS) program. Many ITS research and development (R&D) projects also have had shared-cost arrangements, as presented in Appendix II.

About 16 percent of ITS funding has supported development of a foundation for national deployment, in response to the ISTEA mandate to foster:

¹The ISTEA Priority Corridors are: the I-95 Coalition (Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia); the Midwest Corridor (Gary, Indiana, to Chicago to Milwaukee); Houston; and Southern California.

widespread implementation of intelligent vehicle-highway systems to enhance the capacity, efficiency, and safety of the Federal-aid highway system

and to serve as an alternative to additional capacity of the Federal-aid highway system.

Efforts in this area have included development of a national ITS systems architecture, standards development, funding of early deployment plans, assessment of institutional issues and early training efforts.

3. Program Monitoring and Evaluation

As the ITS program has evolved from a start-up to a mature R&D program, the Department has begun to evaluate program results against national goals, and to monitor the progress of national deployment.

Early results -- An early evaluation of benefits (*Assessment of ITS Benefits--Early Results*, August 1995) accompanies this Report. The benefits assessment indicates that early ITS technologies show real promise of improving the efficiency of our current transportation system at the local level. For example, effective traffic signal synchronization has reduced delays and stops by 15 percent in some projects, and decreased travel times by up to 7 percent in others. In one area, incident management programs saved 300,000 hours of incident-related delay per year, increasing average speeds by 13 percent and vehicle miles traveled by 5 percent. One transit authority saw on-time performance improve by up to 23 percent using Automatic Vehicle Location (AVL) technology. One transit system reported a 12 percent revenue increase after implementing automatic fare collection; another jurisdiction estimated annual savings of up to \$990,000 by using a single payments fare collection system and eliminating separate transfers. Exhibit 4 summarizes some of these early benefits.

Exhibit 4. ITS Benefits Data

FUNCTIONAL AREA	SOURCE
<p>Advanced Traffic Management Systems (ATMS)/ Advanced Traveler Information Systems (ATIS)</p> <p>C FAST-TRAC, a project consisting of computer-controlled adaptive signal control, automated traffic monitoring and other ITS technologies, has increased vehicle speeds by 19 percent during peak hours in the Oakland County, Michigan, area.</p> <p>C The Minnesota Department of Transportation, using a real-time traffic adaptive freeway control system that meters traffic onto the freeway, has decreased its accident rate by 25 percent, improved response times to incidents by 20 minutes, and increased average speeds by 35 percent (34 to 46 miles per hour).</p> <p>C After installation of computerized traffic signals, Abilene, Texas, reduced carbon monoxide and hydrocarbon emissions by 10 percent.</p>	<p>ITS America</p>
<p>Commercial Vehicle Operations (CVO)</p> <p>C Portable computer applications for mobile data communications enhanced field service operations and saved a small private carrier more than \$10,000 per month in total costs.</p> <p>C ADVANTAGE I-75, which allows transponder-equipped, properly documented trucks to travel the I-75 corridor with minimal stoppage, has been implemented. Projected benefits include:</p> <ul style="list-style-type: none"> - reduce overweight loads by 5 percent with estimated saving of up to \$5.6 million annually. - cut weigh station operating costs by up to \$160,000 annually, with electronic credentials checking and safety inspections saving another \$4.5 to \$9.3 million annually. <p>C The COVE study estimates a benefit/cost ratio to the government of 7.2 for electronic clearance, 7.9 for one-stop/no-stop shopping, and 5.4 for automated roadside clearance.</p>	<p>American Trucking Associations</p> <p><i>Report, Assessment of ITS Benefits - Early Results (August 1995)</i></p>
<p>Advanced Public Transportation Systems (APTS)</p> <p>C Baltimore, Maryland, improved on-time performance by 23 percent after installing AVL technology on 50 buses.</p> <p>C Kansas City has saved \$400,000 in operating expenses and cut the response time under emergencies from four minutes to one minute by installing AVL technology on 200 buses.</p> <p>C Winston-Salem Transit Authority reports that its AVL computer-aided dispatching (CAD) system has decreased paratransit passenger waiting time by 50 percent.</p> <p>C Based on operational tests of smart card systems with the Torrance, Gardena and Los Angeles Transit Departments, the Ventura County FARETRANS project estimates savings of up to \$9.5 million per year from smart card deployment.</p>	<p>ITS America</p> <p>Federal Transit Administration</p>
<p>Advanced Vehicle Control and Safety Systems (AVCSS)</p>	

<p>C Blind-spot detectors are now commercially available. The Forewarn system has been applied to school buses since 1993. Although quantitative benefits are not yet available, pilot programs in states considering deployment have performed exceptionally well.</p>	<p><i>Report, Assessment of ITS Benefits - Early Results (June 1995)</i></p>
<p>Electronic Toll and Transportation Management</p>	
<p>C The Oklahoma Turnpike Authority estimates that the annual cost to operate an automated toll lane is \$15,800 versus \$176,000 for an attended lane.</p>	<p>Oklahoma Turnpike Commission</p>
<p>C The New York State Thruway estimates that full implementation of its E-ZPass electronic toll program will save approximately \$5 million per year in toll collection costs.</p>	<p>New York State Thruway Authority</p>

ITS implementation is already showing both real and projected results in Advanced Traffic Management Systems/Advanced Traveler Information Systems; Commercial Vehicle Operations; Advanced Public Transportation Systems; Advanced Vehicle Control and Safety Systems; and Electronic Toll and Transportation Management.

Evaluating Operational Tests -- As the operational test program reaches fruition, the Department has retained a national consultant to ensure comparability and thoroughness in project evaluation. These evaluations will measure benefits such as productivity and safety, and address other key research questions such as the performance parameters of the technology. Feedback from these efforts will allow the program to make course corrections as needed.

Measuring Deployment -- Key to achieving widespread ITS deployment will be the availability of certain *core ITS infrastructure*². We have instituted a program to regularly measure progress in national deployment [See *ITS America Fact Sheets #2, 5, 6, 10 and 11* of Appendix III for highlights of our initial efforts]. We are currently building a database of existing and emerging ITS infrastructure, and expect to include deployment progress data in our annual report to Congress.

B. Program Accomplishments

By almost any standard, the ITS program has achieved results beyond the expectations of the professional community (and, perhaps, even beyond those of Congress). Some of these achievements are precursors to more dramatic, future innovations (for instance, real-time traveler information and fleet vehicle management services, lane-keeping sensors, crash warnings, and adaptive traffic signal control); others are today's building

²The term *core ITS infrastructure*, or *core infrastructure*, refers to one of two core infrastructures: Commercial Vehicle Operations (CVO) and Travel Management. When used in this Report, the term refers to only one type of core infrastructure, as determined by context.

blocks that form the foundation for establishing the first internationally recognized standard for interchangeable transit vehicle components and achieving the long term ITS vision.

To date, we have:

1. **Defined the ITS Vision and Charted a Course to Achieve It** -- In 1992, the Intelligent Transportation Society of America (ITS America) and the Department published complementary ITS visions and strategic plans. These were followed by an unprecedented *jointly developed National ITS Program Plan*. This plan, published in March, 1995, charts a course for both the public and private sectors in achieving this shared vision. Building upon this foundation, JPO coordinated the development of a set of **Road maps** that mark milestones and critical paths for achieving key program objectives. Program offices within FHWA, NHTSA, and FTA worked closely with JPO to develop these maps which now serve as the bases for ITS budgeting and program evaluation.
2. **Launched Aggressive Long term Research Program** --The Department has established long term research programs that, if supported consistently, could ensure that the United States remains an industrial and technological leader in key emerging ITS technology areas. Primary programs of long term research include:
 - \$ **Advanced Public Transportation Systems (APTS)** - FTA has established a R&D program designed to make public transportation travel more user-friendly and more efficient for both the traveling public and the transportation provider. Activities focus on assessments and information dissemination to both the public and to public transportation providers for (a) real-time, interactive, traveler information systems; (b) fare payment systems research and case studies in the cities of Boston, Washington, New York, Chicago, Seattle and San Francisco; and (c) fleet management systems research and development. Additional activities include the development of a National Transit Geographic Information System (GIS) for the further development of ITS technologies in transit and establishing databases for all public bus routes, and conducting workshops to further the awareness and exchange of information of GIS development for transit.
 - C **Advanced Vehicle Control and Safety Systems (AVCSS)** - NHTSA has undertaken a major research effort to facilitate the development and implementation of cost-effective technologies for improving crash avoidance. Also, the agency has taken steps to ensure that the introduction of driver information systems and other vehicle-based electronic innovations do not compromise safe driving. These pursuits are addressed by five **thrusts**:@ 1) development of research tools and knowledge base, 2) problem definition/analysis, 3) demonstration of concept/optimal performance specification, 4) encouragement of commercial development, and 5) system evaluation activities.
 - \$ **Advanced Traffic Control** - FHWA has a long history of providing advanced concepts, technologies, and technical assistance to states and localities to improve efficiency in traffic management. Until recently, however, even the most advanced tools available (e.g., centrally coordinated signal systems) have still placed the burden of system optimization and control on the systems human caretakers. FHWA is working toward a vision of fully integrated surveillance and control systems that allow management across the entire freeway/arterial network.

Current programs aim at developing algorithms that can adapt signals and control strategies automatically to adjust to changing loads on the network (giving green time where it's needed), and developing software tools that actively aid network operators among different jurisdictions in cooperatively managing incidents and controlling the system. R&D on advanced sensors may provide system managers with better ways of receiving data on network performance that will feed the advanced analysis and control software under development.

- \$ **Automated Highway System (AHS)** - AHS is a key component of next-generation U.S. surface transportation. The goal is to enhance quality of life through the significant improvements in safety, mobility, enjoyment, and environmental impact that vehicle automation can achieve. The AHS will provide automatic transit, both commercial and private vehicle operation in special lanes, and facilitate more productive intermodal movement of people and goods.

The National Automated Highway System Consortium (NAHSC) will specify, develop and--as fulfillment of the ISTEA requirement--demonstrate the feasibility of AHS. These efforts will yield system specifications for an evolutionary AHS deployment model that can be adapted to regional and local transportation needs. The Consortium will seek opportunities for early introduction of vehicle and highway automation technologies that benefit all surface transportation users. NAHSC will incorporate public and private stakeholder views to ensure that an AHS is economically, technically and socially viable.

- 3. Tested the Viability of Numerous Technologies and Applications --** The Department has launched 77 operational tests that will provide considerable insight into the ability of numerous technologies to reduce congestion, decrease emergency response time, increase transit system productivity and passenger convenience, increase safety and personal security, and/or reduce the environmental impact of transportation (see Exhibit 5 for a map of operational test locations).

FHWA/FTA/NHTSA ITS Operational Tests



Exhibit 5a. FHWA/FTA/NHTSA ITS Operational Tests

FHWA, FTA and NHTSA have launched 24 operational tests, including an Iowa-Minnesota-Wisconsin multi-state effort, that focus primarily on ITS technology.

Exhibit 5b. FHWA/FTA/NHTSA Operational Tests

FHWA/FTA/NHTSA Operational Tests



FHWA, FTA and NHTSA have launched 16 other operational tests, including several multi-state efforts.

Some preliminary test results are recorded in the accompanying volume, *Assessment of ITS Benefits--Early Results*; the next two years will yield more substantial reporting as formal evaluations of the tests are documented.

Perhaps the greatest measure of success of the operational test program is the demand to extend these tests into the regular operations of the various agencies. For example, Oakland County, Michigan, is permanently integrating its traffic management and traveler information systems as a result of its FAST-TRAC project. Moreover, the move by several agencies to begin investing their own funds to implement ITS services, and the fact that companies are beginning to bring products and services to market, is even stronger evidence of the confidence placed in these early deployment products. Numerous examples include the extensive use of AVL systems for fleet management and traveler information services currently being activated throughout the United States; the in-vehicle navigation system available on some new GM and Ford models; the emergency rescue system for some Ford models; the "311" travel information service in the Greater Cincinnati area; and the San Antonio traffic management center. See Appendix III for more examples of completed and ongoing operational tests.

- 4. Launched National Architecture and Standards-setting Programs --**The Department and ITS America have undertaken the development of a consensus architecture to guide--not mandate--consistency among local investors, purchasers, and producers to reduce the risk of incompatibility among the numerous systems and components to be manufactured and purchased in the ITS industry. Phase I, which involved a competition among viable architectural concepts, is complete. Phase II, scheduled for completion in late 1996, involves developing consensus around a single architecture and deployment strategy that incorporates the best features of the competing concepts in Phase I. The Architecture Development Program is also yielding a series of standards requirements that has launched a standards development process.

Standard-setting activity results have been demonstrated in the official acceptance of a recommended practice for interfacing interchangeable transit vehicle components. This action is expected to minimize the cost of electronic transit components and systems while providing for the expansion and technology advancement with minimum impact on in-place assemblies. This practice is the first ITS recognized standard and is being used for procurements in the United States, Canada and Europe.

- 5. Developed Local Plans for the Deployment of Commercial Vehicle and Travel Management ITS Infrastructure --** The Department has supported state and local agencies in developing plans for early deployment of ITS technology for travel management and commercial vehicle safety regulation. As CVO are frequently multi-jurisdictional, we have encouraged the development of multi-state groups to begin re-engineering their regulatory functions and developing common approaches for deploying ITS technology. The objective is to streamline and enhance those operations for both carriers and states. Exhibit 6 illustrates those state groupings.

Exhibit 6. ITS/CVO Mainstreaming Projects



Currently, 39 states are participants in ITS/CVO mainstreaming projects.

To date, 18 Phase I plans (which identify institutional problems and key interfaces) have been completed; by 1996, 5 Phase II plans, which will lay out deployment strategies for these groups of allied states, will be complete.

ITS early deployment planning to support travel management is underway at both the metropolitan and corridor levels. We anticipate that, by 1996, 75 of those plans will be initiated or in place (see Exhibit 7 for a map).

Exhibit 7. ITS Deployment Planning Studies

ITS Deployment Planning Studies



Current ITS Deployment Planning Studies include metropolitan areas, priority corridor studies, as well as other studies.

In addition, the ITS Priority Corridors are completing their strategic and business planning processes and are expected to move immediately into implementation.

6. **Identified a Set of ACORE® Public ITS Infrastructure to Launch National Deployment of ITS Travel Management and Commercial Vehicle Services --** Early results of field testing and implementation, early deployment planning, and the architecture analysis all indicated the need to identify a set of core ITS infrastructure to provide the early safety, security, passenger convenience and congestion relief benefits of ITS technologies, and to serve as a platform for the evolution of more sophisticated services. These building blocks--technologies such as passenger information services, traffic control signals, ramp meters, weigh-in-motion (WIM), computer-aided dispatch, vehicle tracking systems, etc.--are being deployed every day in states, cities and counties across the Nation.

Unfortunately, many independent deployments thus far lack a common view to forming a unified technology platform for the evolution of even more powerful future services. Continued unfocused deployment presents the risk that incompatibilities or other discontinuities among systems will either preclude integration and evolution or make it very expensive, thereby impeding domestic ITS market development and reducing U.S. industry's ability to compete in the international marketplace.

The Department has identified a critical next step in the ITS program as the *model deployment of an integrated system* of these individual technologies--to showcase the value of such integration and to test many of the key interfaces that will be identified for standards development in the architecture.

C. Where do We Go From Here?

An R&D program is inherently one of discovery and course correction. Thus, there is always uncertainty in plotting a future course; however, the information currently available to the Department suggests the following **Themes** will characterize the ITS program over the next several years:

1. Model Deployment

Several factors make model deployment of core CVO and Travel Management infrastructure a critical next step in this program:

- C The need to **test and demonstrate the architecture** that emerges from the National Consensus Architecture Program; the need to validate standards requirements at key interfaces by testing them in operational environments is particularly important.
- C The need to **test on a wide scale the National Commercial Vehicle Information Network**.
- C The need to **demonstrate the benefit of *integrating into a system*** the various individual core ITS infrastructure elements technologies in a way that mayors, county officials and state transportation officials can **touch and see**. They will be the key decision-makers and architects in deploying the first wave of integrated ITS infrastructure across America.
- C The need to **intervene by example** to preclude current haphazard (or **stovepiped**) ITS deployment.
- C The need to test and **demonstrate the institutional arrangements** necessary to bring together numerous public and private institutions tightly enough to allow exchange of, and real-time access to, multi-layered transportation-related information. This level of coordination and information sharing, based on carefully built trust relationships, can enable services such as real-time passenger information services, truck safety inspection, automated licensing and permitting, emergency response, transit fleet management and traffic management.
- C The need to **test the private market for the value of information**. Although all our models indicate private-sector delivery of various travel information services, few working examples exist. The private sector believes these services cannot be provided until a **critical mass** of real-time information is available. We believe a

fully-integrated core travel management infrastructure would provide that critical mass of information.

We propose to identify, by competitive solicitation, travel management and commercial vehicle model deployment sites. The Federal program will assist in sufficient development of both the institutional and technical infrastructure to provide a national demonstration of a fully-functioning ITS deployment.

2. Mainstreaming

To prepare for national deployment, we have recognized the need to move the program from the laboratories and testbeds to the mainstream of FHWA and FTA practice. Thus, our program will reflect an emphasis on **Amainstreaming@ITS** deployment in three critical areas:

C Champions -- Local **Achampions@** can address local institutional issues. Our early institutional studies showed that, in many instances, ITS is the technical underpinning of a *re-engineered process or approach to dealing with a problem*. That **Aproblem@** could be the streamlining of truck regulation or the management of traffic congestion. The nontechnical barriers to implementation identified early in the ITS program are often merely the challenges inherent in changing the paradigm, process, or approach to dealing with an issue. Our studies identified the following actions that must be addressed for successful ITS deployment:

- C re-engineer truck regulatory processes
- C streamline procurement practices
- C establish new communication channels
- C develop new engineering and system integration skills
- C create methods to protect individual privacy
- C change institutional and corporate culture

We can overcome these barriers, but not with **Aone-size-fits-all@** national policies. In many cases, local champions have solved these **Aproblems@** by bringing together people and institutions that did not traditionally communicate to find ways of changing paradigms, processes or approaches to solving problems.

Experience has shown that many institutional issues are best resolved by supporting local champions or conveners.

C Training -- Unlike the last generation of transportation infrastructure, which was structural in nature and involved a relatively well-defined set of decisions and decision makers, ITS will be implemented through independent decisions by individuals at different government levels, in multiple agencies and in the private sector, and in thousands of regions across the United States. These individuals should become comfortable with the technical specifications of the communications and information infrastructure required to support this new generation of transportation. Achieving the ITS vision requires as aggressive a national commitment to training as was made in the development of the technology

itself. The Department is currently working with ITS America to develop a comprehensive strategic approach for this area.

- C **Guidance** -- Many agencies are purchasing elements of core ITS infrastructure, though relatively unaware that it is or could be part of a larger, area wide system. The ITS architecture will be complete in 1996 and we plan a major effort to provide guidance to FTA and FHWA field representatives and our state and local partners on making acquisitions consistent with that national architecture, and thus capable of evolving and interoperating with future systems.

3. Operational Tests

In the past, the ITS program has sponsored a variety of operational tests of new technology or innovative applications of existing technology. We now have over 77 of these tests underway or completed; over the next several years, they will provide a rich stream of evaluation information. We are now beginning of a new phase of our operational test program: fewer tests are being proposed, and these have emerged from the longer term ITS research program, now mature enough to require field testing. Specifically, we propose:

- C **Field Tests of Crash Avoidance and Other Safety Systems.** To validate safety specifications under real operating conditions, and to help facilitate the development of marketable systems, NHTSA will conduct operational tests and in-service evaluations of refined prototypes in the highway environment. In cooperation with industry, test vehicles will be outfitted with the system and subjected to a carefully designed field trial to assess performance, reliability, maintainability, failure modes/consequences, and costs. NHTSA is currently implementing operational tests of intelligent cruise control (ICC) and automatic collision notification systems. Candidates for the next phase of field testing (FY 1997-99) might include systems for night vision enhancement, driver-impairment warning, smart cruise control, rear-end collision warning, or other concepts already under development by industry.
- C **Field Tests of Adaptive Traffic Signal Control and Traffic Management Coordination.** The FHWA research program in Real-Time Traffic Adaptive Control (RT-TRACS) has developed a number of technical approaches to the problem of real-time optimized control of the roadway network, and is currently evaluating these approaches in a laboratory simulation and research test environment. Operational field tests of RT-TRACS systems will evaluate one or more algorithms in a larger, real-world application. Application of RT-TRACS is expected to form the technological foundation to improved efficiency in roadway network control for the future, eventually allowing multiple jurisdictions to proactively manage roadway service levels to meet anticipated demands.

RT-TRACS and other ITS solutions require the ability to exchange data easily among jurisdictions. This capability is especially important for coordinating operations on roadways that cross jurisdictional boundaries, which means that systems must **Aspeak the same language** when exchanging location-specific (i.e.,

roadway, intersection, High-Occupancy Vehicle (HOV) lane, etc.) data. Work on location-referencing systems and spatial database transfer standards will provide the means to link various jurisdictions into a regional system with the capability to optimize efficiency of freeway and arterial traffic movement.

4. The Automated Highway System (AHS)

The AHS development program is structured in three phases. The Analysis Phase, which is near completion, established the empirical foundation for the System Definition Phase. The National Automated Highway System Consortium (NAHSC) is now conducting the Systems Definition Phase; milestones are the establishment of performance and design objectives, a 1997 proof of technical feasibility demonstration, identification and description of multiple feasible AHS concepts, selection of the preferred AHS system configuration, completion of prototype testing, and completion of system conceptual development and supporting documentation. The Operational Test and Evaluation Phase begins in 2002, following the System Definition Phase. It will include: (1) integrating the proffered AHS system configuration into the existing institutional technological and regulatory environment; (2) evaluating this configuration in a number of operational settings; and (3) establishing guidelines by which U.S. DOT will support AHS deployment.

5. Standards Development

Although standards development has been initiated in several areas, we anticipate that the completion of the national architecture by July 1996 will have launched additional standards development efforts. When a public interest must be advanced quickly, the Department will support the requirements development process through ITS America and the standard-drafting process through the appropriate Standards Developing Organizations (SDOs) by providing technical expertise and financial assistance to help advance the process of building support for these key standards.

6. Evaluation and Tracking

Early focus was on launching a variety of operational tests; in the next two years, we will incorporate goals of the Government Performance and Results Act of 1993 (P.L. 103-62) into the ITS Program by increasing front-end emphasis on the importance of evaluating program results through measurement of project results, service quality, and customer satisfaction. We will adjust our current course and, more importantly, identify research requirements for the rest of the decade based on the insight obtained from a growing set of data provided by ITS operational tests. We anticipate the resulting larger database will allow a more rigorous assessment of ITS benefits. We will also track deployment levels of the travel management and CVO core infrastructure across the Nation.

D. Emerging Issues

We anticipate several issues to promote national dialogue over the next few years and ultimately determine the extent and shape of ITS deployment. These include:

1. National Deployment Strategy -- Launching the first wave of ITS deployment presents two important questions:

1. What is the best catalyst for sustained ITS deployment? What is the most appropriate role for U.S. DOT in fostering nationwide deployment?
2. How can we ensure the evolution of reasonably common national standards, to assure common product markets and inter-operability, without precluding local choice?

One obvious catalyst for deployment is the ability to use regular Federal-aid and state transportation funds for ITS. However, many ITS travel management functions substitute network management and operations for capital expenditure to achieve more capacity; and, historically, Operations and Maintenance (O&M) funds have been among the scarcest and least predictable resources in transportation agencies. Some transit and highway agencies receive funding from existing Federal (and often state) programs for ITS technology deployment; however, similar programs to support CVO core technology deployment do not exist.

2. Wireline Communications Infrastructure Policy. Current information suggests that a fully operational ITS infrastructure would consume considerable bandwidth. A number of states and local governments have established public-private partnerships to obtain this communications capacity, these arrangements often involve the public sector giving telecommunications providers access to highway rights-of-way (for laying fiber optic lines) in exchange for long term use of some of the new capacity for ITS applications. Other jurisdictions have built, or are planning to build, the needed infrastructure themselves. Still others lease communications capacity from existing networks. Some communications companies are concerned about Government agencies building and owning communications infrastructure and, to a lesser degree, the emerging public-private partnerships. They fear transportation agencies may build and/or own excess capacity and sell it in competition with private telecommunications companies. No current, comprehensive analysis on the economics of owning versus leasing communications capacity exists; however, DOT is conducting such an analysis. Preliminary findings indicate that leasing may be less expensive than investing in communications infrastructure, if telecommunications companies are competitive and creative in their pricing. Bartering right of way for long term use of communications infrastructure also has proven to be very cost competitive.

3. Wireless Spectrum Requirements. Many crash avoidance technologies depend on vehicle-to-roadside communication, as do all vehicle identification and transaction technologies and some in-vehicle travel information services. Specific spectrum requirements will depend on technology development and thus will not be defined for several years. As the United States makes more spectrum available, however, staking an early claim becomes critical to protect an emerging ITS industry. Moreover, serious concerns have risen over the effect on the industry of spectrum auctioning,

particularly the spectrum used for emergency response, crash avoidance and other safety services.

4. Maintenance of Software, Architecture and Standards. In the past, certain Department research programs have sponsored production of software products to assist transportation systems analysts and developers. Likewise, several developing ITS arenas will result in widespread use of software and databases that may benefit from long term maintenance, upgrading, and version control. The same may be true for the Department-supported national system architecture and standards development efforts. Although we expect that the existing mechanisms for maintaining standards within national and international Standards Organizations to serve the ITS industry well, it may be necessary to maintain a special interest in standards and architecture in order to preserve national ITS compatibility, as chartered by ISTEA. The Department does not wish to be in the business of software or standards maintenance, but needs to understand how to best support the ISTEA goals of national compatibility. We intend to explore precedents, alternative future scenarios, and potential DOT roles in this area.

II. Program Progress

ITS applies to several broad transportation areas, which correspond to various offices and programs within U.S. DOT, that are responsible for delivering each component of the program:

- C **Advanced Travel Management** encompasses a wide range of ITS services that address traffic management, traveler information, transit management and electronic fare/toll payment.
- C **Advanced Commercial Vehicle Systems** apply advanced technologies and information networks to increase productivity and efficiency for both fleet operators and state motor carrier regulators.
- C **Advanced Crash Avoidance Systems** comprise a program area that explores the use of ITS to improve driver safety through enhanced vehicle control, automated collision notification (ACN) and other technologies.
- C **Automated Highway System (AHS)** comprises a program area that is defining system requirements for the fully automated highways of the future; a demonstration of feasibility will be presented in 1997.
- C **Rural Applications of ITS** use innovative and advanced technologies to address numerous safety problems associated with rural transportation.
- C **System Architecture and Standards** lay the foundation for national interoperability among all ITS components.

In the following sections, we present the status and principal accomplishments of each of these individual program areas.

A. Advanced Travel Management

The long term vision for advanced travel management is an integrated multimodal web of information infrastructure, products and services that:

- C Uses **public and private monitoring sources to sense traffic conditions** on freeways and arterials, and dynamically adjust traffic control devices to: maximize throughput, decrease response times to emergencies and grant priority to transit vehicles.
- C Uses **real-time location information** from transit and emergency response vehicles to achieve: more productive routing and dispatch, quicker response to emergencies, increased passenger security, and enhanced law enforcement.
- C Provides **dynamic traffic and transit routing information, vehicle location and arrival information** (and a variety of other convenience information) to travelers at home, in vehicle, at work, and in other public places--and supports personal and public-agency efforts to reduce travel demand and increase vehicle occupancy.

- C Supports intermodal **smart card** fare payment (for transit, tolls, parking, etc.) as well as various policy-driven pricing strategies.
- C Supports long term metropolitan transportation planning.

It is widely recognized that a fully integrated, metropolitan-area information infrastructure will spawn multiple spin-off applications, services and products--much as the desktop computer introduction spurred the software application explosion.

Achieving this vision will require successful completion of several key **R&D** efforts, continued **field testing** of some technologies, and continued **support for widespread deployment** of what the Department has identified as a core ITS travel management infrastructure in metropolitan regions across the United States. Key objectives in each of these areas are outlined below:

1. Research and Development

There are several primary research frontiers aimed at achieving the long term vision for Advanced Travel Management:

- a. The development of an open architecture, area-wide, **dynamically adaptive traffic control system**. Today, most cities function with static or pre-programmed traffic control. A few cities have adaptive control at key intersections. U.S. DOT is evaluating larger-area proprietary signal systems as part of the FAST-TRAC (Oakland County, MI) and SCOOT Adaptive Control System (Anaheim, CA) operational tests. The goal is to develop a next-generation system available to all vendors that will provide capability to link freeway and arterial control. Key accomplishments include:
 - C the development of a **Traffic Management Laboratory** and a prototype **Traffic Control Center**. The former will be used to simulate metropolitan traffic conditions and test various control strategies, their support systems and hardware and software. The latter is a prototype training center.
 - C launched the development and evaluation of **five dynamic traffic assignment algorithms** which will be critical in developing optimal region-wide adaptive control; which will, in turn, enable the forecasting capabilities necessary to supply efficient routing solutions
 - C launched the development of a version of TRAF-NETSIM **software to evaluate traffic flow** that will interface with the real-time traffic adaptive signal prototypes. This software will allow laboratory testing of the prototypes prior to field testing and deployment, and provide greater capabilities to the more than 800 registered users of the off-line versions

- b. Gaining an understanding of the **human factors** associated with the design and, ultimately, the operation of traffic control centers as well as those associated with delivering traffic information to users in vehicles or through other media. Key accomplishments have been the establishment of a **human factors laboratory** at the Georgia Institute of Technology and the development of a set of preliminary **human factors guidelines** to be considered in the design of transportation control centers.
- c. Development, refinement or adaption of key **enabling technologies** including Global Positioning System (GPS), wireless communications, and geographic location referencing for digital maps. Key accomplishments in this area include:
 - C the completion of a **detailed analysis of spatial data requirements** for ITS. This study evaluated the complex institutional, legal, economic and technical factors related to achieving a common means of referencing locations in various ITS databases and applications, and is considered a critical step in facilitating widespread ITS deployment. All significant existing methods of location referencing were reviewed and evaluated against real-world databases using a specially developed computer model. The project recommended development of an inter-operability framework for ITS spatial data to support ITS infrastructure deployment.
 - C the 1996 completion of **guidelines for a nationwide GPS augmentation infrastructure** to support ITS needs
 - C the 1996 completion of a **comparison of alternative communications technologies** against requirements established by the national architecture
- d. Development and testing of the use of **automated fare and toll payment technology**. Although tag/transponder technology is more widely used for toll collection and other forms of vehicle tracking, and several transit agencies are experimenting with electronic fare payment, the base technologies are different. Moreover, both parallel the rapidly evolving debit/bank card industry which could, conceivably, eventually encompass all transportation electronic payment forms. Last year we completed a study on the development of a conceptual design for an **automated card** that could support fare and toll payment applications. The study presents separate card design characteristics for both person-based and vehicle-based applications for the end card system.

2. Operational Tests

To date, we have launched a total of 41 operational tests in the Travel Management area. Test areas include evaluations of: the capability of individual technologies--personal digital assistants (PDA), pagers, etc.--to deliver travel information; the concept of **vehicles as probes** as a less infrastructure-intensive means of obtaining network information; the use of GPS satellites for transit fleet tracking; complex technical and institutional systems, such as the integrated traffic control/surveillance

system in the FAST-TRAC project in Oakland County, Michigan, or the synthesis of traffic information for private sector dissemination in the TRAVINFO project in San Francisco. Summary and key update information on these tests follows:

- a. **Traffic Management** -- We have launched 14 operational tests³ focusing primarily on ITS traffic management services and technology. Several of these tests are nearing final development stages, and all are expected to be up and running by the end of 1995. Testing includes the full range of system components and technologies used in traffic management systems: surveillance, communications, data analysis and response algorithms, and control mechanisms.

Early findings have shown the following:

- C **Innovative traffic flow monitoring technologies show real promise.** Operational test project contributions include radar testing in Connecticut; **A**electronic toll tag**@**reading in New York/New Jersey and Houston, Texas; flow measurement via cellular phone transmissions in Virginia/Maryland; and aerial surveillance in Maryland/Virginia.
 - C **Advanced video analysis** (i.e., machine vision techniques), though still in development, **will provide valuable monitoring tools** for use by state and local agencies.
 - C **Multiple jurisdictions working together to share information** and cooperatively respond to accidents and other incidents in congested corridors **has proven valuable.** Coordinated action plans for specific situations can maximize freeway and arterial capacity, thus minimizing disruption and delay. The Smart Corridor project in Southern California was in its infancy when successfully used after the January 1994 Northridge earthquake to provide traveler information on transit and HOV use, and to facilitate rerouting of traffic from the damaged Santa Monica Freeway onto the arterial street system.
 - C **A strong set of incident management policies and response procedures can greatly improve response and clearance time,** improving service to the traveling public by reducing congestion-induced delays (facilitated through expanded inter-jurisdictional coordination). The National Incident Management Coalition's success has led to the implementation of numerous incident management projects within metropolitan areas.
- b. **Transit Management** -- Six tests of **GPS-based vehicle tracking** technology were launched to improve fleet management, schedule performance, safety and travel information disseminated to the public. Signpost technology for vehicle

³ The 14 tests are San Antonio, FAST-TRAC, Integrated Ramp Metering/Adaptive Signal Control, Mobile Communications System, Satellite Communications System, Seattle Wide-Area Information for Travelers (SWIFT), SCOOT, Smart Call Box, Smart Corridor, Spread Spectrum, TRANSMIT, CAPITAL, CT Freeway ATMS, & Multi-Agency Aerial Surveillance.

location has also shown results are extremely encouraging: Kansas City reduced the number of buses required to serve its customers at the same level of service. For a \$2.3 million investment, the city has saved \$400,000 per year in operating expenses and \$1.5 million in capital expenditures for replacement buses, and has amortized its investment in under 2 years. Baltimore and Milwaukee saw 23 and 28 percent respective improvements in on-time performance; Denver and others have recorded major reductions in emergency response time to bus incidents by pinpointing bus locations and dispatching aid (police, medical, etc.). To date, some 25 transit agencies have or are deploying this technology.

Also in testing, **Abus priority**® technology allows traffic signals to adapt to the presence of transit vehicles. A bus approaching a signalized intersection notifies the signal, which either extends the **Agreen**® time or shortens the **Ared**® time as appropriate. The test objective is to shorten bus drive times, and thus increase throughput by moving more people faster.

Two operational tests are using different approaches to this technique. In Portland, a limited test of four intersections along a major artery showed up to an 8 percent reduction in bus travel times. The potential need for fewer buses on major routes makes this technology a cost-effective tool for transit agencies--and the added benefits of convenience and speed for passengers.

- c. **Electronic Fare Payment** -- Two electronic transit fare payment tests were launched: the Washington Metropolitan Area Transit Authority (WMATA) in Washington, D.C., is testing a single card for bus, rail and parking fees; and the State Department of Transportation in Wilmington, Delaware, is working with the banking community to test a bus fare collection system that also facilitates an employer-subsidized transit incentive program. A number of cities are testing these technologies in pilot projects; most have just begun operations, including New York; New Jersey; Delaware; Ventura, California; Washington, D.C; and the Puget Sound area.

Some projected benefits of this technology follow:

- C New Jersey estimates a saving of \$2.7 million per year in reduced labor costs; Central Puget Sound estimates \$8.5 million savings in reduced maintenance.
- C Ventura County, California, estimates a \$9.5 million per year savings on reduced fare evasion; New York estimates savings up to \$2.5 million per year.
- C New York estimates increased ridership producing annual revenue of \$4.9 million from improved convenience and marketing opportunities.

- d. **Traveler Information** -- Seventeen tests of ITS traveler information services and technology have been launched. In addition, many transit properties are routinely testing approaches to delivering real-time transit information including cable TV, video text data which can be accessed on personal computers, and automated telephone information centers. Three key operational tests have been completed

(INFORM, TravTek and Boston SmarTraveler), and at least three others will be actively collecting data by the end of 1995⁴. The remaining projects are in various phases of design, integration, and engineering.

These efforts have produced an important development: the provision of combined traffic and transit information kiosks. This technology has been placed in the form of interactive devices in the workplace, shopping malls, and major transportation centers to test public acceptance. A key demonstration of combined transit and traffic information will appear at the 1996 Summer Olympics in Atlanta.

Early Traveler Information test findings show:

- C The INFORM project in Long Island, New York, demonstrated that drivers will divert to less congested routes if presented with reliable and credible traffic congestion information. The project showed that 5 to 10 percent of freeway traffic can be diverted to appropriate off-ramps when necessary, saving an estimated 300,000 vehicle-hours of travel; the ramp metering system has increased morning peak-period speeds by 3 to 8 percent.
- C The hugely successful TravTek project, fully operational for one year ending March 1993 in Orlando, Florida, showed that drivers were receptive to (and enthusiastic about) in-vehicle, dynamic route guidance devices. System use analysis showed that drivers using route suggestions provided by the system shortened travel times by up to 20 percent. Many users reported an easy transition to (and eventual reliance on) finding destinations electronically, without using paper maps. The TravTek experience has influenced private-sector development decisions, including marketing of in-vehicle devices now available as both new-car sales options and after-market installations.
- C The Boston SmarTraveler project evaluated public acceptance and potential traffic impacts of a telephone-based audiotext traffic information system. Public response and system use have been excellent, with over 3 million calls received from the system launch in January, 1993, to October 1995. The SmarTraveler Operations Center has expanded its role as a regional incident management provider by transmitting an average of 300 roadway incident first notifications per month. SmartRoute Systems (the project's private-sector partner) is continuing the project in cooperation with the State of Massachusetts.

⁴ The 17 tests are INFORM, Trilogy, TravLink, TravInfo, ADAS, Atlanta Kiosks, Boston SmarTraveler, Denver PIDS, Detroit Transit Info., DIRECT, Genesis, Herald, Houston Smart Commuter, TransCal, ADVANCE, Travel-Aid, & TravTek. Travel-Aid, ADVANCE, and DIRECT will be actively collecting data by the end of 1995.

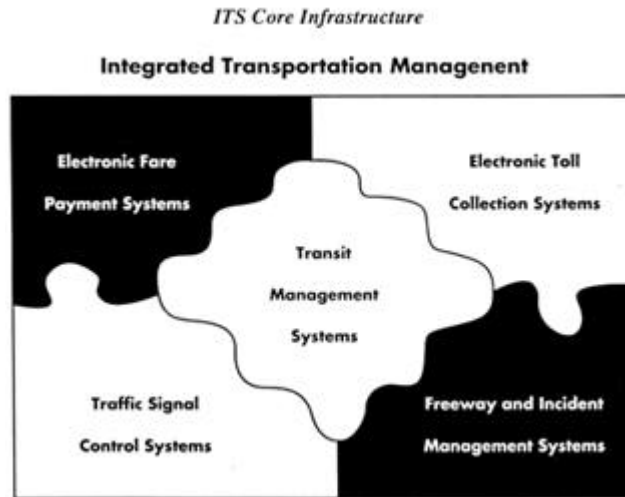
- C In Los Angeles, the use of first generation travel information kiosks received extremely positive response. Additional deployment and expansion of informational services is being considered by additional agencies.

- C Collecting and fusing data from multiple sources using dissimilar databases and protocol is a challenging effort, as the TravInfo project in San Francisco has shown. This effort is moving toward an openly-available database of region-wide traffic and transit performance information for use by both public sector operating agencies and private sector value-added services. Linking geographic databases from various sources, and reaching consensus among public and private sector entities on technical aspects of the system, have proven challenging and educational. These experiences will guide further efforts to develop location referencing standards, spatial database transfer standards, and metropolitan-wide information sharing systems.
- C DOT is also learning more about the dynamics and flexibility necessary to forge effective public/private partnerships. In some cases, we have established preliminary partnerships which have stalled due to changes in corporate priorities. This is an every-day occurrence for most private firms as they continually re-evaluate the market potential for specific services and/or technologies, but these changes can disrupt ITS program plans and schedules. DOT is learning to work within the private sector environment, and to quickly adjust to dynamic situations, which is necessary to maintain and evolve the public-private relationships essential to the success of the overall ITS Program.
- e. **Dynamic Route Guidance** -- We have launched two significant tests of the use of real-time traffic information to assist the in-vehicle selection of routes:
 - C The TravTek field trial in Orlando, Florida, was successfully completed in 1993 and the evaluation summary published in 1995.
 - C The ADVANCE project in the Chicago Metropolitan area was designed to build upon the TravTek experience. ADVANCE originally planned to field a much larger fleet of vehicles than did TravTek; this would have greatly improved the extent of the probe data on roadway flow speeds reported by the vehicles to the control center. System development issues led the Partnership to reduce the scope of the project and focus on a targeted deployment of less than 100 vehicles. The project will still achieve many of the original test objectives at a much reduced cost. In addition, the Mid-West ITS Priority Corridor, which includes portions of three states and the Gary-Chicago-Milwaukee metropolitan areas will use many of the resources and products created for the ADVANCE project.

3. Deployment Support

Perhaps the most critical accomplishment of 1995 was the Department's and ITS America's joint identification of a **core set of ITS infrastructure** that would share a common national architecture to allow consistent market evolution of ITS technologies. Each core infrastructure component, illustrated below in Exhibit 8a and outlined in Exhibit 8b, delivers its own particular set of safety, congestion reduction, security and/or productivity benefits [see Appendix IV for a detailed discussion].

Exhibit 8a. ITS Core Infrastructure



ITS Core Infrastructure can be broken down into seven component systems that, when integrated, work together as smoothly as the pieces of a puzzle.

Exhibit 8b. ITS Core Infrastructure Elements

1. **Traffic Signal Control Systems.** Optimizes traffic flow by adjusting signal timing and patterns in response to real-time traffic data. Coordinated, computerized traffic signals in Lexington, KY, reduced stop and go traffic delays by about 40 percent and reduced accidents by 31 percent.
2. **Freeway Management Systems.** A formal program for improving traffic flow on high-volume roadway segments via adjustments to ramp metering rates, changeable message signs and highway advisory radio messages based on real-time traffic surveillance. Ramp metering in Minneapolis, MN, increased freeway speeds by 35 percent and freeway capacity by 22 percent, and reduced accident rates by 25 percent.
3. **Transit Management Systems.** A program for managing bus operations based on real-time bus location information. Using AVL data to optimize bus routes and reduce run times allowed Kansas City, MO, to eliminate seven buses from its fleet of 200. The savings paid for the system in two years.
4. **Incident Management Programs.** A program to identify and respond to vehicle accidents or breakdowns with appropriate emergency services; restore roadway to full service. The Incident Management Program in Chicago, IL, has reduced incident clearance time by 50 percent.
5. **Electronic Fare Payment Systems.** A system to consolidate all transit and parking transactions onto one card to add convenience for users and provide centralized information to transit agency managers. In Los Angeles, CA, the benefits of Smart Cards were shown to exceed the costs by more than double.
6. **Electronic Toll Collection Systems.** A system to allow non-stop toll payment. The Oklahoma Turnpike's ETC system minimizes driver delays and has cut the State's operational cost per lane for toll collection by 91 percent.
7. **Regional Multi-modal Traveler Information Centers.** Collect, analyze and distribute accurate, reliable and timely travel information to travelers and commercial carriers when and where they want it. Montgomery County, MD, broadcasts traffic conditions on major roadways to 180,000 homes via cable television.

The elements of Core Infrastructure have, through implementation, already proven positive results.

The collective benefits of these individual components are considerably enhanced when they are integrated to allow easy information access and sharing among components and across agency-agency and agency-private partner boundaries. This integration creates an enhanced set of ITS services--several of which have revenue potential--that can be provided by a variety of public and/or private mechanisms. This core integrated infrastructure, deployed in each metropolitan region, becomes a solid platform for evolution of the ultimate ITS vision.

The Department has pledged to facilitate implementation of an appropriate level of this Core Travel Management Infrastructure in all U.S. major metropolitan areas over the next 10 years. Future deployment support activity will focus on that goal.

Five key accomplishments will facilitate this deployment support:

1. the **completion, by 1997, of 75 Early Deployment Plans** for the major U.S. metropolitan areas (see Appendix V for a funding breakdown)
2. the completion of **business plans and key early deployments** by the four ISTEA-designated Priority Corridors (see Appendix VI for detailed funding and accomplishment breakdowns)
3. the completion of **key sets of institutional analyses and consensus development** including:
 - C analysis of privacy issues and development of ITS privacy principles
 - C analysis of financial, legal, and institutional issues involved in the contractual arrangements for installing communications systems
 - C development of ITS contracting models for use by states and localities
 - C development of case studies evaluating ITS environmental issues
 - C development of case studies evaluating lessons learned from select operational tests
 - C analysis of the learning gained from focus groups and formal surveys designed to test understanding and acceptance of ITS technology among local elected officials and state and local transportation professionals
4. the mid-1996 completion of a **strategic plan for training** DOT field personnel and key partners slated for involvement in the deployment effort
5. the 1996 **completion of a National ITS Architecture** which provides the technical underpinnings for the deployment of ITS core infrastructure

Key next steps in deployment support will focus on:

1. **Model Deployment** of the integrated core infrastructure, and the institutional arrangements necessary to deliver multi-modal travel information in metropolitan areas through public/private partnerships. Our proposal to Congress outlined the competitive selection of one to three sites currently operating most of the elements of the core infrastructure. Selection criteria would include demonstrating long term funding and a long term relationship with the private sector for delivering multi-modal travel information. The Department would support the integration of infrastructure elements consistent with the national architecture to demonstrate both the national architecture and the enabling value of such an integration.
2. **Technical Guidance** -- The Department has developed a body of information on solving technical and institutional barriers, and the architecture development program will provide additional information within the year. The key next step is to develop guidance consistent with the National Architecture for local agencies acquiring core infrastructure components.

3. **Training** -- The Department must devote significant resources to training field staff and local partners in the procurement, design, specification, and legal issues associated with developing the integrated core infrastructure. Such training has been designated as an agency-wide goal in the FHWA strategic plan.
4. **Champions** -- Our institutional issues analyses indicate that the identified initial barriers are not show stoppers; each has proved surmountable through changes in local legislation, organizational cultural habits and communication channels, and business partners and procedures. The most successful changes were enacted by respected local champions who convened local players to collectively solve problems and develop commitments to integrate applications. The Department is refocusing its support to local champions and peer-to-peer problem solving exchanges rather than national-level institutional analyses.

B. Advanced Commercial Vehicle Systems

The CVO program's long term vision is free and safe movement of trucks and buses throughout North America. It envisions electronic vehicle and driver identification and screening with the help of a nationwide, real-time data and information system. Such a system would allow roadside inspectors to target high-risk carriers, commercial motor vehicles and drivers, and let low-risk vehicles proceed at highway speed without stopping for weight, credential, or safety checks (except on a random basis). States could streamline regulatory operations (one-stop shopping), carriers could reduce drive time and record keeping, and the public would enjoy a new level of commercial vehicle safety on the nation's highways.

To achieve this vision, we must:

- C complete **development of a Commercial Vehicle Information System Network (CVISN)** to allow information on carriers and drivers to flow easily across state boundaries, and to bring databases to as near real-time currency as possible.
- C continue R&D on **automatic brake inspection technologies** and **on-board safety monitoring technologies**.
- C develop **standards for vehicle to roadside communication** and **electronic data interchange**.
- C **field test** the above technologies and **deploy pilot models of the integrated set of core CVO infrastructure** necessary to achieve the vision. Continued field testing will also help determine appropriate technical and institutional models for exchanging information across international boundaries.
- C support **the institutional coordination, training, and high-level commitment** required for widespread deployment of core CVO infrastructure in every state.

Key accomplishments over the past two years in each of these areas are outlined below:

1. Research and Development

There is currently emphasis on two general areas of commercial vehicle ITS R&D:

a. Development of the CVISN. Today's motor carrier industry evolved from small, local operations, so most motor carrier regulations are state-based. In many states, several agencies create and enforce regulations, which means multiple transactions per state per carrier--multiplied by the number of states in which each carrier does business. An expensive bureaucracy has evolved within the states with multiple staffs maintaining different databases. U.S. DOT is developing a national information systems network (CVISN) to streamline this cumbersome system. CVISN will facilitate the exchange and processing of data among agencies and states in much the same way as universities share research information through the Internet--by linking existing information systems and databases to provide vehicle and driver safety and credential information. Two national databases will form the core of this system:

1. **SAFER** (Safety and Fitness Electronic Records System) -- safety data on inter- and intrastate carriers and (ultimately) individual vehicles
2. **CDLIS** (Commercial Driver's License Information System) -- licensing data system for all drivers with commercial drivers licenses

CVISN will also link existing state-level databases used for electronic clearance, credential purchases, registration, fuel tracking and permitting. A preliminary report on the operational concept and architecture of CVISN has been completed.

We intend to field test the concept and move into model deployment of the system in FY 1996 and FY 1997.

b. Automated Brake Inspection Technology Research and Development.

Detecting inoperative, ineffective or poorly adjusted brakes remains a challenge to roadside inspectors, and brake defects account for the highest number of out-of-service violations. Routine inspections identify obvious brake defects (e.g., out of adjustment air brakes or inoperative brakes), but pinpointing others requires closer inspection. In an effort to improve the quality and efficiency of roadside inspections, the Department is working with several states to evaluate and test devices that measure performance. A draft report of first-round tests will be completed by the end of 1995; a final report will be completed by the end of 1996.

2. Operational Tests

U.S. DOT has launched 31 ITS technology field trials related to CVO, in a variety of promising areas:

- a. **Roadside Electronic Clearance.** Three tests focus on electronic clearance of transponder-equipped, safe, legal vehicles. Two tests are significant multi-state trials involving the integration of several core CVO infrastructure elements; one is statewide. Both will become important platforms for evolutionary deployment of the full core infrastructure, including the capability to check vehicles electronically at the roadside without transponders, and **One stop electronic@shopping.**

- C **The HELP (Heavy Vehicle Electronic License Plate Program)/ Crescent** operational test was a multi-state (CA, NM, OR, TX, WA) effort testing an integrated heavy vehicle monitoring system using automatic vehicle identification (AVI), automatic vehicle classification (AVC) and weigh in motion (WIM) technology, and a private-sector approach to handling the electronic clearance functions. HELP has demonstrated the functionality of the technologies and has now moved to deployment by a private, non-profit operation. HELP, Inc., offers a **Pre pass@service** to enrolled carriers, charging each time a vehicle passes.

- C **Advantage I-75** is testing pre-clearance technologies under a public sector institutional model. By the end of 1995, over 30 sites from Florida through Ontario will be brought on-line to allow prequalified carriers to drive non-stop along this international corridor. States will monitor carriers via tag/transponder technology at weigh and inspection sites along the corridor and via random inspections.

- C **Operation AGreenlight@** in Oregon is just getting underway. This comprehensive statewide implementation of automated fixed and mobile sites will identify and screen transponder-equipped commercial vehicles.

- b. **Border Crossings.** ITS technologies will play a key role in realizing the North American Free Trade Agreement (NAFTA) goal of moving goods across **Atransparent borders.@** In support of those goals, the U.S. DOT ITS program is sponsoring field tests applying ITS technologies to border crossings at Nogales, Arizona; Otay Mesa, California; Detroit, Michigan; Buffalo, New York, and Santa Teresa, New Mexico. These projects will develop systems that meet the multiple requirements of transportation, customs, immigration and toll agencies, as well as for intermodal operation.

- c. **Tests of Individual Technology Applications.** Individual technology applications are currently being tested in 24 of the 31 CVO operational tests; 22 are now operational. These applications range from automated speed/weight monitoring and warnings to out-of-service verification, hazardous material emergency response and one-stop shopping for credentials.

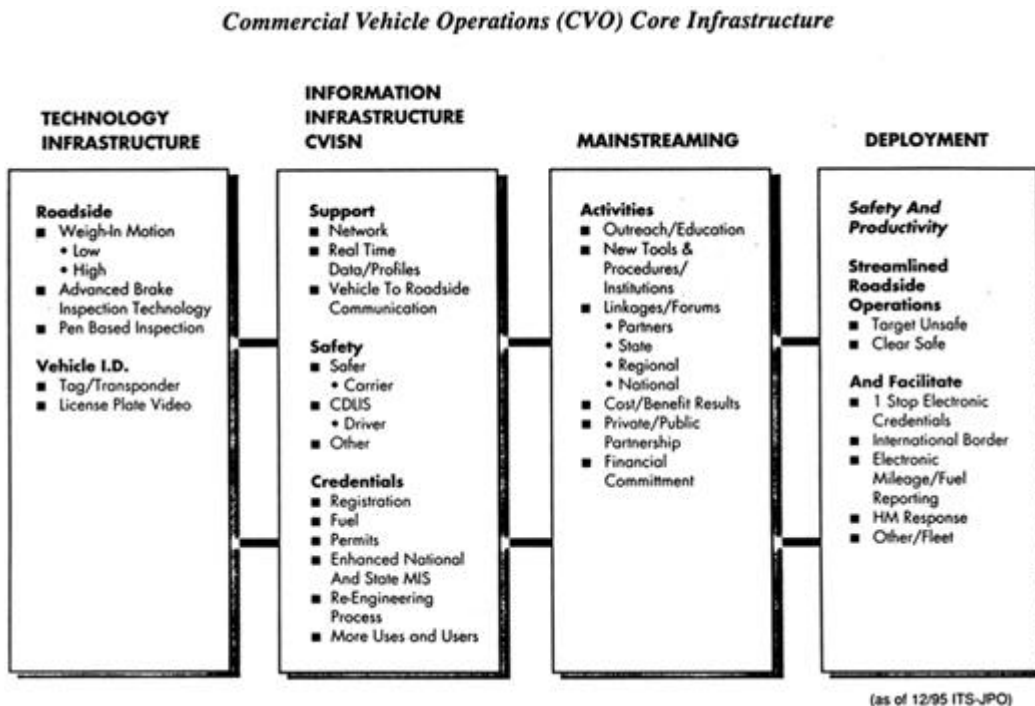
- d. **Enhancement of Motor Carrier Safety Assistance Program (MCSAP) Sites.** Congress has mandated upgrading 200 MCSAP sites to provide roadside access to available national motor carrier safety rating information. Inspectors have been equipped with a pen-based computer system that improves inspection speed and national database accuracy. Inspectors can use prior carrier safety data to pinpoint

vehicles and drivers for inspection, electronically check driver's license status and input inspection data. FHWA estimates a potential savings to the states of a cumulative 125 staff years annually by using this system. One hundred sites will be equipped with the system by the end of 1995; 200 sites will be equipped by the end of 1997.

3. Deployment Support

A set of core CVO infrastructure must be in place at the national and state levels to move commercial vehicles across state and international boundaries freely and safely. That infrastructure (see Exhibit 9 below and Appendix IV) involves the national information communication infrastructure of CVISN, as well as roadside technology for vehicle identification (tag/transponders and/or video imaging) and inspection (pen-based computers, WIM and, ultimately, advanced brake testing).

Exhibit 9. Commercial Vehicle Operations (CVO) Core Infrastructure



A specific set of core infrastructure has evolved for Commercial Vehicle Operations (CVO).

Implementation of this infrastructure will require coordinated decisions by numerous regulatory players at the state level--from the police, public service commissions, and departments of taxation and motor vehicles to departments of transportation. It will also depend more on institutional coordination and reengineering of process than on the functionality of the technology; therefore, we have supported a series of planning grants to groups of states to identify issues and barriers for coordinated multi-state

CVO operations. ITS/CVO institutional grants were provided to states/regions to initiate conversations among agency representatives. Fifty states participated in 7 multi-state groups; 38 of those planning efforts are completed. Phase II efforts will involve 29 states (in 4 multi-state groups), and the Department expects most to be completed in late 1996.

All of the above efforts have resulted in three critical next steps:

- a. State and regional convening support.** Unlike the highway and transit communities, CVO has few (if any) forums that regularly pull together CVO regulators. As part of its effort to engineer effective use of the power of available technology, U.S. DOT has committed to support several state and multi-state-level forums focused on these issues and CVO deployment.
- b. Model Deployment.** The most effective argument to encourage state actors to participate in the CVISN and implement roadside technology is a fully-functioning ITS model that demonstrates the benefits to both states and carriers. We believe ITS offers a powerful solution to the mounting pressures on state organizations to do more with less, and a fully implemented example of the core infrastructure linked to the CVISN will drive that point home. We therefore propose to move directly into full model deployment at the successful conclusion of CVISN testing.
- c. Training.** As with the metropolitan regional travel program, significant resources must be devoted to training state and local regulators in using the CVISN, procurement, roadside technology and other CVO systems, e.g., hazardous material response.

C. Advanced Crash Avoidance Systems

Highway crashes remain one of the leading causes of death among adults despite strides made in seat belt usage and air bag prevalence. Analysis suggests that crash protection improvements will show diminishing returns in reducing the highway death toll compared to the significant gains possible with crash avoidance. Human error is the leading cause of accidents, so we have focused on sensing, data processing, and driver-vehicle interface technologies to warn drivers of crash-eminent situations, and automatic vehicle control to potentially enhance vehicle performance. Based on the potential of these opportunities, the Department has articulated a threefold program mission:

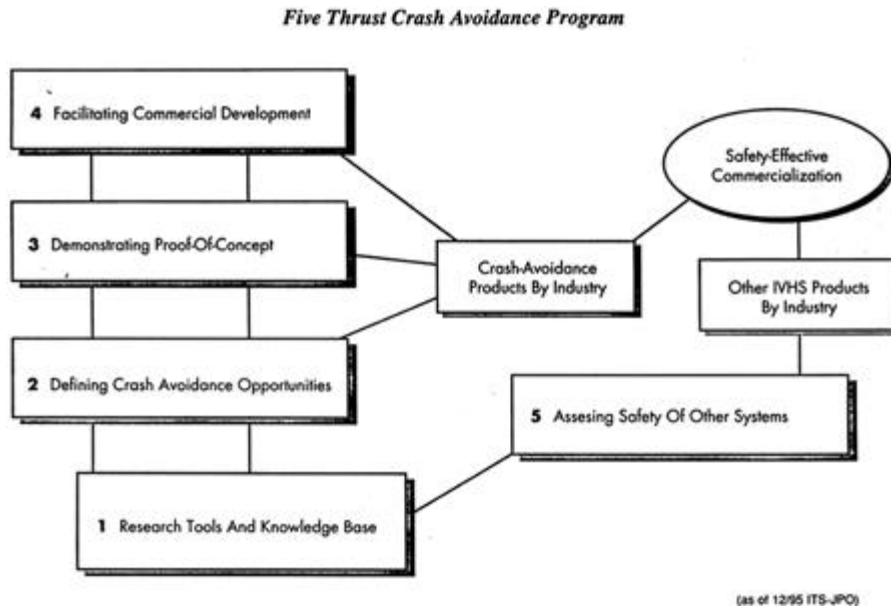
1. Demonstrate that advanced technology can improve safety by enhancing vehicle crash-avoidance performance.
2. Ensure that ITS in-vehicle systems do not compromise safety.
3. Facilitate safety-effective commercialization of these technologies.

The Department will accomplish this mission through the following:

- C developing a knowledge base and basic research tools, and applying these tools and knowledge bases to obtain better understanding of the driver's performance in crash situations
- C defining crash-avoidance opportunities based on detailed analysis of accidents and near-miss incidents
- C developing performance specifications for effective collision avoidance systems, demonstrating the application of technology to these opportunities in field trials, and working with industry to facilitate commercial development of these technologies
- C evaluating the safety features of other in-vehicle systems along with other ITS industry members

Exhibit 10 describes the relationship of these program elements.

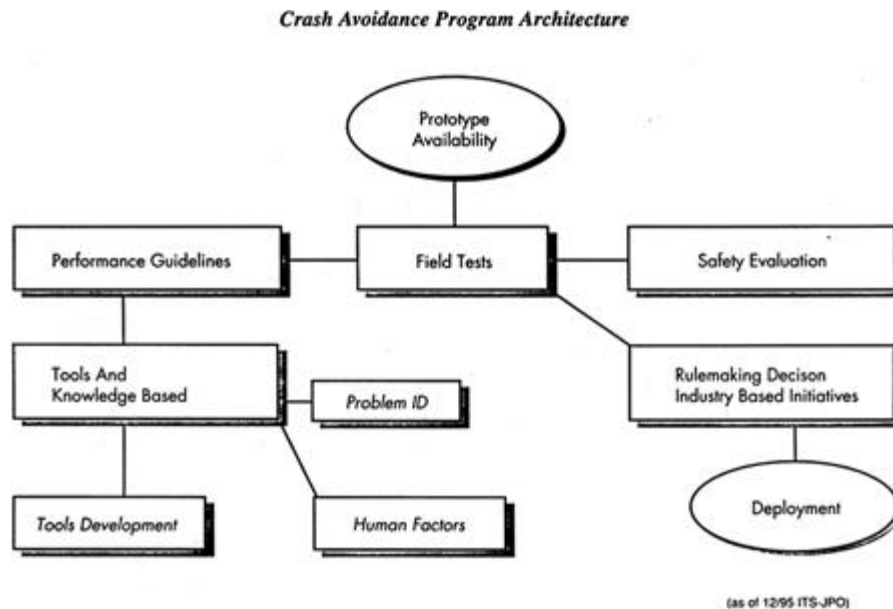
Exhibit 10. Five Thrust Crash Avoidance Program



The Crash Avoidance Program addresses concept development via five thrusts.

Unlike those of Advanced Travel management or Advanced Commercial Vehicle Operations, many of the technology applications associated with crash avoidance are still in the R&D stage. Exhibit 11 illustrates the research and testing program architecture the Department is pursuing.

Exhibit 11. Crash Avoidance Program Architecture



The Crash Avoidance Program Architecture outlines the various stages of R&D of the program.

Several fundamental research projects will identify accident causes and aspects of driver behavior under various circumstances. These results will help define preliminary specifications for system performance to help avoid particular kinds of accidents. The specifications will guide both automotive industry product developers and field test criteria in developing and evaluating available and new technology. Field test results will be used to revise the final performance specifications, which will become a resource for industry development and possible NHTSA regulatory actions.

The Department is involved in several cooperative development efforts with industry as part of this research program. These efforts are intended to accelerate the availability of effective commercial products.

Significant accomplishments for each of the program areas are outlined below:

1. Development of Research Tools and Knowledge Base

This program element's objectives are to develop research and analysis tools to evaluate crash avoidance concepts and products, and to develop a knowledge base of driver/vehicle behavior to support system development. Significant effort has been focused in six areas:

- a. Develop and **analyze a comprehensive accident database**. Reports covering intersection crossings, roadway departure, backing, lane changes, rear-end crashes and other crash conditions have been completed.

- b. A portable Data Acquisition System for Crash-Avoidance Research (**DASCAR**) has been developed. This in-vehicle sensing system unobtrusively monitors numerous driver behaviors/vehicle responses. The system will be critical to understanding **normal** driving behavior and evaluating crash-avoidance technologies. Specifications have been completed and a prototype delivered for testing in 1995.
- c. A **standardized tool for assessing driver workload** has been completed, and will be available for use by ITS designers to measure the driver workload associated with in-vehicle features and equipment.
- d. Construction has begun on the **Variable Dynamics Test Vehicle (VDTV)**, a test bed vehicle featuring adjustable ride and handling characteristics, and the capability for on- or off-board control through computer/ communication systems. This test bed will provide critical information on driver-vehicle interaction that will impact AHS and crash avoidance technology development. The initial needs study and preliminary specifications have been completed.
- e. A measurement system (**vehicle-motion environment, VME**) that quantifies specific vehicle motions exhibited while moving through intersections or along highways under full traffic operations is under development. The information collected by this system will become the foundation for understanding the detailed motion of vehicles as drivers perform the real-world task of avoiding collisions. The information from this system will be useful to system designers and when estimating benefits.
- f. Develop a **human factors knowledge base**. A series of studies is developing an understanding of human performance under various driving conditions and with varying distractions, information and displays.

By the end of 1996, testing of both the DASCAR and VME systems will be complete; and recommendations will be made on human factors to consider in developing crash warning systems.

2. Defining Crash Avoidance Opportunities and Developing Performance Guidelines

This program element objective is to identify opportunities ripe for the application of advanced technology countermeasures, and develop specific performance measures. To date, efforts have focused on developing guidelines for lateral, longitudinal, intersection, vision enhancement, and drowsy driver collision-avoidance systems. Each set of guidelines identifies and addresses a diverse range of causal scenarios, and provides input to the development of performance requirements for systems which advise drivers of potentially hazardous situations, warn of imminent collision and automatically provide collision avoidance control of vehicles. Development of these countermeasures specifications includes evaluating available crash-avoidance systems.

These performance specifications will help product designers maximize safety benefits.

Preliminary guidelines for each targeted area will be complete by the end of 1995. The next steps in the development of performance guidelines will focus on an assessment of available technologies for use in meeting these performance measures.

3. Demonstrating Proof of Concept -- Field Trials

The complexity of both driver behavior and ITS technologies requires that deployment consideration include comprehensive field testing to ensure system safety objectives are met. Field tests identify needed refinements and help define appropriate and effective deployment strategies.

This year, the Department launched a field test of **Intelligent Cruise Control (ICC)** systems targeting ease of learning and use, driver reaction, and driver attention and response to braking situations. The test evaluates a vehicle's ability to automatically maintain a safe speed and distance between it and other vehicles. The offeror selected for funding this operational test is a partnership led by the University of Michigan Transportation Research Institute and includes the Michigan Department of Transportation, Leica AG, and Haugen Associates.

The Department is also testing an **Automated Collision Notification (ACN)** in-vehicle system that identifies when a serious collision has occurred and automatically summons emergency medical service (EMS) response. The offeror selected for funding for this operational test is a partnership led by CALSPAN Advanced Technology Center and includes the New York State Department of Transportation, General Motors, Cellular One, Rockwell International, Erie County Emergency Management Service, Erie Community College, and Datumtech. The offeror proposes to design, build and deploy an automatic collision notification system using 1,000 privately-owned cars in a large area in western New York State.

4. Facilitating Commercial Development of Crash Avoidance Technologies

The Department is engaged in six cooperative agreements with industry for the testing and development of various crash avoiding technologies, including:

- C Development, Evaluation, and Deployment of Forward Crash Avoidance Systems (FOCAS)** -- Cooperative agreement between the University of Michigan Transportation Research Institute and NHTSA, with Leica supplying hardware. The primary goal is to develop a range of commercial sensors and associated applications systems that supplement the forward crash avoidance performance of drivers. This is the second year of a three-year agreement.
- C Brake Analysis for Collision Avoidance** -- Heavy Commercial Vehicles - This cooperative program with Eaton Corporation studied the feasibility of adding

automatic braking to heavy commercial vehicles. The prototype was demonstrated in July and a final report published in October.

- C **Vehicle-based Lane Detection** -- This cooperative agreement with Rockwell International will result in a two-year field evaluation of a prototype machine-vision, lane-detection sensor. Testing of the initial prototype has been completed. The system is being upgraded for the next test phase and the final report will be delivered in 1996.
- C **Human Factors Studies for the Evaluation, Analysis and Operational Assessment of an Intelligent Cruise Control (ICC) System** -- A cooperative agreement with Ford to establish guidelines for key ICC operational and interface design characteristics based on driver performance and preference measurements.
- C **Automotive Collision Avoidance System Development** -- Cooperative Agency development of a wide range of collision-avoidance systems continues with the Delco Electronics/General Motors Partnership, under the Advanced Research Projects Agency (ARPA) Technology Reinvestment Program (TRP). The program is structured in six phases: Crash-avoidance system definition, sensor development, system studies, driver-vehicle interface studies, and cost reduction/production readiness and validation. A demonstration of level-one or existing capability of forward-looking sensors has been completed.
- C **Characterization of a Forward-looking Radar Sensor** -- This cooperative agreement with the Environmental Research Institute of Michigan and TRW will develop a knowledge base of radar cross-section data from laboratory measurements and a variety of freeway settings using a prototype forward-looking automotive radar sensor. Lab testing has been completed, and an advanced sensor is being integrated for road testing.

5. ITS Safety Evaluations

Researchers and practitioners in this area have played key roles in evaluating the safety aspects of several other field tests including the Florida TravTek, the Washington TRAVEL-AID, the Illinois ADVANCE and the Michigan FAST-TRAC project. They have also been active in supporting the human factors and safety analyses in the AHS effort.

D. Automated Highway System

FHWA signed a cooperative agreement with the NAHSC in October 1994 to launch a multi-year research effort to develop an AHS concept. The idea of vehicle-highway communications sufficient to assume driving functions for the driver is not new. Researchers have articulated both its value and feasibility for several decades; and military and vehicle manufacturer test facility developments have proven the concept's viability.

As mounting congestion conflicts with environmental constraints, the AHS promise of doubling our existing highway system's capacity is worth investigating.

Spurred by that promise, and the potential for more rapid development of component crash-avoidance technologies, the Department launched 15 AHS precursor studies in late 1993 to investigate the viability of both the technology and its potential benefits. The studies involved 55 organizations, ranging from universities to law firms to system integrators, and was completed in early 1995. See Exhibit 12 for a summary of primary investigation areas.

Exhibit 12. AHS Precursor Study Topics

- C Urban and Rural AHS Comparison
- C Automated Check-in
- C Automated Check-out
- C Lateral and Longitudinal Control Analysis
- C Malfunction Management and Analysis
- C Commercial and Transit AHS Analysis
- C Comparable Systems Analysis
- C AHS Roadway Deployment Analysis
- C Impact of AHS on non-AHS Roadways
- C AHS Entry/Exit Implementation
- C AHS Roadway Operational Analysis
- C AHS Safety Issues
- C Institutional and Societal Aspects
- C Preliminary Cost/Benefit Factors Analysis

The AHS Precursor Study addressed 14 different topics.

Although the studies identified a number of significant technical and societal challenges, there were no showstoppers; reasonable courses of action were identified for each potential challenge. The studies indicated that AHS could improve vehicles/lane/hour by two- or threefold, cut travel time by 33 to 50 percent, and potentially reduce accidents by 50 to 80 percent. Not surprisingly, non-technical challenges will likely be more difficult to resolve than technical ones, and will require careful balancing of stakeholder needs (e.g., examining tradeoffs among safety, efficiency, environmental impact, cost, etc.).

Based on these findings, the Department entered a cooperative agreement with industry to further develop the concept. NAHSC's core partners include General Motors, Bechtel Corporation, the California Department of Transportation (Caltrans), the Carnegie-Mellon University Robotics Institute, Delco Electronics, Hughes Aircraft, Lockheed Martin, Parsons Brinkerhoff, and the University of California Partners for Advanced Transit and Highways (PATH) Program. To date, U.S. DOT has funded 80 percent of the research; however, the partners will fund increasing proportions of development as the concept proves its feasibility, as well as the ultimate cost of bringing spin-off and final products to market.

The consortium has outlined the following primary milestones for achievement over the next 7 years:

- C develop AHS system requirements
- C identify and analyze competing concepts
- C develop critical enabling technologies
- C conduct 1997 Proof of Feasibility Demonstration
- C down-select to a preferred system configuration
- C develop, test and demonstrate final prototype AHS
- C document prototype AHS design and performance
- C produce specifications for an operable AHS

The team will also launch an extensive stakeholder and public outreach effort, and investigate the societal, environmental and institutional impacts of the deployed concept.

To date, the consortium has completed a Systems Description Document that defines AHS goals, objectives and functions; has begun the identification and evaluation of potential AHS approaches; has prepared a detailed work plan for the 1997 AHS technology proof-of-technical-feasibility demonstration; has launched several societal and institutional analysis efforts; and has involved numerous stakeholder organizations as Associate Participants in ongoing activities.

E. Rural Applications of ITS

Early ITS efforts were driven by the desire to address growing transportation problems in urban areas and in interurban corridors. While many of the technologies and systems aimed at solving these problems also have application outside urban settings, the market structure, application logistics, and motivating factors underlying their deployment vary considerably from urban to rural areas. The federal program recognized these differences and, in the past year, has developed an ITS program component with a uniquely rural focus.

The rural ITS customer ranks ITS need priorities much differently than an urban dweller. These differences largely reflect characteristics of the rural environment: long driving distances, relatively low traffic volume, relatively rare traffic congestion but fewer alternate routes, travelers and tourists who may be unfamiliar with the surroundings, rugged terrain in remote areas, extreme climate conditions, and frequent roadway obstructions.

Travel and safety statistics illustrate the enormous potential role for ITS in rural environments:

- C 80 percent⁵ of the road mileage in the United States is in rural and small urban areas (less than 50,000 population).
- C While less than 40 percent of annual vehicle miles traveled--or about 900 billion vehicle-miles--is on rural roads, *these roads account for about 60 percent of all traffic fatalities*⁶.

⁵Figure according to U.S. DOT/FHWA's Highway Statistics, 1993.

⁶Figures according to U.S. DOT/FHWA's Highway Statistics, 1993.

- C *More work zone fatalities occur in rural areas than urban areas (454 versus 376). Work zone fatalities in non-Interstate, local roadways outnumber those*

occurring on Interstates by 3 to 1. Accidents and lane closures from work zones can tie up rural roads for hours.

- C *Rural travelers are more apt to be involved in fatal single vehicle run-off-the-road accidents than urban travelers.* Collisions with fixed objects accounted for almost one third of all fatal accidents in rural areas. Rural areas also accounted for twice the number of fatal noncollision accidents (overturns, jackknives, etc.) than urban areas. Contributing factors are weather, road conditions, and speeding.
- C *Emergency Medical Response is slower in rural areas.* The average time elapsed between a rural-area crash and EMS notification is twice that in urban areas; and the ratio is about the same for elapsed time between crash and arrival at a hospital. In rural Colorado, for example, 12 minutes on the average elapse from time of crash to EMS notification, and 57 minutes from time of crash to hospital arrival. In contrast, in urban Colorado, it takes 6 minutes for EMS notification and 28 minutes before hospital arrival. Chances of survival and less impairment are influenced by the quality of medical care received in the **AGolden Hour@**immediately following the crash.
- C Although there are approximately 1,200 rural public transportation systems in the United States funded through the Public Transportation for Nonurbanized Areas program, of the small rural communities with less than 2,500 persons, 90 percent do not have intercity bus service, specialized transit service, or any taxi *service.
- C Of the rural communities with between 2,500 and 10,000 persons, three-fifths do not have intercity bus service and two-thirds do not have any specialized transit service.

ITS applications such as incident notification (Mayday), advanced hazard warning systems, advanced traveler information services, and in-vehicle crash avoidance systems, are some of the ITS applications which can address the issues above and significantly impact the safety and mobility of rural travelers.

1. Research and Development

The Department's first step in addressing rural America's transportation needs was to launch a \$1.8 million R&D effort entitled Rural Applications of Advanced Traveler Information Systems (ATIS). FHWA commissioned this effort in 1992 to assess ways to improve safety, mobility, and services in rural areas. This effort has already produced guidance for federal ITS programs to benefit rural and small urban areas, and to provide state and local guidelines for rural ATIS implementation efforts.

The study has already produced a rural user needs assessment, a technology review, development of rural system concepts, and an activities assessment. The final products (now available in draft form) include a vision for rural ATIS

and a recommended Action Plan for the U.S. DOT to facilitate implementation of rural ATIS applications, which will include explicit recommendations for further R&D and operational test projects. Results of this study will help lay the foundation for a dedicated, rurally-focused ATIS component of the federal ITS program.

Other ITS R&D programs within NHTSA and FHWA have substantial rural components--that is, they examine traveler information, vehicle control, automated roadway, or other safety technologies that have primary applications in improving rural safety. Most of these projects are covered elsewhere in this report and are contained in Appendix II, *Research and Development Projects with Cost-Share Arrangements*. Examples include: cooperative development of a Forward-Looking Automotive Radar Sensor; Vehicle-Based Lane Detection research; NHTSA's DASCAR project; Monitoring of Driver Status and Performance; Heavy Vehicle Dynamic Stability Enhancement; work that the NAHSC is doing in assessing automated roadways for rural environments; and many others.

2. Operational Tests

Many of the Department's ongoing ITS operational tests--especially those in the CVO and border crossing areas--have substantial rural components, but are not necessarily dedicated to exploring solutions to primarily rural problems, and so are discussed elsewhere in this Report. Some of the test groups dedicated to addressing rural issues are highlighted below:

- a. **Mayday systems** -- several tests have been launched to explore the use of Automated Collision Notification (ACN) systems, or Mayday, which the FHWA rural user needs assessment identified as the highest-priority, most desired service. The Puget Sound Help Me, TransCal, and Colorado Mayday projects are exploring different means of automatically delivering the critical location and status information needed by EMS in the event of a debilitating incident. A recently awarded project in Erie County, New York, will attempt to deploy an ACN in over 1000 privately-owned vehicles to test system effectiveness.
- b. **Traveler Information and Communications** -- a major challenge to delivering ITS services in rural areas is the lack of resident communications infrastructure. U.S. DOT is supporting several efforts to demonstrate and evaluate options for getting information to and from travelers where they need it. Independent projects are investigating the use of AM subcarrier, FM subcarrier, data paging, cellular telephony, VSAT satellite communications, live aerial video transmission, traveler center kiosks, and portable detection and surveillance to enhance communications for critical ITS services in less-infrastructure intensive areas. Minnesota DOT's Guidestar program is experimenting with coordination and centralization of the communications systems of several public agencies, to improve information sharing and response to emergencies.

- c. **Weather Monitoring and Traveler Advisories** -- two projects, the Idaho Storm Warning System, and the Travel-Aid project along Snoqualmie Pass, Washington, involve the use of environmental sensors and variable message signs to convey dynamic weather and warning information to travelers along remote and accident-prone corridors.
- d. **Rail Crossing Safety** -- the Advanced Railroad-Highway Grade Crossing System represents a two-year prototyping and field testing cooperative effort (scheduled to wrap-up at the end of 1996) between FHWA and the state of New York, to test use of interactive devices at highway/rail crossings that communicate with both trains and vehicles to create safer situations at the crossings. This builds on previous work done by FTA and ARPA on Advanced Automatic Train Control (AATC), as well as FHWA's previous In-Vehicle Safety Advisory Warning System (IVSAWS) research.
- e. **Public Transportation** -- many rural residents, particularly the elderly and physically challenged, depend on paratransit service for access to basic needs such as food and medical care. Because of low population density, relatively long distances, and corresponding high costs, rural paratransit service can be infrequent and expensive to provide. ITS operational tests of paratransit are aimed at developing fleet management systems that reduce costs and enhance services using real-time vehicle location, automated scheduling, and related technologies. In Delaware County, Pennsylvania, FTA and a private sector partner are testing an Automated Billing and Identification System that will automate reservations, billing, and vehicle dispatch procedures, resulting in lower overhead costs and more efficient vehicle routing. In Michigan, an FHWA-sponsored paratransit fleet management system will automate reservations, scheduling and dispatching, and will use AVL to track the fleet. The project will also establish a regional 800' number to connect customers with regional paratransit services and information.
- f. **Commercial Vehicle Projects** -- in addition to those covered in this Report's CVO section, there are a dozen or more tests of technology aimed at improving safety or efficiency of motor carrier fleets through automation, especially in remote areas. For example, the Dynamic Truck Speed Warning for Long Downgrades, a recently-operational field test, provides drivers with real-time warnings and suggested speeds for downgrades based on their current weights and speeds. Other technology trials include video imaging systems to determine out-of-service vehicles, and automated mileage recording for fuel tax purposes.

F. System Architecture and Standards

This component of the U.S. DOT's ITS program most directly addresses the charge by Congress, through ISTEA, to provide and ensure compatibility in the

implementation of intelligent vehicle-highway systems technologies...@The first step toward this goal, the development of a National System Architecture for ITS, is well underway. In conjunction with this effort, we are aggressively pursuing the development of key enabling standards for ITS. The issues surrounding the need for standards cut across all areas of the ITS program, and have impacts at both national and international levels. Numerous references to standards related activities are interspersed throughout this document but are consolidated in this section for visibility and focus.

1. System Architecture

The Department has entered the second phase of developing a national system architecture for ITS. The architecture will describe how ITS components interact and work together, and will ultimately guide multi-level government and private-sector business planners in developing and deploying nationally compatible systems. By ensuring system compatibility, the Department hopes to accelerate ITS introduction nationwide and develop a strong, diverse marketplace for related products and services. Initially, four teams led by Hughes Aircraft, Westinghouse Electric, Rockwell International and Loral Federal Systems were awarded contracts to develop competing architecture concepts. The National Architecture Program examined the four resulting concepts and awarded contracts to two teams, Rockwell and Loral, in February 1995 to work cooperatively to develop a consensus national architecture. Some features and themes that were common among the different Phase I concepts will be incorporated into the final National Architecture, as listed in Exhibit 13:

Exhibit 13. National Architecture Phase I Themes and Features

- | | |
|---|---|
| C | maximizing use of existing infrastructure (e.g., communications, transportation, financial, etc.) |
| C | allowing flexibility in route determination (e.g., from within vehicles and/or from a central location) |
| C | using tag/beacon systems for special purposes (e.g., tolls, electronic clearance, etc.) |
| C | using open standards to encourage competition for services and equipment |
| C | encouraging competitive markets via private independent service providers (e.g., weather, transit schedules, travel information, etc.) |
| C | promoting nationwide compatibility by standardizing key interfaces (e.g., vehicle to infrastructure) and encouraging national service markets |
| C | permitting the use of vehicle probes for traffic data collection |

Several key themes and features were common among the Phase I concepts evaluated, and will thus be incorporated into Phase II.

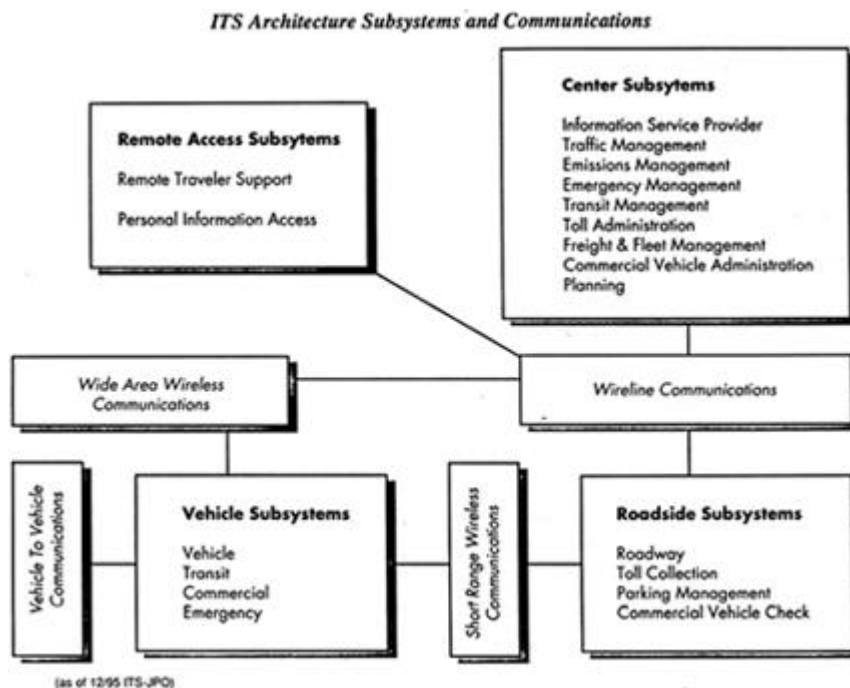
The Department and the Phase II teams will immediately address several issues, including:

- C definition of a basis for national standards to enable ITS deployment

- C how many and what kinds of paths to take toward ITS implementation
- C Federal, state, and local government roles, as well as those of private-sector entities in developing, implementing, and operating ITS systems

Public comment and reaction is being solicited throughout Phase II of the architecture development program. The program has an active outreach and consensus activity--involving workshops, online resources, and regional forums across the Nation--in order to garner as much public input and support from involved stakeholders as possible, to ensure that the final products are based on a broad consensus among the transportation and ITS communities. The Department has planned over 20 additional coordination meetings during Phase II to ensure successful, consensus architecture development. Exhibit 14 illustrates subsystem and communications relationships.

Exhibit 14. ITS Architecture Subsystems and Communications



Phase II will comprise over 20 additional coordination meetings, with various architecture subsystems and communications relationships.

Accomplishments in R&D include the establishment of the National Transit GIS and the development of national workshops for information exchange. An open architecture standard to interface interchangeable transit vehicle components was accepted by the industry and is the first officially recognized ITS standard.

FTA and Sandia National Laboratories are further assessing the system architecture needs of the transit community to ensure that the overall national ITS systems architecture development program adequately consider transit needs. In addition to its value to the national system architecture development program, the transit system architecture has been of significant utility to transit operators planning ITS technology deployments. A comparable system architecture analysis is being performed for FHWA in the CVO area by the Johns Hopkins University Applied Physics Laboratory, and for NHTSA (for the collection of collision avoidance related ITS services) by Stanford Telecomm. These efforts are being coordinated closely with the National System Architecture development effort by Rockwell and Loral.

2. Standards Development

The Department is currently funding a number of initiatives to facilitate standards development in critical areas that relate to the public interest. The areas of interest include but are not limited to: ensuring public safety, reducing the risk of infrastructure development by the public sector, facilitating interstate commerce, and developing enabling standards. The approaches are:

- C standards precursor activities such as the **development of standards requirements**--the basis from which standards are developed
- C **agreements with multiple standards development organizations** (SDOs) to provide dedicated technical support for what is typically a voluntary process
- C **public sector participation** throughout the standards development process to ensure that the public agency customers are getting the products they need
- C **participation of U.S. experts in international ITS forums** such as the International Standards Organization Technical Committee 204 - Transport Information and Control Systems.

The Department is also working closely with ITS America and its Council of Standards Organizations subcommittee to ensure a smooth and efficient process of developing standards for ITS.

Listed below are specific U.S. DOT-funded standards requirements activities that will be handed off to SDOs in support of standards development:

- C **National Architecture** - An overarching framework that will identify sub-system interfaces and information flows between these sub-systems (e.g., the transfer of traffic information between a traffic management center and vehicle). The results from this three year effort will stimulate a multitude

of standards activities in the area of message set definitions (i.e., the information that needs to flow between the sub-systems) and communication links (i.e., defining the communications load for transferring data between sub-systems).

- C **Commercial Vehicle Information System Network (CVISN)** - Builds upon the National Architecture activities and defines in greater detail the CVO requirements. CVISN activity supports future standards activities in the areas of electronic data interchange and vehicle-to-roadside communications.

- C **Vehicle-to-roadside communications (VRC)** - A comprehensive document detailing the standards requirements for VRC applications is currently underway (this makes use of both the National Architecture and CVISN results, as well as a study by ITS America to define the requirements for electronic toll and traffic management (ETTM)). This VRC document will support standards development activities in the areas of message sets and communications links for application areas such as CVO (electronic border clearance), ETC, traffic management, transit operations, traveler information, etc.

- C **Location Referencing System** - Interoperability issues currently exist based upon different commercial map databases utilizing various geographic referencing mechanisms--a location in one database map may be referenced differently in another database. A study is currently underway at the Oak Ridge National Laboratory to develop a draft protocol standard that will allow for real-time location referencing interoperability among databases.

- C **Spatial Data Transfer Standard ITS Profile (pending)** - Current compatibility issues inhibit transferring spatial data between database products. An activity is being defined to identify an **ITS profile** that will provide a mechanism to facilitate the transfer of non-real-time spatial data between various database products and public agency databases.

- C **Advanced Traffic Management System (ATMS) Architecture** - This effort examines one of the sub-systems within the National Architecture effort and defines it to a deeper level of detail, sufficient for use by travel management system integrators. Current activities include surveying and standardizing the definition of terms (to form a **dictionary** of possible data elements) to foster inter-operability among existing and future commercial database systems.

- C **National Transportation Control/ITS Communications Protocol (NTCIP)** - This broad-based government/industry effort is defining a suite of protocols to establish easy inter-operability among a variety of ATMS hardware and software elements. The NTCIP will determine how traffic

signal systems ~~Atalk@~~to local controllers, changeable message signs (CMS), highway advisory radio (HAR), etc.

F. ITS Program Management

The Joint Program Office (JPO) for Intelligent Transportation Systems was formally established in May 1994. JPO is responsible for setting a unified, strategic program direction, guiding policy coordination, and exercising fiscal control over all funding resources. JPO receives policy guidance from the ITS Management Council chaired by the Deputy Secretary of Transportation, and planning guidance from the ITS Strategic Planning Group consisting of surface transportation leaders throughout the Department.

JPO immediately developed and implemented an oversight mechanism to evaluate both program and project objectives, partly in response to an Inspector General's Program Audit of the Department's ITS Program Delivery Process. The Inspector General's December 15, 1994, audit report concluded that the Department's ITS program management and oversight controls required improvement to ensure effective project selection, cost and schedule monitoring, and timely evaluation plan preparation.

The Inspector General recommended that the JPO Director and Program Office:

1. Oversee final selection and approval for all prospective projects.
2. Establish controls to ensure that all new ITS projects are solicited and selected according to prescribed criteria and the selection basis documented.
3. Establish centralized systems to monitor ITS projects and initiate appropriate corrective actions.
4. Advise ITS-participating program office managers that Contracting Officer's Technical Representatives (i.e., technical or project managers) must review progress reports to monitor and justify billing amounts.

JPO implemented ITS program improvements with help from participating program offices in FHWA, FRA, FTA and NHTSA. The Inspector General's draft report recommendation inspired the changes, as well as implementation of improved program management and coordination processes. The improved processes include developing a computerized system to track spending and ITS project milestones, and spending plans based on program ~~Aroad maps@~~to ensure responsible and targeted direction of funds.

III. Conclusion

The Department has set a clear goal to move to targeted ITS deployment. To meet our objective, we are examining strategies to mainstream ITS into the transportation planning objectives of states and localities, and to adopt roles that complement the product-based interests of industry while representing the public interest in safety enhancement. The Department will also focus on training, skills, standards, and strategies for innovative funding (i.e., public/private partnerships) to integrate ITS technologies into the Nation's surface transportation system. Our ultimate goal is simple--facilitate the deployment of those technologies that truly improve Americans' lives. Our accomplishments to date and strategic plans for the future together form the basis we need to attain this goal.

Appendix I

ITS Operational Tests Awarded in Fiscal Year 1995

Title	Partners	Description
AUTOMATED COLLISION NOTIFICATION (ACN)		
Field Operational Test Program of an ACN System for Emergency Notification and Personal Security User Service	Calspan, New York State Department of Transportation, General Motors, Cellular One, Rockwell International, Datumtech, Erie County EMS, Erie Community College	The project encompasses designing, building and deploying an ACN system for a large scale test, using 1000 privately-owned cars in Erie County, New York, for a period of one year. The ACN system will use 3-axis accelerometers for crash sensing, GPS for vehicle location, and cellular telephone for communications. Interface to the emergency management system (EMS) will be through a centralized dispatch facility. Local EMS providers and medical community will assist in the evaluation of the medical outcomes of crash victims to assess system benefits.
INTELLIGENT CRUISE CONTROL (ICC)		
Intelligent Cruise Control Field Operational Test	University of Michigan Transportation Research Institute, Leica AG, Michigan Department of Transportation, Haugan Associates	The project will evaluate intelligent cruise control technology using ten passenger cars for a 24 month period with 196 lay drivers. A total of 130,000 to 200,000 vehicle-miles of operation on freeway, including 80,000 to 100,000 vehicle miles for long trips, is planned. This test will focus on evaluating the human factors and safety aspects of intelligent cruise control.
ADVANCED PUBLIC TRANSPORTATION SYSTEMS (APTS)		
Traveler Information Kiosk	Metro-Dade Transit Agency, Metropolitan Dade County Government, FTA	Travelers will be provided with an automated trip planning capability including real-time on-line public transportation route and schedule information.
Transit Information System	Central Florida Regional Transportation Authority, Florida Department of Transportation, FTA	Electronic bus stop displays using vehicle location and signal preemption systems will provide travelers with next bus information. Vehicle data will be monitored for improved fleet performance and customer service.
INTERNATIONAL BORDER CROSSING		
Expedited Processing at International Crossings	Arizona Department of Transportation, Lockheed Martin, Mexican Secretary of Transport, Hughes, the Western Highway Institute, et al.	The project will demonstrate an automated clearance system for compliance monitoring and regulatory data processing and transfer using: electronic filing, data storage, cargo security/integrity, data transfer using vehicle-to-roadside communication and a two-way radio link, License Plate Recognition, automated vehicle emissions monitoring, expedited safety inspection, electronic seals to ensure cargo

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ITS Operational Tests Awarded in Fiscal Year 1995

Title	Partners	Description
		integrity, and traffic management and control systems for priority assignment to minimize processing time.
International Border Electronic Clearance	Caltrans, U.S. Customs Service, Department of Justice Border Research & Technology Center, Qualcomm, Calstart, Scientific Atlanta, et al.	This project will facilitate development of a system compatible with the HELP/I-75 tests which positively identifies commercial vehicle and cargo using a radio frequency (RF) transponder, positive driver identification using voice recognition, cargo security using electronic signature, automated positioning of vehicles using electronic maps, a secure means of distributing and updating documents, and cargo/safety/environmental monitoring systems.

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Appendix I

ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

No.	Projects	Location	Funding		Percent Non-Fed Funding
			Federal ITS	Total Cost	
I.	Ada County Travel Demand Mgmt Emissions Detection This test will evaluate the feasibility of using remote sensing technology to monitor vehicle emissions. Active infra-red roadside emissions detection technology will determine the relative contributions of in-county and out-of-county vehicles to mobile-source emissions.	Ada County, Idaho (Boise)	\$253,000	\$327,900	23%
II.*	ADVANCE This test will evaluate an infrastructure to support dynamic route guidance. The Traffic Information Center will combine real-time information from equipped vehicles and other sources, and transmit the processed information to equipped vehicles where it will be used to develop a preferred route. The routing information will be presented to the driver through voice instructions and screen-displayed arrows depicting the required turning movements.	Northwest suburbs of Chicago, Illinois	\$21,079,185	\$31,000,000	32%
III.	Advanced Fare Payment Media II This project will evaluate a computerized system for integrating various advanced fare media technologies and processing systems, including on-board electronic transit fare and data collection, and on-site travel support services such as congestion pricing, parking management and data collection.	Los Angeles, California, area	\$25,290	\$300,000	92%
IV.*	Advanced Rural Transportation Information and Coordination This project establishes a centralized communication site and coordinates the communications systems of several public agencies (highway, state patrol and transit). Response time to accident and road condition emergencies are expected to improve; real-time vehicle status and schedule information will be provided.	Itasca and St. Louis Counties, Minnesota	\$903,000	\$1,542,000	41%
V.*	Advantage I-75 The project facilitates motor-carrier operations by allowing transponder-equipped and properly documented trucks to travel any segment along the entire length of I-75 at mainline speeds with minimal stopping at weigh/inspection stations. Electronic clearance decisions at downstream stations is based on truck size and weight measurements taken upstream, and on computerized checking of operating credentials in each state.	I-75 in Florida, Georgia, Tennessee, Kentucky, Ohio, Michigan, and Ontario, Canada	\$7,490,511	\$8,247,340	9%
VI.	Ann Arbor Intermodal System This project will evaluate an on-board bus communication and navigation system, a central control system, and a "Smart Card" fare collection system. The on-board system monitors actual performance regarding route, location, speed and status of mechanical systems.	Ann Arbor, Michigan	\$1,980,000	\$2,442,500	19%
VII.	Atlanta Driver Advisory System This test will evaluate the benefits of en-route traveler advisory and traveler services information using FM subcarrier wide area communications systems and applications of the 220 MHZ frequency pairs. All elements will be integrated into Atlanta's advanced traffic management system.	Atlanta Metropolitan Area	\$7,236,916	\$9,097,803	20%
VIII.	Atlanta Traveler Information System This project will build upon the Atlanta Regional Advanced Transportation Management System infrastructure to test and evaluate	Georgia, statewide with a concentration in	\$4,000,000	\$5,000,000	20%

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Appendix I

ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

No.	Projects	Location	Funding		Percent Non-Fed Funding
			Federal ITS	Total Cost	
	provision of travel information through electronic, interactive kiosks, welcome centers, major transfers points, and other gathering points such as hotels.	the Atlanta Metropolitan Area			
9*	Borman Expressway ATMS This fully-functioning advanced traffic management system includes mobile units that can perform transportation management functions (e.g., control of video surveillance, highway advisory radio, changeable message signs and signals) at the site of an incident. The project is evaluating promising new electronic sensors and integrating them using spread spectrum radio. The Borman ATMS will become an essential component of the Gary-Chicago-Milwaukee Midwest Priority Corridor.	Gary-Chicago-Milwaukee Corridor	\$550,000	1,750,000	69%
10	Boston Smart Traveler The project tested the public acceptance and potential traffic impacts of a telephone-based audiotext traffic information service.	Boston, Massachusetts	\$1,515,000	\$3,395,000	55%
11	"CAPITAL" - (D.C. Cellular Surveillance) This test uses the existing cellular infrastructure extensively for areawide surveillance to determine geolocation accuracy and traffic information completeness, and the usefulness of passive statistical processing for measuring traffic flow and incidents.	Washington, D.C., Metropolitan Area	\$5,511,731	\$7,169,418	23%
12	California Smart Traveler This project consisted of two components: (1) Los Angeles Smart Card tested the use of smart cards for express transit services as well as for parking and other services at employment sites; and (2) Orange County Smart Intermodal system tested a real-time information system that will include special event information.	Los Angeles and Orange County, California	\$1,500,000	\$3,300,000	55%
13	Chattanooga Smart Card This project will support the planning and development of a smart card fare and parking system to be used to increase the appeal of transit and park-and ride lots in the downtown area.	Chattanooga, Tennessee	\$75,000	\$93,750	20%
14	Chicago (CTA) Intermodal System This project will evaluate the process of creating a Bus Service Management System (BSMS) which includes an Automatic Vehicle Location (AVL) system, a computer-assisted dispatch and control system, real-time passenger information signs, and a traffic signal preemption system.	Chicago, Illinois	\$490,000	\$3,640,000	87%
15	Colorado Mayday System This project will evaluate the use of GPS for vehicle location and cellular phone for two-way communications to provide emergency and non-emergency assistance to travelers operating in an area of over 12,000 square miles in north-central Colorado. The test will involve up to 2,000 vehicles equipped with a low-cost location device called TIDGET.	North-central Colorado	\$2,439,654	\$3,832,285	36%
16	Connecticut Freeway Advanced Traffic Management Systems This ATMS project evaluates the use of roadside mounted radar detectors in combination with closed circuit television (CCTV) for incident detection and verification. The ATMS utilizes 44 radar detectors (wide- and narrow-beam) and compressed video.	Hartford, Connecticut	\$600,000	\$1,380,000	57%

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ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

No.	Projects	Location	Funding		Percent Non-Fed Funding
			Federal ITS	Total Cost	
17	Dallas Area Rapid Transit Personalized Public Transit This test will evaluate a combination of a fixed and flexible transit routes in the Dallas area. Fixed-route transit vehicles will be able to pick-up off-route passengers based on scheduling allowances and convenience of point-of-pick-up.	Dallas, Texas	\$391,560	\$491,560	20%
18	Dallas Smart Bus Evaluation This test will evaluate the effectiveness of implementing an Integrated Radio System that includes automatic vehicle location on 823 transit buses, 200 mobility-impaired vans and 142 supervisory and support vehicles.	Dallas, Texas	\$460,000	\$560,000	18%
19	Delaware County Ridetracking This project will develop and evaluate an automated identification and billing system (AIBS) for paratransit service. Evaluation will cover advanced technology for passenger identification, the accounting and billing data collected on each passenger trip, and the reporting required for coordination with various transportation suppliers and internal performance monitoring.	Delaware County, Pennsylvania	\$200,000	\$518,000	61%
20	Denver Rapid Transit District (RTD) PIDS This project will utilize the data gathered from the Automatic Vehicle Location (AVL) system, currently being installed on all RTD buses, to provide information to video monitors regarding estimated bus departures for waiting bus passengers.	Denver, Colorado	\$1,000,000	\$2,000,000	50%
21	Detroit/St. Clair Rivers International Border Crossing This project is studying the institutional issues of applying new technologies to the International Border at the Detroit/Port Huron, Michigan frontier. The project envisions an automated primarily paperless system, using the latest technologies, to enhance border crossing by commercial and private vehicles. The system designed will be shared with a similar site in the Buffalo, NY, area.	Detroit-Windsor Ambassador Bridge, Detroit; Blue Water Bridge, Port Huron, Michigan	\$110,000	\$500,000	78%
22	Detroit Transportation Center Transit Information This project provided real-time traffic condition information to dispatch centers of public transit agencies in the Detroit area.	Detroit, Michigan	\$50,000	\$100,000	50%
23*	DIRECT This test will evaluate several alternative low-cost methods of communicating advisory information to motorists. These include use of the Radio Data System (RDS), voice on a FM subcarrier, Automatic Highway Advisory Radio (AHAR), Low Power Highway Advisory Radio (HAR), and cellular phones.	Along sections of I-75, I-94 and M-10 within the city of Detroit.	\$2,500,000	\$4,400,000	43%
24	Dynamic Truck Speed Warning for Long Downgrades This project provides for the installation of a weigh-in-motion station to determine the weight of each truck, and for the installation of loops to determine vehicle speeds. Drivers will be advised of individual safe downhill speeds by changeable message signs.	I-70, Straight Creek Pass, Colorado	\$195,000	\$243,000	20%
25	Evaluating Environmental Impacts of IVHS Using LIDAR This test combined Light Detection and Ranging (LIDAR) technology for wide area emissions detection with active infrared technology for	Minneapolis and St. Paul, Minnesota	\$500,000	\$766,847	35%

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ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

No.	Projects	Location	Funding		Percent Non-Fed Funding
			Federal ITS	Total Cost	
	roadside emissions detection to evaluate any improvements in air quality due to implementing traffic responsive control strategies for events at a sports complex.				
26*	FAST-TRAC This test combines ATMS (SCATS traffic adaptive control system) and ATIS (Siemens Ali-Scout route guidance and driver information system) for improved traffic flow. Traffic flow detection uses AutoscopeJ video image processing technology. Infrared beacons are installed at critical locations in the network to provide a continuous exchange of real time traffic and route guidance information with equipped vehicles.	Oakland County, Michigan	\$55,500,000	\$69,375,000	20%
27*	Genesis This project evaluates the use of personal communication devices (PCDs) to distribute transit and traffic information. Genesis provides to the urban traveler current traffic or transit data relevant to the chosen trip mode and route.	Minneapolis/St. Paul, Minnesota	\$4,082,000	\$5,307,000	23%
28*	HELP/Crescent This project was a multi-state, multi-national effort to design and test an integrated heavy vehicle monitoring system that uses Automatic Vehicle Identification (AVI), Automatic Vehicle Classification (AVC), and Weigh-In-Motion (WIM) technology.	British Columbia, WA, OR, CA, AZ NM, TX	\$5,850,000	\$6,090,000	23%
29	HELP One-Stop Electronic Purchase This test involves issuance of both annual and temporary credentials, such as International Fuel Tax Agreement (IFTA) and International Registration Plan (IRP). The customer will have terminal access to electronically obtain multiple state credentials and permits, calculate fees and make payments.	California, Arizona and New Mexico	\$2,093,200	\$3,093,200	32%
30	Herald En-Route Driver Advisory via AM Subcarrier This project will test the dissemination of important traveler information in difficult-to-reach, remote, rural areas using a subcarrier on an AM broadcast station.	Colorado and Iowa	\$200,000	\$260,000	30%
31*	Houston Smart Commuter This project evaluates a real-time traffic and transit information system. The test will assess the market potential to increase bus, vanpool, and carpool use by providing traffic information, bus choices, and carpool options to travelers at home and work.	Harris County, Texas	\$5,000,000	\$5,000,000	0%
32	Idaho Out-of-Service Verification This project tests various types of machine-readable tags and video image analysis to assure compliance with an out-of-service order issued after a vehicle/driver safety inspection. Roadside inspection sites will be equipped with an alarm system activated when an out-of-service vehicle attempts to leave.	State of Idaho	\$800,000	\$1,240,000	35%
33	Idaho Storm Warning System This test investigates various sensor systems that provide accurate and reliable visibility and weather data, and uses that data to provide general warnings, speed advisories and possible road closure information to travelers on a section of I-84 in southeast Idaho.	Interstate-84 in southeastern Idaho	\$804,500	\$1,231,900	35%

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ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

No.	Projects	Location	Funding		Percent Non-Fed Funding
			Federal ITS	Total Cost	
34	<p>Imaging Technology for Automatic Real-Time Out-of-Service Verification</p> <p>This project tests a system of automatic, real-time out-of-service verification among several commercial vehicle inspection sites along a 252-mile section of westbound I-90/94. Using video identification equipment, a database will be created containing key out-of-service data on specific vehicles.</p>	252-mile section of westbound I-90/94 in Minnesota and Wisconsin	\$216,000	\$270,000	20%
35*	<p>Integrated Ramp Metering/Adaptive Signal Control</p> <p>This test will evaluate the effects of balancing traffic flow between I-5/I-405 and the parallel arterial streets. The project integrates an existing centrally-controlled freeway ramp meter system with an arterial signal system consisting of existing signal controllers, a new Advanced Traffic Controller, and a candidate adaptive control measure.</p>	Irvine (Orange County), California	\$2,617,000	\$3,271,250	20%
36	<p>ITS for Voluntary Emissions Reduction</p> <p>This test will evaluate the measurement of real-time emissions using an infrared roadside emissions sensor and providing that measurement to drivers via a changeable message sign at a freeway entrance ramp, as well as education material about the fuel savings and air quality benefits of well tuned vehicles. The effectiveness of offering free or subsidized vehicle tune-ups will also be evaluated.</p>	Denver, Colorado	\$304,663	\$498,358	39%
37	<p>Los Angeles Smart Traveler</p> <p>This project will demonstrate the use of real-time and other reliable sources of transportation information to determine high-occupancy-vehicle (HOV) travel options. Kiosks using audiotext and Videotext will be used to provide the information which also will include transit, paratransit and rideshare options.</p>	Los Angeles, California	\$1,500,000	\$3,300,000	55%
38	<p>MidWest States One-Stop Electronic Purchase Test</p> <p>The project tests one-stop, multi-state electronic purchase of credentials from locations such as motor carrier facilities, permitting services, truck stops and state agencies. The carriers will be able to purchase registration, fuel tax, authority, and over-dimensional permits from eight states through the system.</p>	MN, IA, IL, KS, MO, NE, SD, and WI	\$1,300,000	\$2,377,665	45%
39	<p>Milwaukee Smart Bus</p> <p>This project supports the efforts of Milwaukee County to evaluate its Automatic Vehicle Location (AVL) and bus fleet management system.</p>	Milwaukee County, Wisconsin	\$50,000	\$50,000	0%
40*	<p>Mobile Communications System</p> <p>This project will test and evaluate the use of a portable detection and surveillance system for highway construction, special events, and incident locations. Specially-equipped trailers will be placed at temporary traffic congestion locations.</p>	Orange County, California	(FY93)\$2,459,432	\$3,679,690	33%
41	<p>MTA Baltimore Smart Bus</p> <p>This project implemented an Automatic Vehicle Location (AVL) system providing bus status information to the public while simultaneously improving bus schedule adherence and labor productivity. The system is expanding to include all 900 Baltimore transit buses; Global Positioning System (GPS) inputs are replacing LORAN-C for vehicle location.</p>	Baltimore, Maryland	\$2,000,000	\$6,400,000	69%

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ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

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42	Multi-jurisdictional Live Aerial Video Surveillance System I This test evaluated live video transmission from a gyro-stabilized camera mounted on helicopters for observing, evaluating and properly managing major highway incidents and situations of a public safety nature.	Fairfax County, Virginia	\$355,000	\$355,000	0%
43	Multi-jurisdictional Live Aerial Video Surveillance System II This test evaluates live video transmission from fixed-wing aircraft to county and state traffic management centers and the feasibility of transmitting live video to mobile command centers.	Montgomery County, Maryland	\$445,000	\$740,000	40%
44	Northern Virginia Integrated Route Deviation/Fixed Route This test will evaluate an enhanced, ridesharing-route deviation transportation system integrated with conventional transit and ridesharing in the Northern Virginia suburbs of Washington, D.C., including Prince William and Stafford Counties. The system will provide on-demand service through an audiotext request system which uses scheduling software similar to the taxi industry.	Northern Virginia	\$1,184,460	\$3,243,593	64%
45	NY City Metro Transportation Authority Travel Information System This test will evaluate the effectiveness of providing comprehensive traffic and transit information via kiosks at bus stops and on board buses. The system will use data generated by the GPS bus locating system to display real-time travel information.	New York, New York	\$3,000,000	\$5,029,460	40%
46	On-Board Automated Mileage Test (IA) This project tests and evaluates the effectiveness of using the Global Positioning System (GPS) and first-generation on-board computers to record the miles driven within a state for fuel tax allocation purposes in a manner acceptable to state auditors.	Iowa-Minnesota-Wisconsin	\$1,068,239	\$1,745,748	39%
47	PASS (OR) The project examined integrating Automatic Vehicle Identification (AVI), Weigh In Motion (WIM), Automated Vehicle Classification (AVC) and On-Board Computers (OBC) to identify, weigh, and classify selected heavy vehicles in advance of weigh stations and ports-of-entry.	Ashland, Oregon, Port-of-Entry, Northbound I-5	\$350,000	\$552,900	33%
48	Puget Sound Help Me (PuSHME) Mayday System This test assesses operational, institutional and technology requirements for implementing a regional Mayday system that allows a driver to transmit an immediate notification of an incident, its location and need for assistance to a response center.	Puget Sound, Maine	\$1,216,942	\$2,300,000	47%
49	Rogue Valley Mobility Manager This project demonstrates the Mobility Manager concept to integrate transportation users, providers, and funding sources. Advanced electronic technology, including magnetic-stripe farecards, is used to record financial transactions. The initial phase focuses on providing transportation service to the elderly and disabled who are unable to use fixed-route transit.	Medford, Oregon	\$460,000	\$935,000	51%
50	RTD (Denver) Smart Bus This test evaluated the implementation of an Automatic Vehicle Location (AVL) system, as part of an upgraded communications system,	Denver, Colorado	\$8,440,000	\$10,520,000	20%

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	providing bus location information to transit dispatchers to increase efficiency, ridership and passenger safety.				
51	Sacramento Real-Time Ride Matching This project will use a geographic information system (GIS) to provide single-trip or multiple-trip real-time ridesharing information.	Sacramento, California	\$204,000	\$825,000	75%
52	San Antonio TransGuide This test will evaluate and document the San Antonio advanced traffic management system's digital communication network for cost effectiveness and benefits versus "traditional" transportation data communication systems. An additional element is the on-line evaluation and comparison of several incident detection algorithms.	San Antonio, Texas	\$899,654	\$1,298,460	31%
53	Santa Clara County Smart Paratransit This project will use global positioning system (GPS) technology for automatic vehicle location (AVL) operation of a paratransit system in conjunction with bus, light-rail and train operations. The service provided will allow disabled travelers to request specific transportation service.	Santa Clara County, California	\$425,000	\$850,000	50%
54	Satellite Communications Feasibility This project will evaluate the use of a VSAT (very small aperture terminal) satellite as the communications medium for four stationary closed-circuit television (CCTV) cameras and a mobile CCTV camera and communication platform.	I-95 in Philadelphia, Pennsylvania	\$2,220,000	\$2,800,000	21%
55*	SCOOT Adaptive Traffic Control System This test implements SCOOT in an area of the City of Anaheim's traffic control system to evaluate its effectiveness as an adaptive signal timing control package. SCOOT automates the traffic flow data collection and automatically optimizes traffic signal timing based on real-time traffic conditions.	Anaheim, California	\$1,153,927	\$2,438,427	53%
56	Seattle (Bellevue) Smart Traveler This project examines possible uses for mobile communications, such as cellular phones and information kiosks, to make ridesharing (carpooling and vanpooling) more attractive.	Metropolitan Seattle	\$244,000	\$545,000	57%
57	Seattle Wide Area Information for Travelers/Bellevue This project tests delivery of traveler information via three devices: the Seiko ReceptorJ MessageWatchJ, an in-vehicle FM subcarrier radio and a palm-top computer. This project will also expand service currently available under the Bellevue Smart Traveler project.	Seattle, Washington	\$4,526,540	\$7,200,000	37%
58*	Smart Call Box The project tests the feasibility of using call boxes for additional purposes. Smart Call Boxes will be evaluated to collect traffic census data; obtain traffic counts, flows and speeds for incident detection; report information from roadside weather information systems; control changeable message signs; and control roadside closed-circuit television cameras.	San Diego, California	\$915,000	\$1,607,600	43%
59*	Smart Corridor This test evaluates the use of advanced technologies to advise travelers	Los Angeles, California	\$1,100,000	\$4,000,000 (central	64%

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ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

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			Federal ITS	Total Cost	
	of current conditions and alternate routes (using communication systems such as Highway Advisory Radio (HAR), Changeable Message Signs (CMS), kiosks, and teletext), to improve emergency response, and to provide coordinated inter-agency traffic management.			database and expert systems development total cost)	
60	Southwest States Electronic One-Stop Shopping This project demonstrates a microcomputer-based vehicle one-stop credential purchasing process that will reduce public and private sector time and costs; streamline administrative processes and speed turn-around times; improve consistency and uniformity; extend access and availability; and ensure all commercial vehicle operators uniform access to one-stop shopping without substantial expenditures or establishment of new bureaucracies.	Arkansas, Colorado and New Mexico	\$537,305	\$671,632	20%
61*	Spread Spectrum Radio Traffic Interconnect This test will evaluate the use of spread spectrum radio to interconnect traffic signal communications devices within the Los Angeles ATSAC signal system. The radios will be tested in a network of signals to determine their ability to reliably reroute communications links, work in a variety of geographies, and provide for large-scale communications.	Los Angeles, California	\$2,594,075	\$3,824,685	32%
62*	Suburban Mobility Authority for Regional Transportation (SMART) This project will provide a system with automatic reservations, scheduling and dispatch for paratransit operations and an automatic vehicle location system for fleet management. The project will be integrated with FAST-TRAC and the Michigan DOT's Metropolitan Transportation Center to provide an intermodal transportation information service.	Detroit, Michigan	\$12,000,000	\$15,000,000	20%
63	TransCal This project will evaluate the integration of road, traffic, transit, weather and value-added traveler services information sources from across the entire geographic region. Land line and cellular telephones, and wireless FM subcarrier networks, will be used to transport information to and from travelers via telephones, personal digital assistants, in-vehicle navigation/display devices, interactive kiosks, etc. The project will also include a satellite-based Mayday system that will provide low-cost coverage within the corridor.	California and Nevada	\$3,163,000	\$7,155,000	56%
64*	TRANSMIT (TRANSCOM) This test will evaluate the use of automatic vehicle identification (AVI) technology as an incident detection tool. The system consists of additional AVI "tag" readers which allow vehicles equipped with transponders to serve as traffic probes to identify potential incidents by comparing actual to predicted travel times between readers.	Rockland County/Bergen County, New Jersey	\$2,750,000	\$3,437,300	20%
65	Travel-Aid This project will use variable speed limit signs, changeable message signs, and in-vehicle communications and signing equipment to improve safety along a 40-mile stretch of I-90 across Snoqualmie Pass, a rural area prone to snow, ice and poor visibility.	Snoqualmie Pass, Washington State	\$1,878,525	\$4,690,791	60%
66	TravInfo	San Francisco	\$4,800,000	\$7,075,000	32%

**Indicates operational tests which have been funded, either partially or totally, with Congressionally earmarked funds.*

Appendix I

ITS Operational Tests Awarded from Fiscal Year 1991 to Fiscal Year 1994

No.	Projects	Location	Funding		Percent Non-Fed Funding
			Federal ITS	Total Cost	
	The test designs and implements a comprehensive, region-wide traveler information system capable of supplying a broad array of information devices and users with transportation information both before and during trips. Multi-modal transportation information centers will integrate transportation information from a wide variety of sources and make the information available to the general public, public agencies and commercial (value-added) vendors.	Bay Area, California			
67*	TravLink This project implements an ATIS/APTS along the I-394 corridor extending west from the downtown Minneapolis area. The project provides real-time transit schedule and traffic information through a combination of kiosks and terminals at work, home, shopping centers, and transit stations.	Minneapolis/St. Paul, Minnesota	\$4,071,000	\$6,525,000	38%
68*	TravTek This test provided traffic congestion information, motorist services ("yellow pages") information, tourist information and route guidance to operators of 100 test vehicles, rented through AVIS, that were equipped with in-vehicle TravTek devices. Route guidance instructions were displayed on a moving map and reflected real-time traffic conditions in the TravTek traffic network.	Orlando, Florida	\$2,679,163	\$12,000,000	78%
69*	Trilogy This test will provide traveler information through three different communications techniques: the Radio Broadcast Data System-Traffic Message Channel (RBDS-TMC), a low-speed FM subcarrier, and a high-speed subcarrier similar to the STIC system. The receiving devices will provide end users with area and route-specific en-route advisories on the highway operating conditions in the Twin Cities Metropolitan Area.	Twin Cities Metropolitan Area	\$2,800,000	\$4,000,000	30%
70	Twin Cities Smart Traveler This project conducted a preliminary study of the potential of smart cards to improve paratransit service.	St. Paul, Minnesota	\$40,000	\$40,000	0%
71	Washington, D.C., Advanced Fare Media This project tests a fare collection system that allows passengers to use a smart card to pay for metrorail, metrobus and parking. The contractor has developed, installed and is demonstrating a contactless, smart-card-based fare collection system.	Washington, D.C., Metropolitan Area	\$1,000,000	\$1,000,000	0%
72	Wilmington, Delaware, Smart DART This project will test smart card technology in a transit application in Wilmington, Delaware. A smart card fare collection system will be developed for the Wilmington bus fleet.	Wilmington, Delaware	\$1,191,424	\$2,179,155	45%
73	Winston-Salem Mobility Management This project evaluates a mobility management system involving an automated scheduling and demand-responsive, shared-ride transit for the young, elderly, and disabled who are unable to use fixed-route transit. The project extends the transportation service to fixed-route transit, ridesharing and taxis used by the general public.	Winston-Salem, North Carolina	\$220,000	\$275,000	20%

**Indicates operational tests which have been funded, either partially or totally, with Congressionally earmarked funds.*

Appendix II

Research and Development Projects with Cost-Share Arrangements

Project Name	Description	Total Project Cost	Federal Share
Advanced Traveler Information Systems (ATIS)/Advanced Traffic Management Systems (ATMS)			
Real-Time Traffic Adaptive Control for ITS	This study develops a prototype real-time, traffic adaptive signal control system suitable for use in an ITS environment by 1997, and is the first of three studies which will eventually develop five prototypes for laboratory evaluation, from which one will be selected for further development and field evaluation by 1997. CONTRACTORS: Farradyne Systems, Inc., (prime) in a consortium composed of state and local Departments of Transportation.	\$4,915,852	\$3,403,382 (60%)
Rural Applications of Advanced Traveler Information Systems (ATIS)	The research will examine a broad range of rural environments, categories of travelers, ATIS applications, and advanced electronics and communications technologies to determine the needs for ATIS services in small and rural urban areas. CONTRACTORS: JHK & Associates (lead), Hughes, Virginia Tech, and Bell-Atlantic.	\$1,836,000	\$1,673,500 (92%)
Encoding Scheme for Advanced Traveler Information System (ATIS)/Advanced Traffic Management System (ATMS) Data Fusion	The State of Washington is currently developing a data fusion algorithm for ATMS/ATIS applications. Funding would partially cover the development of the methodology and investigate possible approaches to enable national implementation. CONTRACTOR: Washington State Department of Transportation.	\$247,000	\$198,000 (80%)
Integration of Traffic Operations and Traffic Data Collections	This research will establish a process and methodology for the integrated collection of traffic data. CONTRACTORS: Georgia and Washington State Departments of Transportation.	\$495,000	\$345,000 (60%)
Fixed Route Bus Data for GIS	This project will complete the development of the national bus fixed route database of the transit GIS. This project will also facilitate the addition of the national Transit GIS database to the proposed National Transportation System.	\$400,000	\$300,000 (75%)
Design of Support Systems for ATMS Control Centers	This study will develop 9 support systems (software) for mature ATMS control centers, and define the platforms and plan for integration with other ATMS elements.	\$3,072,679	\$2,942,679 (96%)
Advanced Vehicle Control and Safety Systems (AVCSS)			
Human Factors Studies for the Evaluation, Analysis, and Operational Assessment of an Intelligent Cruise Control System	This program will address a range of human factors issues associated with implementation of Intelligent Cruise Control (ICC) systems. CONTRACTOR: Ford Motor Company.	\$1,744,057	\$900,000 (52%)
Braking Analysis for Heavy Commercial Vehicle Collision Avoidance	This project will study the feasibility of adding automatic braking to heavy commercial vehicles. CONTRACTOR: Eaton Corporation.	\$559,290	\$451,138 (80%)
Characteristics of a Forward-Looking Automotive Radar Sensor	This project will develop a knowledge base of radar cross-section data from measurements in the laboratory and a variety of freeway settings using a prototype forward-looking automotive radar sensor. CONTRACTOR: Environmental Research Institute of Michigan and TRW,	\$1,139,487	\$880,376 (78%)

Appendix II

Research and Development Projects with Cost-Share Arrangements

Project Name	Description	Total Project Cost	Federal Share
	Inc.		
Vehicle-Based Lane Detection	Evaluates sensor performance under various operating conditions; identifies general lane detection sensor performance requirements. CONTRACTOR: Rockwell International.	\$824,733	\$414,733 (50%)
Driver Status/Performance Monitoring	This project will lead to the development of vehicle-based countermeasures that will monitor driver status/performance, detect degraded performance, and provide a warning signal or other countermeasure to prevent its continuance. CONTRACTOR: MTI Research, Inc.	\$835,000	\$660,000 (79%)
Heavy Vehicle Dynamic Stability Enhancement	This project will develop, evaluate, and deploy two prototype systems. The first is a Rollover Stability Advisor (RSA) to warn drivers of how close to rollover threshold they are operating their vehicles. The second is a Rearward Amplification Suppression System (RAMS) which employs electronic braking as an active controller to prevent rollovers when multiple-trailer combinations execute abrupt obstacle avoidance maneuvers at speeds above 70 kph (45 mph). CONTRACTORS: University of Michigan Transportation Research Institute, Freightliner, Hendrickson-Turner, Midland-Grau, Rockwell International, and TRW/Steering Division.	\$1,319,016	\$646,896 (49%)
Development, Evaluation, and Deployment of an Intelligent Commercial Vehicle Communication and Powering Enhancement System	This project will develop, evaluate, and deploy prototypes for field evaluation of enhanced systems that provide electrical powering and signaling/communications capability between and among trailer(s) and tractor in a combination-unit heavy truck. Two separate teams are working under this cooperative agreement. CONTRACTORS: (1) Delco Electronics, Vehicle Enhancement Systems, Ryder Truck Rental Inc., Freightliner, Volvo-GM; (2) Eaton Corp., PACCAR, Great Dane Trailers, Thermo-King, Caterpillar Grote, and the American Trucking Associations.	Eaton - \$828,506 Delco - \$2,503,167	Eaton - \$476,169 (57%) Delco - \$575,000 (23%)
Fostering the Development, Evaluation, and Deployment of Forward Crash Avoidance Systems (FOCAS)	This program will facilitate the development of a range of commercial sensors and associated application systems that supplement the forward crash avoidance performance of drivers. CONTRACTOR: The University of Michigan Transportation Research Institute (UMTRI).	\$1,746,824	\$899,777 (52%)
Automotive Collision Avoidance System Development	This program aims to advance the state-of-the-art and reduce the cost of existing and emerging collision avoidance technologies. Its goal is near-term commercial safety systems introduction. CONTRACTORS: Delco Electronics, GM Research, and Hughes Research Labs.	\$13,034,000	\$6,116,000 (46%)
Portable Data Acquisition System for Crash Avoidance Research	The objectives of this project are to apply state-of-the-art technology and methods to develop an easily-installed, portable instrumentation package and a set of analytical methods/tools to allow driver-vehicle performance data to be collected using a variety of vehicle types. CONTRACTORS: The Department of Energy	\$1,324,900	\$1,11,800 (85%)

Appendix II
Research and Development Projects with Cost-Share Arrangements

Project Name	Description	Total Project Cost	Federal Share
	(interagency agreement with Oak Ridge National Laboratory), and Scientific Atlanta Cooperative Research and Development Agreement (CRADA).		
Automated Highway System (AHS)			
PATH AVCS Research Program	Ongoing research is focused on sensors and communications for longitudinal control of vehicles, and on advanced braking actuators for AHS. CONTRACTOR: The University of California Partners for Advanced Transit and Highways (PATH) Program.	\$2,500,000	\$1,275,000 (51%)
National Automated Highway System Consortium	The AHS program is a broad national effort to provide the basis for, and transition to, the next major performance upgrade of the U.S. vehicle/ highway system by using automated vehicle control technology. A prototype system will be demonstrated in 1997. CONTRACTORS: General Motors (lead), Bechtel Corporation, the California Department of Transportation (Caltrans), Carnegie-Mellon University of Robotics Institute, Delco Electronics, Lockheed-Martin, Parsons Brinckerhoff, and the University of California Partners for Advanced Transit and Highways (PATH) Program.	\$202,000,000	\$160,000,000 (80%)
Other ITS Research-Related Projects			
ITS Research Centers of Excellence	The three Centers of Excellence will create a research environment where a quality mix of basic and applied research will be conducted to advance the ITS Program while attracting high quality students and professors to the ITS program. CONTRACTORS: University of Michigan, Texas A&M University, and Virginia Polytechnic Institute.	\$18,350,000	\$15,350,000 (80%)

Appendix III

Examples of AEarly Deployments@

- 1. Route Guidance in the U.S.**
- 2. Electronic Toll Collection in the U.S.**
- 3. Collision Warning Systems in the U.S.**
- 4. Intelligent Cruise Control in the U.S.**
- 5. Transit Automated Vehicle Locator Systems in the U.S. and Canada**
- 6. Deployment of Advanced Traffic Management Systems in the U.S. by State Agencies**
- 7. Measured Benefits of Deployed ITS Technologies**
- 8. The National Automated Highway System Consortium**
- 9. Traffic Information on the World Wide Web**
- 10. Multimodal Transit Information on the World Wide Web**
- 11. Traveler Services Information on the World Wide Web**
- 12. Commuter and Intercity Passenger Rail Information on the World Wide Web**

International ITS Information Clearinghouse Fact Sheet #1 Route Guidance in the U.S.

Company: Oldsmobile Division of the General Motors Corporation

Product Name: Guidestar, GPS-based

Cost: \$1,995 MSRP

Description: This in-vehicle navigation system is currently available as an option on Oldsmobile Eighty-Eight models in California, Michigan, Indiana, Florida, Georgia, and Illinois. The system will be available in Washington DC, Maryland, Virginia, New York, New Jersey and Rhode Island in early 1995. The system will be available nationally in the first quarter of 1996 (1).

Company: Sony

Product Name: NVX-F160, GPS-based

Cost: \$2,995 MSRP

Description: This in-vehicle navigation system is currently available at major car stereo dealers throughout California and Nevada (2).

Company: Avis Rental

Product Name: Guidestar, GPS-based

Cost: Not Available

Description: Avis is making vehicle navigation available through its rental fleet. The system was developed by Zexel and manufactured by Rockwell. The system is currently available in the San Francisco Bay area, San Jose and South Florida. Final testing is now being conducted in the following areas: parts of Metropolitan NY, Greater Detroit, areas of Illinois including Chicago and areas of Indiana including Indianapolis (3).

Company: Delco Electronics

Product Name: Telepath 100, GPS-based

Cost: \$800 (estimated)

Description: This in-vehicle navigation system provides distance and direction to selected destinations. Telepath 100's lower cost is attributable to its being fully integrated into a car stereo. The system will be introduced in 1995 and is currently being field tested by Avis rental cars in Indianapolis (4).

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Company: Hertz

Product Name: NeverLost, GPS-based

Cost: Not Available

Description: Hertz is making vehicle navigation available through its rental fleet. The system will be available in December 1994 in California and Florida and in Atlanta, Boston, Chicago, Detroit, New York, and Washington DC. (13).

Company: Pioneer

Product Name: GPS-X77, GPS-based

Cost: \$2,700

Description: Pioneer will begin to sell its in-vehicle navigation system in the U.S. in January 1995. Pioneer expects to sell 3,000 units in 1995 (5).

Company: Amerigon Inc.

Product Name: AudioNav, non GPS-based

Cost: under \$500 (estimated)

Description: This in-vehicle navigation system features interactive voice system technology. AudioNav was marketed by **Alpine, Clarion, Fujitsu Ten's Eclipse and Kenwood** at the Consumer Electronics Show in Las Vegas, January 1995 (6).

Company: Rockwell

Product Name: PathMaster, GPS-based

Cost: Not Available

Description: In the near future Rockwell plans to sell a vehicle navigation system called PathMaster which will be one of the most advanced route guidance systems on the market. The system will be available through the automotive aftermarket (7).

Company: Mercedes Benz

Product Name: APS (Auto-Pilot System), GPS-based

Cost: Not Available

Description: This in-vehicle navigation system will be available on some 1996 models. APS uses computer technology developed with Bosch and Blaupunkt. The system guides the driver to destinations with a dash-mounted display and synthesized voice commands (8).

Company: Siemens

Product Name: Ali-Scout, non GPS-based

Cost: Not Available

Description: Ali-Scout is a beacon-based dynamic route guidance system being tested as part of FAST-TRAC, an operational field test in Oakland County, MI (9).

Company: Motorola

Product Name: Not Available, GPS-based

Cost: Not Available

Description: Motorola is providing the dynamic route guidance system as part of the ADVANCE operational field test in the Chicago area (10).

Company: Clarion

Product Name: NAX-500, GPS-based

Cost: \$1,500

Description: Clarion's in-vehicle navigation system uses dead-reckoning and speed sensors that tie into the car's engine management system. Clarion hopes to market the system by the end of 1995 (11).

Company: Itochu International

Product Name: Not Available, GPS-based

Cost: Not Available

Description: This in-vehicle navigation system was showcased at the Winter Consumer Electronics Show. The system uses Etak software and will be available at the end of 1995 (12).

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5. Nikkei (Japanese Newspaper) Kentaro Sakamoto; "Twice," 1/23/95, atis.044
6. Autoweek, 12/20/93, atis.039; Amerigon news release, 1/6/95, atis.024
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(* catalog numbers from the National ITS Program Database)

February 15, 1995

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International ITS Information Clearinghouse Fact Sheet #2 Electronic Toll Collection in the U.S.

There are 12 toll agencies in 9 states currently operating electronic toll collection (ETC) systems. These systems handle approximately 250,000 toll transactions per day. Systems are being planned or considered in another 12 states. Potentially there are an additional 23 toll agencies which could be operating ETC systems in the near future. The following is a list of states currently involved with ETC (operating systems are italicized).

State: California

1. California Private Transportation Company: State Route 91 Electronic Toll Road, MFS (1)
2. CALTRANS: Advanced Toll Collection and Accounting System, MFS (1)
3. Transportation Corridor Agencies (TCA) Foothill: MFS and Lockheed (1)
4. San Joaquin Hills and Eastern Transportation Corridor projects in Orange County: MFS and Lockheed (1)
5. Golden Gate Bridge, Highway & Transportation District: ETC system being planned (9)

State: Colorado

1. *E-470 Public Highway Authority Denver: EXPRESSTOLL, X-Cyte, implemented 7/91 (9)*

State: Delaware

1. Delaware River & Bay Authority: Delaware Memorial Bridge, ETC system under consideration (9)

State: Florida

1. Florida Department of Transportation: Florida Turnpike, ETC system being planned (9)
2. *Orlando-Orange County Expressway Authority: E-Pass, Mark IV, operational system (10)*

State: Georgia

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1. *Georgia Department of Transportation: Georgia Route 400 extension near Atlanta, Amtech subcontract to Lockheed, operational since August 1993 (3)*

State: Illinois

1. *Illinois State Toll Highway Authority: I-Pass Electronic Toll Collection and Traffic Management system, AT/Comm, 200 lanes to become operational by November 1994 (7)*

State: Indiana

1. Indiana Department of Transportation - Toll Road Division: Indiana Toll Road, ETC system being planned (9)

State: Kansas

1. Kansas Turnpike Authority: K-TAG, Amtech, 2-lane test scheduled for the 2nd quarter of 1994 (8)

State: Louisiana

1. *Louisiana Department of Transportation and Development: Crescent City Connection Bridge, Amtech, implemented 1/4/89 (3,9)*
2. *Greater New Orleans Expressway Commission: Lake Pontchartrain Causeway, implemented 12/17/90, Amtech (3, 9)*

State: Maine

1. Maine Turnpike: Electronic Toll and Traffic Management, AT/Comm, contract awarded 10/25/94 (4)

State: Maryland

1. Maryland Transportation Authority: Baltimore Harbor Tunnel, JFK Memorial Highway, Ft. McHenry Tunnel, Frances Scott Key Bridge, Harry W. Nice Memorial Bridge, William J. Lane Jr. Memorial Bridge, Thomas J. Hatem Memorial Bridge, ETC systems being planned (9)

State: Massachusetts

1. Massachusetts Port Authority: recently tested Amtech technology (11)

State: Michigan

1. Mackinac Bridge Authority: Mackinac Bridge, ETC system being planned (9)

State: New Jersey

1. New Jersey Expressway Authority: Atlantic City Expressway, E-ZPass system being planned (9)
2. New Jersey Highway Authority: Garden State Parkway, E-ZPass system being planned, Mark IV (9)
3. *Port Authority of New York and New Jersey: Lincoln Tunnel, Electronic Toll System for Buses, SAIC and Amtech, operational since April 1988 (3)*
4. Port Authority of New York and New Jersey: Bayonne Bridge, George Washington Bridge, Goethels Bridge, Holland Tunnel, Lincoln Tunnel, Outerbridge Crossing, E-ZPass systems being planned (9)

State: New York

1. MTA Bridges and Tunnels: E-ZPass Electronic Toll System, Mark IV, contract signed 5/94 (2), Amtech systems integrator, contract awarded 8/94 (5), E-ZPass systems for all bridges and tunnels are being planned, Mark IV (9)
2. *New York State Thruway Authority: Spring Valley, Tappansee Bridge and Grand Island Bridge, Amtech, implemented August 1993 for Spring Valley, Tappansee Bridge and Grand Island Bridge implemented October 1993 (3)*
3. Buffalo & Fort Erie Public Bridge Authority: Peace Bridge, ETC system being planned (9)

State: Ohio

1. Ohio Turnpike Commission: Ohio Turnpike, ETC system being planned (9)

State: Oklahoma

1. *Oklahoma Turnpike Authority: PikePass, Amtech, implementation began in 1/91 (3)*

State: Pennsylvania

1. Pennsylvania Turnpike Commission: E-ZPass Electronic Toll System, Mark IV, contract announced 6/27/94 (2)

State: Rhode Island

1. Rhode Island Turnpike & Bridge Authority: Mt. Hope Bridge and Newport Bridge, ETC systems under consideration (9)

State: Texas

1. *Texas Turnpike Authority: Dallas North Tollway, TollTag, Amtech, system operational since mid-1989 (3)*
2. *Harris County Toll Road Authority: Sam Houston Tollway and the Hardy Toll Road, ETC provided for 69 lanes in October 1992 (3)*
3. *Texas Department of Transportation: Houston Freeway Monitoring using ETTM AVI technology, Amtech, contract awarded in May 1993 (3)*

State: Virginia

1. Toll Road Investors Partnership II (Trip II): Dulles Greenway, Syntonic Technology, contract awarded 7/12/94 (6).
2. Virginia DOT: Dulles Toll Road, ETC system is being planned (10)

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2. Mark IV news release, 6/27/94, atms.008
3. Amtech Installations Report, 2/14/94, atms.070
4. AT/Comm news release, 10/25/94, atms.019
5. Amtech news release, 8/1/94, atms.016
6. Syntonic news release, 7/12/94, atms.014
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(* catalog numbers from the National ITS Program Database)

February 9, 1995

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International ITS Information Clearinghouse Fact Sheet #3 Collision Warning Systems in the U.S.

Collision warning systems such as Delco Electronics' FOREWARN and VORAD's CWS are currently available in the U.S. for truck and bus applications. Automotive supply companies are developing low-cost collision warning technologies for the passenger car market. General Motors, Ford and Chrysler are also currently developing systems for passenger cars. It is expected that these systems will be available by the end of the decade. The following is a list of companies involved in collision warning systems.

Company: Delco Electronics, part of General Motors' Hughes aerospace unit

Product Name: FOREWARN

Cost: \$1,895

Description:

This 360 degree radar detection system has been installed on school buses since March 1993 and detects the presence of children in the driver's blind-spots. To date 2000 units have been sold. Delco collision warning systems will be available for the commercial truck market in 1995 and will be available for passenger cars in 1998 or 1999 (1).

Company: Eaton - VORAD

Product Name: EVT-200 Collision Warning System (CWS)

Cost: less than \$2,500

Description:

This radar-based collision warning system became available as a retrofit unit for trucks in June 1994. The system offers front and side detection for equipped vehicles. Greyhound Lines has about 1600 VORAD collision warning systems in operation. In 1993 Greyhound had a 21 percent reduction in total number of accidents compared to 1992 (2).

Company: TRW

Product Name: Not Available

Cost: \$200 wholesale

Description:

This radar-based blind spot detection system scans the side and rear of a passenger vehicle when a turn signal is activated. This system is not currently available on the market (3).

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Company: Siemens

Product Name: SideMinder

Cost: \$50 wholesale price in automotive production quantities

Description:

This collision warning system uses infrared sensor and light-emitting diode (LED) technology and is activated when the turn signal is engaged. The infrared sensors are located in the vehicle's taillight assembly and the LED signals are located in the passenger- and driver-side mirrors. Prototypes are now being tested in the U.S. and Europe (4).

Company: Amerigon Inc.

Product Name: Not Available

Cost: Not Available

Description:

Amerigon is employing a simpler radar-based technology for its collision warning system. Instead of generating continuous radar waves, Amerigon's system generates single impulses which decreases the costs of the system's computer hardware. Amerigon is being approached by manufacturers regarding the system (5).

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February 15, 1995

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International ITS Information Clearinghouse Fact Sheet #4 Intelligent Cruise Control in the U.S.

Intelligent cruise control (ICC) systems are expected to be available as optional equipment on passenger vehicles by the end of the decade. Currently there are two competing technologies, infrared and radar systems which are being developed. Radar-based systems have the ability to function in foggy conditions whereas infrared-based systems do not. Leica Corporation of Switzerland has been testing an early version of ICC on a Saab 9000 and has been working with Daimler-Benz in the European Prometheus program. TRW demonstrated a radar-based ICC system on a Chrysler LHS at last year's IVHS AMERICA annual meeting in Atlanta.

Buick (Division of GM) recently introduced the XP2000 concept car at the North American International Auto Show this past January in Detroit. This concept car showcases a variety of ITS technologies including adaptive cruise control. Ford Motor Company believes that ICC is the type of innovation which is viable in the foreseeable future.

The market for ICC looks promising in the United States. Approximately 70 percent of new cars come equipped with traditional cruise control. ICC systems are expected to cost between \$300-\$350 which is about \$100 more than existing cruise control systems. A recent survey of automotive executives and engineers predicted that there will be a 50 percent application rate of ICC by the year 2000. However, liability issues may be a concern to potential automotive manufacturers marketing ICC in the U.S. The following automotive suppliers are involved with ICC systems: Delco Electronics, Leica Corp., TRW, Rockwell, Raytheon, and Vorad.

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International ITS Information Clearinghouse Fact Sheet #5 Transit Automated Vehicle Locator Systems in the U.S. and Canada

Twenty-five (25) transit properties in fifteen (15) states and three Canadian territories currently operate automated vehicle location systems. These systems monitor and control approximately 13,460 vehicles. In addition, another nineteen (19) procurements (new or enhancements to existing) will be in place in 1995 adding 9,170 vehicles and five states to the count. Of the entities listed, twenty (20) properties have chosen non-GPS-based systems while twenty-three (23) GPS systems are deployed or planned. *Systems which are currently operational are italicized.*

State: Arizona

1. Tucson-Sun Tran; GPS technology for 200 vehicles to be procured in 1995

State: California

1. *San Francisco-MUNI; signpost technology for 850 vehicles operational in 1985*
2. *San Mateo-samTrans; signpost technology for 320 vehicles operational in 1994*
3. Fresno-FAX; GPS technology for 110 vehicles to be procured in 1995
4. Oakland-AC Transit; GPS technology for 680 vehicles to be procured in 1995
5. San Francisco-MUNI; GPS technology for 850 vehicles to be procured in 1995
6. Stockton; GPS technology for 90 vehicles to be procured in 1995

State: Colorado

1. *Denver-RTD; GPS technology for 1,200 vehicles operational in 1994*

State: Florida

1. *Miami-MDTA; GPS technology for 600 vehicles operational in 1995*
2. *Palm Beach-CoTran; signpost technology for 100 vehicles*
3. *Tampa-Hartline; signpost technology for 167 vehicles operational in 1994*
4. Broward Co. Mass Transit; GPS technology for 200 vehicles to be procured in 1995

State: Illinois

1. *Champaign/Urbana-MTD; Loran C technology for 50 vehicles*
2. *Chicago-CTA; GPS technology for 2,080 vehicles to be procured in 1995*
3. *Suburban Chicago-PACE; GPS technology for 1,000 vehicles to be procured in 1995*

State: Kentucky

1. *Louisville-TARC; signpost technology for 300 vehicles operational in 1994*

State: Maryland

1. *Baltimore-MTA; Loran C technology for 50 vehicles operational in 1991*
2. *Baltimore-MTA; GPS technology for 850 vehicles to be procured in 1995*

State: Michigan

1. *Ann Arbor-AATA; GPS technology for 70 vehicles to be procured in 1995*
2. *Detroit-DDOT; GPS technology for 500 vehicles to be procured in 1995*

State: Missouri

1. *Kansas City-KCATA; signpost technology for 224 vehicles operational in 1991*

State: Minnesota

1. *Minneapolis-MTC; GPS technology for 80 vehicles operational in 1994*

State: Nevada

1. *Reno-RTC Citifare; GPS technology for 90 vehicles to be procured in 1995*

State: New Mexico

1. *Albuquerque-Sun Tran; GPS technology for 30 paratransit vehicles to be procured in 1995*

State: New Jersey

1. *Newark-NJTA; signpost technology for 2,800 vehicles operational in 1995*

State: New York

1. *Westchester County Transit; signpost technology for 100 vehicles*
2. *Buffalo-NFTA; GPS technology for 350 vehicles to be procured in 1995*
3. *New York City Transit Authority; GPS technology for 230 vehicles to be procured in 1995 (ultimately 4,000 vehicles)*
4. *Syracuse-RTA Centro; GPS technology for 190 vehicles to be procured in 1995*

State: Ohio

1. *Cincinnati-SORTA; GPS technology for 380 vehicles to be procured in 1995*
2. *Lake City; GPS technology for 60 vehicles to be procured in 1995*

State: Pennsylvania

1. *Beaver County Transit Authority; Loran C technology for 36 vehicles operational in 1991*

State: Texas

1. *Dallas-DART; GPS technology for 1,280 vehicles operational in 1994*
2. *San Antonio-VIA; signpost technology for 550 vehicles operational in 1987*
3. *Houston-METRO; terrestrial triangulation technology for 140 paratransit vehicles operational in 1993*
4. *Houston-METRO; technology for 1,200 vehicles to be procured in 1995*

State: Virginia

1. *Norfolk-TRT; signpost technology for 180 vehicles*

State: Washington

1. *Seattle-Metro; signpost technology for 1,100 vehicles*

State: Wisconsin

1. *Milwaukee-MCTS; GPS technology for 440 vehicles operational in 1994*
2. *Sheboygan-ST; signpost technology for 100 vehicles*

Territory: Nova Scotia

1. *Halifax; signpost technology for 160 vehicles operational in 1987*

Territory: Ontario

1. *Hamilton; dead reckoning technology for 280 vehicles*
2. *Ottawa; radio frequency tag technology for 800 vehicles operational in 1994*

Territory: Quebec

1. *Toronto; signpost technology for 1,600 vehicles operational in 1989*

References:

1. Intelligent Transportation Society of America Research Survey, Winter/Spring 1995.
2. APTS State of the Art Report--1994 Update, U.S. Department of Transportation, Federal Transit Administration, January, 1994.

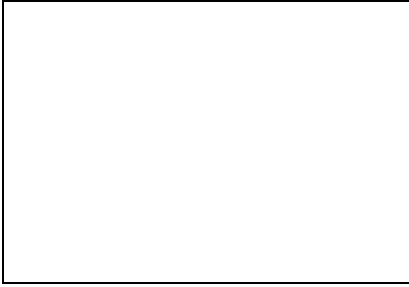
February 17, 1995

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International ITS Information Clearinghouse Fact Sheet # 6 Deployment of Advanced Traffic Management Systems in the U.S. by State Agencies

There are more than 20 Advanced Traffic Management Systems currently deployed in the U.S. by state transportation agencies. These systems use a variety of detection, control, and information technologies to manage the flow of traffic. There are over 2,000 miles of roadways instrumented with more than 2,100 ramp meters, 600 changeable message signs, and 375 closed-circuit TV (CCTV) cameras, plus a variety of other technologies. Several of the systems coordinate their traffic management with systems operated by local jurisdictions.

Name: Sacramento Transportation Management Center 1
Location: Sacramento, CA
Operated by: California Department of Transportation
Centerline Miles: 22
Roadway Jurisdictions: Interstates, State Highways
Detection Technologies: Loop Detectors, 1 CCTV Camera
Control Technologies: 19 Ramp Meters
Information Technologies: 8 Changeable Message Signs, Highway Advisory Radio

Name: Vallejo Interim Transportation Management Center 2
Location: San Francisco, CA
Operated by: California Department of Transportation
Centerline Miles: 118
Roadway Jurisdictions: Interstates, State Highways
Detection Technologies: Loop Detectors, 58 CCTV Cameras
Control Technologies: 96 Ramp Meters
Information Technologies: 23 Changeable Message Signs, Highway Advisory Radio

.....
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Name: Central Valley Transportation Management Center 3

Location: Fresno, CA
Operated by: California Department of Transportation
Centerline Miles: 12
Roadway Jurisdictions: Interstates, State Highways
Detection Technologies: Loop Detectors
Control Technologies: 15 Ramp Meters
Information Technologies: 35 Changeable Message Signs, Highway Advisory Radio

Name: Los Angeles Transportation Management Center 4
Location: Los Angeles, CA
Operated by: California Department of Transportation
Centerline Miles: 700
Roadway Jurisdictions: Interstates, State Highways
Detection Technologies: Loop Detectors, 27 CCTV Cameras
Control Technologies: 808 Ramp Meters
Information Technologies: 71 Changeable Message Signs, Highway Advisory Radio

Name: Inland Valley Transportation Management Center 5
Location: San Bernardino, CA
Operated by: California Department of Transportation
Centerline Miles: 71
Roadway Jurisdictions: Interstates, State Highways
Detection Technologies: Loop Detectors, 13 CCTV Cameras
Control Technologies: 51 Ramp Meters
Information Technologies: 18 Changeable Message Signs, Highway Advisory Radio

Name: San Diego Transportation Management Center 6
Location: San Diego, CA
Operated by: California Department of Transportation
Centerline Miles: 126
Roadway Jurisdictions: Interstates, State Highways
Detection Technologies: Loop Detectors, 9 CCTV Cameras
Control Technologies: 134 Ramp Meters
Information Technologies: 19 Changeable Message Signs, Highway Advisory Radio

Name: Orange County Transportation Management Center 7
Location: Orange County, CA
Operated by: California Department of Transportation
Centerline Miles: 258
Roadway Jurisdictions: Interstates, State Highways
Detection Technologies: Loop Detectors, 4 CCTV Cameras
Control Technologies: 278 Ramp Meters
Information Technologies: 27 Changeable Message Signs, Highway Advisory Radio

Name: Colorado Traffic Operations Center 8
Location: Denver, CO
Operated by: Colorado Department of Transportation
Centerline Miles: 7
Roadway Jurisdictions: Interstate

Detection Technologies: 330 Loop Detectors, 15 CCTV

Control Technologies:

Information Technologies: Highway Advisory Radio

Name: Connecticut Freeway Advanced Traffic Management System 9

Location: Hartford, CT

Operated by: Connecticut Department of Transportation

Centerline Miles: 18

Roadway Jurisdictions: Interstates

Detection Technologies: 10 Radar Detection Stations (44 Detectors), 2 CCTV Cameras

Control Technologies:

Information Technologies:

Name: I-95 Incident Management System 10

Location: Bridgeport, CT

Operated by: Connecticut Department of Transportation

Centerline Miles: 56

Roadway Jurisdictions: Interstate

Detection Technologies: Radar Detectors, CCTV Cameras

Control Technologies:

Information Technologies: Changeable Message Signs

Name: IDOT Traffic Systems Center 11

Location: Chicago, IL

Operated by: Illinois Department of Transportation

Centerline Miles: 136

Roadway Jurisdictions:

Detection Technologies: 2,000 Loop Detectors

Control Technologies: 109 Ramp Meters

Information Technologies: 20 Changeable Message Signs

Name: Michigan Intelligent Transportation Systems Center 12

Location: Detroit, MI

Operated by: Michigan Department of Transportation

Centerline Miles: 32

Roadway Jurisdictions: Interstates, State Highways

Detection Technologies: 1,240 Loop Detectors, 10 CCTV Cameras

Control Technologies: 49 Ramp Meters

Information Technologies: 14 Changeable Message Signs

Name: Mn/DOT Traffic Management Center 13

Location: Minneapolis, MN

Operated by: Minnesota Department of Transportation

Centerline Miles: 160

Roadway Jurisdictions: Interstates, State Highways

Detection Technologies: Autoscopes, Loop Detectors, 156 CCTV Cameras

Control Technologies: 367 Ramp Meters

Information Technologies: 49 Changeable Message Signs, Highway Advisory Radio, Cable TV Traffic Channel

Name: Traffic Operations Center 14
Location: New Brunswick, NJ
Operated by: New Jersey Turnpike Authority
Centerline Miles: 148
Roadway Jurisdictions: Interstate, State Tollway
Detection Technologies: Over 900 Loop Detectors, Video Imaging, Microwave Detectors 2 CCTV Cameras
Control Technologies: Over 100 variable speed limit and speed warning signs
Information Technologies: Over 100 Changeable Message Signs, 2 CCTV Cameras

Name: INFORM 15
Location: Long Island, NY
Operated by: New York State Department of Transportation
Centerline Miles: 35
Roadway Jurisdictions: Interstates, Parkways, State Arterials
Detection Technologies: 2069 Loop Detectors, 34 CCTV Cameras
Control Technologies: 75 Ramp Meters, 133 Arterial Signals
Information Technologies: 101 Changeable Message Signs

Name: Penn DOT Traffic Operations Center 16
Location: St. Davids, PA
Operated by: Pennsylvania Department of Transportation
Centerline Miles: 12
Roadway Jurisdictions: Interstate
Detection Technologies: 12 CCTV Cameras
Control Technologies:
Information Technologies: 2 Sets of Changeable Message Signs

Name: Greater Houston Transportation and Emergency Management Center 17
Location: Houston, TX
Operated by: Texas Department of Transportation
Centerline Miles:
Roadway Jurisdictions:
Detection Technologies: Loop Detectors, Video Detectors, CCTV Cameras
Control Technologies: Ramp Meters, Lane Control Signals
Information Technologies: Changeable Message Signs

Name: 18
Location: Fort Worth, TX
Operated by: Texas Department of Transportation
Centerline Miles:
Roadway Jurisdictions:
Detection Technologies: Loop Detectors, CCTV Cameras
Control Technologies: Lane Control Signals
Information Technologies: Changeable Message Signs

Name:	TransGuide	19
Location:	San Antonio, TX	
Operated by:	Texas Department of Transportation	
Centerline Miles:	25	
Roadway Jurisdictions:		
Detection Technologies:	Loop Detectors, CCTV Cameras	
Control Technologies:	Lane Control Signals	
Information Technologies:	Changeable Message Signs	
Name:		20
Location:	El Paso, TX	
Operated by:	Texas Department of Transportation	
Centerline Miles:		
Roadway Jurisdictions:		
Detection Technologies:	Loop Detectors	
Control Technologies:		
Information Technologies:	Changeable Message Signs	
Name:	Northern Virginia Traffic Management System	21
Location:	Arlington, VA	
Operated by:	Virginia Department of Transportation	
Centerline Miles:	32	
Roadway Jurisdictions:	Interstates	
Detection Technologies:	550 Loop Detectors, 48 CCTV Cameras	
Control Technologies:	26 Ramp Meters	
Information Technologies:	100 Changeable Message Signs	
Name:	Seattle Freeway Management System	22
Location:	Seattle, WA	
Operated by:	Washington Department of Transportation	
Centerline Miles:		
Roadway Jurisdictions:	Interstates, State Highways	
Detection Technologies:	Loop Detectors, CCTV Cameras	
Control Technologies:	Ramp Meters	
Information Technologies:	Changeable Message Signs, Highway Advisory Radio	
Name:	Traffic Operations Center	23
Location:	Milwaukee, WI	
Operated by:	Wisconsin Department of Transportation	
Centerline Miles:	32	
Roadway Jurisdictions:	Interstates, U.S. Highway	
Detection Technologies:	Loop Detectors, Overhead micro-wave Detectors, 14 CCTV Cameras, 1 Video Detector	
Control Technologies:	43 Ramp Meters	
Information Technologies:	11 Changeable Message Signs	

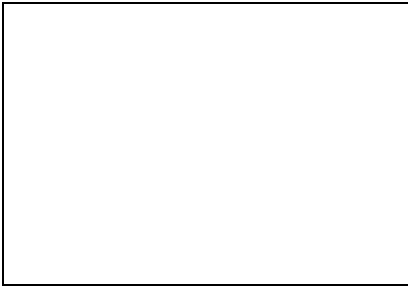
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- 1-7. Data provided by Laurie Guinness, Caltrans.
8. Data provided by Larry Corcoran, Colorado DOT.
- 9-10. Data provided by James Mona, Connecticut DOT.
11. TRB Freeway Operations Committee report (1/95).
12. Report - IVHS Programs and Projects (9/1/94) by the Michigan DOT.
13. TRB Freeway Operations Committee report (1/95).
14. TRB Freeway Operations Committee report (1/95) and Robert Dale, New Jersey Turnpike A
15. Data provided by Thomas Warner, New York DOT.
16. Data provided by Doug May, Pennsylvania DOT.
- 17-20. Data provided by Al Kosik, Texas DOT.
21. Data provided by Chandra Clayton, Virginia DOT.
22. Data provided by Les Jacobson, Washington DOT.
23. TRB Freeway Operations Committee report (1/95).

March 1, 1995

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Phone: 202/484-4665 E-Mail: shay@spaceworks.com



International ITS Information Clearinghouse Fact Sheet #7 Measured Benefits of Deployed ITS Technologies

The deployment of Intelligent Transportation Systems technologies has resulted in benefits that have been evaluated and measured. The results have shown improved safety and productivity along with a reduction in congestion and adverse environmental impacts.

ADVANCED TRAFFIC MANAGEMENT SYSTEMS

1) Oakland County, Michigan - FAST-TRAC

FAST-TRAC is one of the largest ITS projects. It is a public/private partnership encompassing:

- G Computer Controlled Adaptive Signal Control System for the control of traffic signals at intersections based on real-time traffic densities.
- G Automated Traffic Monitoring System using video detection devices to provide data on traffic density.
- G Beacon based dynamic route guidance system providing real-time information to motorists on the best route to use and how to get there based on current traffic conditions.
- G A Comprehensive Intermodal Transportation Information Management System for processing transportation data into information for dissemination to users over a variety of media.
 - ! Integration of ATMS/ATIS
 - ! Integration of ATMS/APTS
 - ! Integrated Corridor Traffic Management

RESULTS:

- Safety: ! 89percent decrease in left-turn accidents intersections
 - ! 6percent decrease in injury accidents
 - ! 27percent decrease in total injuries
 - ! 100percent decrease in serious injuries

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Congestion: ! Up to 19 percent increase in vehicle speeds during peak hour

2) Minneapolis, Minnesota

The Minnesota Department of Transportation (Mn/DOT) Traffic Management Center (TMC) is a

RESULTS:

Safety: ! Accident rates decrease by 25 percent (421/year to 308/year)
! 20-minute reduction in response time to incidents

Congestion: ! Average speeds increase by 35 percent (34 mph to 46 mph) during rush hours
! Capacity of Freeway increased by 22 percent

3) Abilene, Texas

As part of the Texas DOT program, computerized traffic signals were installed in Abilene to time traffic signals based on traffic density.

RESULTS:

Congestion: ! 14 percent reduction in travel time
! 37 percent reduction in delays
! 22 percent increase in travel speed

Air Pollution: ! 10 percent reduction in carbon monoxide and hydrocarbon emissions

ADVANCED TRAVELER INFORMATION SYSTEMS

1) Orlando, Florida - TRAV-TEK

A large public/private partnership program to test an Advanced Traveler Information System. The program involved 5 organizations, 100 vehicles, most of which were AVIS rental cars, and 4,000 drivers over an extended period of time. Vehicles had electronic route guidance systems installed.

Provides detailed directions to drivers who input destination information, and GPS data on real-time location of the vehicle. The system was connected to a Traffic Control Center via satellite.

RESULTS:

Congestion: ! 19 percent reduction in travel time

ELECTRONIC TOLL AND TRAFFIC MANAGEMENT

1) Oklahoma Turnpike Authority - PIKEPASS

Electronic toll collection systems have been operational for several years and are currently being installed in 20 states. Electronic toll technology uses a special RF (Radio Frequency) tag that talks to the toll gate as the vehicle approaches. The tag identifies the driver and the toll system then debits the driver's account for the amount of the toll. The vehicle does not need to slow down at all, and proceeds through the toll plaza at regular freeway speeds, eliminating the slowdown and deceleration at toll booths.

RESULTS:

Safety: ! Reduced accidents to zero in first year (eg 71 accidents in regular toll lane, zero in PIKEPASS lane)

Congestion: ! Reduced time lost to toll congestion by 1 million hours/year

Productivity: ! Reduced annual cost of operation of toll lane by 11 to 1 (\$176,000 to \$15,800)

Air Pollution: ! Reduced air pollutants:

"Hydrocarbons by 6 to 1

"Carbon Monoxide by 4 to 1

"Nitrous Oxide by 2 to 1

ADVANCED PUBLIC TRANSIT SYSTEMS

Automatic Vehicle Location / Computer-Aided Dispatch

Twenty-one cities in the United States have or are in the process of installing AVL/CAD (Automatic Vehicle Location / Computer-Aided Dispatch) systems on their buses. AVL/CAD provides precise position of the bus along its route and reports this to the central computer at dispatch headquarters. This data is used to determine the on-time performance and provides the driver and the dispatcher with a visual

indication of where the bus is (if desired) and schedule adherence (ahead of schedule or behind schedule.) The systems also provide accurate run times on routes and a covert "mayday" message capability. AVL is also the basic ingredient for providing real-time schedule information to the public to make transit easier to use and more reliable.

1) Baltimore MTA, Maryland

Baltimore installed a system on 50 buses in 1991 and conducted a schedule performance test versus non-equipped buses. They are in the process of installing AVL on the remainder of their 850 buses.

RESULTS:

Productivity: ! Achieved a 23 percent improvement in on-time performance by the AVL-equipped buses

2) Kansas City, Missouri - Kansas City Area Transportation Authority

Kansas City installed a system in 1991 on 200 buses. As a result of improving schedule adherence and accurate run times, Kansas City was able to utilize 7 fewer buses to operate its routes.

RESULTS:

Productivity: ! Operating expense savings: \$400,000/year
! Capital for buses: \$1,575,000
! Amortized Investment in less than 3 years

Safety: ! Reduced time to respond to an incident (medical, criminal, etc.) from 3 to 10 minutes to 1 minute by always being able to pinpoint the location of buses

3) Toronto, Canada

Toronto has had an AVL system operating for several years.

RESULTS:

Productivity: ! Achieved a 4 percent reduction in the number of buses required to serve existing routes
Amortized investment in 2 years

COMMERCIAL VEHICLE OPERATIONS

1) A Large Trucking Company

A trucking company installed an on-board computer and communication system on its trucks. This is connected to a Computer-Aided Dispatch system at dispatch headquarters. The system allowed the company to better utilize the fleet of 10,000 trucks by an average 20-25 miles per day per truck. This is significant in an industry that operates on a low margin.

RESULTS:

Productivity: ! An increase of 4 percent in fleet productivity

Compiled by William S. Jones, consultant to ITS America.

References:

1. "IVHS on the FAST-TRAC," John L. Grubba and James C. Barbaresso; IVHS Review, Summer, 1994.
2. Mn/DOT Freeway Operations Program Status Report, October, 1994.
3. Information provided by Jon Krieg, City of Abilene, TX.
4. "Results of the Trav-Tek System Evaluation," Joseph L. Peters and Frank J. Mammano;
Proceedings of the First World Congress on Applications of Transport Telematics and IVHS.
5. VORAD Collision Warning Radar, J.D. Walk, VORAD Safety Systems, Inc., IEEE International Radar Conference, May 8-10, 1994.
6. Oklahoma Turnpike Authority - Pike Pass Facts and Action, report by John Scott, 12-27-93.
7. AVL On Time Performance, Baltimore MTA by David Hill, 4-14-93.
8. Interview with Delores Brehm, Superintendent of Schedules, Kansas City Area Transportation Authority, January, 1995 and "ITS Technology in Public Transit - Deployment and Benefits," ITS America report by W.S. Jones, 2-27-95.
9. Interview with N. Melnyck, Manager, Corporate Planning, Toronto Transit Commission, December, 1994.
10. Confidential source.

March 7, 1995

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e-mail: shay@spaceworks.com

International ITS Information Clearinghouse
Fact Sheet #8
The National Automated Highway System Consortium
Revised 8/15/95

Mission Statement:

The National Automated Highway System Consortium (NAHSC) mission is to specify, develop and demonstrate a prototype automated highway system (AHS) by the year 2002. The prototype AHS will provide fully automatic vehicle operation in dedicated lanes to make travel safer and more efficient, improve the mobility of people and goods, increase the productivity of surface transportation and contribute to a better quality of life. It will facilitate intermodal travel while accommodating transit, commercial and private vehicles, and contribute to a better environment.

The AHS specifications will provide for progressive deployment tailored to meet regional and local transportation needs. The Consortium will seek opportunities for spin-off vehicle and highway automation technologies to achieve early benefits for all users of the U.S. surface transportation system.

The Consortium is committed to achieving a national consensus on major AHS decisions by engaging public and private stakeholders in the definition, development and evaluation of an automated highway system that is technically, economically and socially viable.

Core Participants:

- ! Bechtel Corp.
- ! Caltrans (California Department of Transportation)
- ! Carnegie Mellon University
- ! Delco Electronics Corp.
- ! General Motors Corp.
- ! Hughes Aircraft Co.
- ! Lockheed Martin
- ! Parsons Brinckerhoff

..... ! The University of California Partnership for Advanced Transit and Highways (PATH) :
 Sixth Annual ITS America Meeting ! April 15 - 18, 1996 ! George R. Brown Convention Center ! Houston, Texas

Project

Appendix II: Research and Development Projects with Cost-Share Arrangements

Significant Milestones:

- ! Demonstration of technology in 1996
- ! Automated system demonstration on a test track in 1997
- ! Demonstration of a prototype system in 2002

Short-term Events:

A workshop presenting and soliciting feedback on the NAHSC Program Plan; AHS System Requirements; '97 Demonstration Plan and Concept Development and Downselection will be held in San Diego at the Sheraton Inn - Central on October 18 - 20, 1995. To register contact Jo Ann Breckenridge at (303) 977-5761.

Associate Participants (to date):

- ! Virginia Polytechnic Institute and State University (Virginia Tech) Center for Transportation Research, Blacksburg, VA
- ! The Ohio State University Center of Intelligent Transportation Research, Columbus
- ! Creative Transit Alternatives, Falls Church, VA
- ! State University of New York at Stony Brook Department of Electrical Engineering
- ! Robotic Technology Inc., Potomac, MD
- ! BRW, Inc., Phoenix, AZ
- ! CCG Associates, Inc., Silver Spring, MD
- ! Wilbur Smith Associates, Columbia, SC
- ! Daniel Consultants, Inc., Columbia, MD
- ! Oakland University, Rochester, MI
- ! ITS America, Washington, D.C.

Contact: Celeste Speier, Public Relations, NAHSC, (810) 816-3407

The International ITS Clearinghouse Fact Sheet 9 Traffic Information on the World Wide Web

Pre-Trip Travel Information systems are intended to allow travelers to access a range of multimodal transportation information at home, work, and other major sites where trips originate. These systems may include information on transit routes, schedules, transfers, and fares; intermodal connections to rail or other transportation systems; access to ridematching services; updates of traffic and highway conditions; real-time information on incidents, accidents, road construction, alternate routes, traffic regulations and tolls; measured and predicted congestion and traffic speeds along specific routes; parking conditions and fees; availability of park-and-ride facilities; tolls; special event information; and weather information.

As envisioned in the National ITS Program Plan, Pre-Trip Travel Information systems will become a part of wider information services that appeal to a range of consumer needs in addition to transportation. As services such as interactive television and the National Information Infrastructure (specifically, the Internet) evolve, Pre-Trip Travel Information systems will complement other home information networks such as home shopping, banking or educational services. This Fact Sheet lists a sample of the traffic information services available on the World Wide Web (WWW). Because of the way the WWW is structured (users can move around various Web sites using pre-established links) the information described here may be accessed from a large number of web pages. Whenever possible, originating addresses are noted here.

1.0 Southern California Real-time Traffic Reports

The Southern California Area Traffic Report is an experimental public service and joint effort between Maxwell Laboratories and the California State Department of Transportation to provide real-time freeway traffic information to homeward bound commuters in their offices via the Internet. Current information includes traffic reports for San Diego, Los Angeles, and Orange Counties. Users are invited to post information on local traffic conditions in other cities world wide. The page also links user to a wide range of transportation information resources.

Address: <http://www.scubed.com/caltrans/transnet.html>
For information: S-Cubed, 3398 Carmel Mountain Road
San Diego, CA 92121-1095

2.0 City of Anaheim Traffic Management System

The City of Anaheim Traffic Internet Information Server is operational in a beta-test mode (the address of the site is subject to change). It provides traffic speeds and road information for the local Anaheim area and Los Angeles and Orange Counties. The information is updated approximately every 1/2 minute. Detailed maps are provided for the areas immediately adjacent to Disneyland, Orange County Airport, East Anaheim, West Anaheim, and the Stadium area. Users may also access detailed maps of LA county, and LAX and the California Highway Patrol (CHP) Road Conditions Report, Weather Information, and a wide range of other traffic and travel related services. TraView, an application developed by JHK, imports sensor data from Caltrans Districts 7 and 12 and the city's street sensor network, and converts it directly into graphics displayable on a World Wide Web page.

Address: Beta test site- <http://www.ci.anaheim.ca.us>
For information: Traffic Management Center - James Paral, City of Anaheim 714-254-5183 or Mike Kruger, JHK/Anaheim 714-758-0019

3.0 Seattle Area Traffic Information:

Traffic data and a color congestion map for the Seattle Region is updated every 2.5 minutes. The color map rates traffic on major routes as Stop, Heavy, Moderate, or Light. Areas with no sensors are shown in blue; those for which no data are available are shown in gray. Maps are clearly labeled with the time the map was generated and the time at which map data was retrieved from the sensors. The map can be located at the Washington State Department of Transportation Home Page. A Construction Update, using data less than five minutes old, is also available. A software page "Webflow" is available that will allow users to access data directly by clicking on individual section of the roadway.

Address: <http://www.wsdot.wa.gov/regions/northwest/nwflow/>
For Information: Mike Forbis or Mark Butler
(TRAFFICMASTER@WSDOT.WA.GOV)
Phone: 206-440-4475
FAX: 206-440-4804

4.0 Houston Area Real-Time Traffic Report

The Greater Houston Transportation and Emergency Management Center provides real-time traffic conditions information for the Houston region. Probe vehicles are used to estimate travel speeds. Speed ranges are displayed on a color map for I48, SR 59, I 10, I610, Sam Houston, and portions of Highway 6 and FM 1960. Map data is updated approximately once a minute.

Address: <http://herman.tamu.houston.real.html>

5.0TRANSCOM Travel Advisory

The TRANSCOM Travel Advisory includes general travel advisories for major routes in and through New York City, New Jersey, Westchester & Rockland Counties in New York State, Long Island, and Connecticut. General advisories are also provided for area Transit Systems.

Information is delivered weekly to subscribers through an E-mail discussion group, however, a number of WWW pages have incorporated these reports. The information included in the TRANSCOM Travel Advisory is primarily special events, construction activities, and other non-recurrent disruptions.

Mail list address: i95berniew@aol.com
For Information: Bernie Wagenblast
TRANSCOM
111 Pavonia Avenue
Jersey City, NJ 07310-1755
201-963-4033
Fax 201-963-7488

Other Interesting Places to Look:

Transportation Resources- maintained by the Intelligent Transportation Systems Program at Princeton University. *Address:* <http://dragon.princeton.edu/~dhh/systems.html>

Galaxy Transportation-Engineering and Technology-Transportation.

Address: <http://galazy.einet.net/galazy/Engineering-and-Technology/Transportation.html>

Related fact sheets:

Fact Sheet #10: Multimodal Transit Information on the World Wide Web

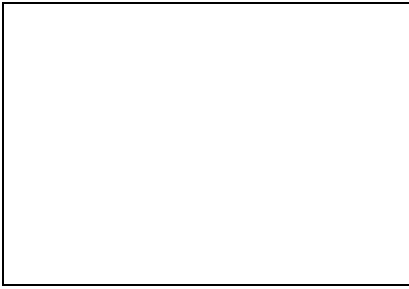
Fact Sheet #11: Traveler Services Information on the World Wide Web

Fact Sheet #12: Commuter and Intercity Traveler Information on the World Wide Web

Fact Sheet Author:

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Date: August 11, 1995



The International ITS Clearinghouse Fact Sheet 10

Multimodal Transit Information on the World Wide Web

Pre-trip travel information systems allow travelers to access a range of multimodal transportation information at home, work, and other major sites where trips originate. These systems provide timely information on transit routes, schedules, transfers, and fares; and on intermodal connections to rail or other transportation systems. Pre-trip travel information also includes updates of traffic and highway conditions; real-time information on incidents, accidents, road construction, alternative routes, traffic regulations, tolls, and other information a traveler needs to make mode and route decisions.

The INTERNET and the World Wide Web (WWW) are part of the National Information Infrastructure. The Internet allows computer users across the globe to easily access information on a wide range of subjects. In the past two years, INTERNET and WWW use have skyrocketed as a growing number of home and office users gain access. Consequently, a number of transit service providers have recognized the WWW's potential utility in disseminating pre-trip transit information.

The following list includes a cross-section of examples of how transit can be disseminated on the Internet. Some web sites are sponsored by transit organizations or local governments. In some cases, the information is provided by volunteers. The last three services listed here are an interactive "route finder" services. These services are generally provided for cities with very dense transit networks, providing a number of possible transit routes to a single station or location. The listings below were up to date as of July 25, 1995. See the list of related Fact Sheets at the end of this document.

1. Riderlink: Transportation Options for Central Puget Sound

Riderlink is a joint project between Metro Transit in King County, Washington and the Overlake TMA. This service provides electronic access to information on bus routes and schedules, rideshare and carpool information, on-line ridematch applications, bicycling information, ferry routes and schedules, and information about employer transportation programs (at kiosk sites only). Riderlink is also accessible at a few kiosks.

Address: <http://transit.metrokc.gov/>

For Information: Catherine Bradshaw (catherine.bradshaw@metrokc.gov)
206-684-1770

2. San Francisco Bay Area Transit Information

The Transit Information Project is a public service of **Students Improving Campus on-line Services** from the University of California at Berkeley. This site includes route, schedule, and fare information for at least twenty transit providers throughout the bay area, as well as transportation related regional information and announcements. Transportation service providers include bus, BART, and ferry services covering most of the San Francisco Bay Area region.

Address: <http://server/berkeley.edu/transit/carriers/>
For Information: Daniel Gildea (gildea@pasteur.eecs.berkeley.edu)
 Mikael Sheikh (sheikh@server.berkeley.edu)

3. Stockholm Subway

This site provides route and schedule information for the Stockholm Subway System. It also links to the Subway Navigator (described below), which provides route alternatives and travel times.

Address: www.sunet.se/stockholm/sl/sl.html

4. The New York City Subway System

This service is part of a series of pages titled **A Paperless Guide to New York City**. This page is part of a series of New York City Transit Authority maps for downtown Manhattan, Midtown Manhattan, Upper Manhattan, and North Manhattan. The maps, presented in color, show service times (part-time or full-time), stops and transfer points.

Address: <http://www.mediabridge.com/nyc/transportation/subways/picker.html>
For Information: nyc@mediabridge.com

5. Welcome to Union Station- The L.A.Rail Transit Web site

This page provides route, schedule, and fare information for the growing rail transit network in Los Angeles. It also provides information on AMTRAK lines serving Los Angeles including: The San Diegans, the Coast Starlight, the Dessert Wind, and the Southwest Chief.

Address: <http://ucs.usc.edu/~ertrinidad/larail.html>
For Information: Elson Trinidad (etrinidad@scf.usc.edu)

6. Pittsburgh Transit Guide

The site will route and schedule information for Pittsburgh neighborhoods; as well as general information on Pittsburgh Area Transit (PAT) including riding instructions, fares, and equipment.

Address: <http://transit.dementia.org/transit-guide>

For information Derrick J. Brashear <db74+@andrew.cmu.edu>

7. Paris Metro

Contains full color maps, schedules, and fare information for the Paris Metro, the RER and buses. This page also links to the Subway Navigator (described below), which provides route information. This information is part of an extensive set of files on the Paris area.

Address: <http://www.paris.org/metro/>

For Information: Norman Barth (Norman@ucsd.edu)

8. Delaware Administration for Regional Transit Schedules

The DART First State Page provides information on regularly scheduled transit services within the state of Delaware. This page includes DART fare, route, and schedule information, and a DART system map.

Address: <http://www.dtcc.edu/dart/>

For information: webmaster@www.dtcc.edu

9. Transportation in Portland (Oregon)

This page provides information in public and private transportation alternatives. Transit information is provided for the Tri-Met and MAX Light Rail Services, as well as for the "Fareless Square" area, the Portland Transit Mall, and the Tri-Met Cultural Bus. The page also includes information on taxi and limousine services, biking, car rentals, and Amtrak train service.

Address: <http://www.teleport.com/~peekpa/transport.html>

For information: Michael Cox, Peek & Associates, Inc.
(MCox@AOL.com or Peekb@teleport.com)

10. Subway Navigator

Finds subway routes and information for approximately 30 cities internationally. Users enter origin and destination stations, and the system provides travel time and transfer instructions. A list of station names is included for most of the cities.

Address: <http://metro.jussieu.fr:10001/bin/cities/english>

For information: Pierre David (Pierre.David@Prism.uvsq.fr)

11. London - WWW Tube Journey Planner

This page contains journey planning software which provides travelers with routing operations through the London Underground. Users enter their origin station and destination station, and the system provides route information (including transfer stations). Additional software is available that calculates travel distance.

Address: <http://www.cs.ucl.ac.uk/misc/uk/london/tube/index.html>
For information: Martin Smith (msmith@lssec.bt.co.uk)

12. New York Street Locator

This page contains software that provides users with a map from any street address in New York City to/from the closest subway station.

Address: <http://www.mediabridge.com/nyc/locator>
For information: Barry Krusch (address available on-line)

13. Other Interesting Places to look for related information:

Tokyo - <http://neoteny.eccosys.com>
Berlin - <http://www.informatik.hu-berlin.de/Berlin/verkehr> (in German)
Munich - <http://www.fast.de/wegbeschreibungE.html> (in English)
Transit info <http://www.reed.edu/~reyn/transport.html>
Links to subways and other transportation information.
<http://www.reed.edu/~reyn/transport.html>

Related Fact Sheets:

Fact Sheet 9: Traffic Information on the World Wide Web

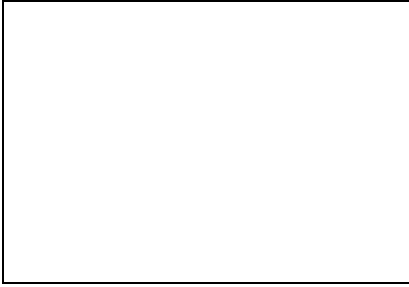
Fact Sheet 11: Traveler Information and Electronic Yellow Pages on the World Wide Web

Fact Sheet 12: Commuter and Intercity Rail Information on the World Wide Web

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The International ITS Clearinghouse Fact Sheet 11 Traveler Services Information on the World Wide Web

As envisioned in the National Program Plan for ITS, the Traveler Services Information user service provides the traveler with access to information regarding a variety of travel-related services and facilities. This information, sometimes referred to as "electronic yellow pages" is intended to provide quick access to services in the local vicinity of the traveler. Traveler services information may be accessible to the traveler in the home or office to support pre-trip planning and while en-route, either in a vehicle or at public facilities such as public transit terminals or highway rest stops to help the traveler locate critical local services.

The INTERNET and the World Wide Web (WWW) are part of the National Information Infrastructure. The Internet and WWW allow computer users around the globe to easily access information on a wide range of subjects. In the past two years, INTERNET and WWW usage have skyrocketed, as a growing number of home and office users gain access.

A large number of sites offer traveler services information on the WWW. The following list includes a sample of WWW "pages" that either present this information or organize and link to information provided by others. These web sites are sponsored by a wide range of organizations including Chambers of Commerce, tourist bureaus, state/local governments, and non-profit organizations. In some cases, the information is provided by volunteers. In all cases, the pages link to other pages of interest to their readers. For example, the page for Steamboat Springs Colorado provides information on services available in Steamboat Springs and is also linked to information on weather conditions, ski conditions for the State of Colorado, and road condition information.

The listings below were up to date as of July 25, 1995. See the list of related Fact Sheets at the end of this document. There may be overlap with information provided by the pages listed on Fact Sheets 9, 10, and 12.

1. California Yellow Pages - The California Virtual Tourist

This web site focuses on information of interest to tourists and residents in California. The main headings include retail business, internet services, companies, media, and organizations. The retail business yellow pages contains information directly relevant to travelers, including entertainment, shopping, and personal services.

Address: <http://www.research.digital.com/src/virtual-tourist/california.html>
For information: Steve Glassman (steveg@pa.dec.com)
Digital Equipment Corporation

2. The Paperless Guide to New York City

The Paperless Guide contains a wide range of information of value to travelers and visitors in New York City. Listings include: shopping, dining and restaurants, hotels, museums and other places of interest. The page also links to information on ground, air, and water transportation and provides toll information for most bridges and tunnels.

Address: <http://www.mediabridge.com/nyc>

3. The PARIS Pages

The Paris pages provide an extensive range of information to travelers visiting Paris. Information is provided on the public transportation system (Metro/RER,Buses), monuments and museums (including maps, entrance fees, and hours), schools and universities, and other locations of interest. It also links to several journals (including one devoted to the culinary arts), a listing of cafes, special expositions, and a listing of shops and stores.

Address: <http://www.paris.org/metro/>
For Information: Norman Barth (Norman@ucsd.edu)

4. National Parks

This site provides visitor information for all the National Parks in the United States. Parks can be located by state, region, theme and park name. Information included varies depending on the size and location of the park, but generally includes camping regulations and availability, travel directions, transportation alternatives, services offered, and general park regulations. The HomePage includes a Virtual Visitor Center, which provides a general introduction to the National Parks System.

Address: <http://woodstock.rmro.nps.gov/index.html>

5. City.Net

City.Net provides links to information on over 800 communities in 251 countries. Most of the information linked to this page is provided by the cities and countries themselves; City.Net serves as the focal point for potential users. The information available for each location varies, however, most include information on transportation to and within the city, entertainment, hotels and accommodations, parks and sights of interest, local business, and government/community services.

Address: <http://www.city.net>

6. USA Citilink Project

Citilink provides links to tourist and travel information for a large number of cities, towns, parks, and entertainment providers in each of the fifty states. As with City.Net, the individual pages are maintained by others, Citilink provides a focal point for users. The information available for each location varies, however, most include information on transportation to and within the city, entertainment, hotels and accommodations, parks and sights of interest, local business, and government/community services. The page for San Diego is a good example (http://www.nosc.mil/planet_earth/sandiego.html)

Address: <http://www.NetSoft.com/citylink/>

7. **Transportation- For the 1996 Olympics in Atlanta**

This page provides transportation information for visitors to Atlanta during the 1996 Olympics. It includes an overview of MARTA, how the transportation system for spectators will work, the cost of Olympic events, service availability, paring (or lack thereof), passenger load factors, disabled access, walking, getting to the Atlanta area, and getting to other venue cities. More specific transportation information (e.g. bus and MART routes and schedules are listed in the general pages for Atlanta.)

Address: www.atlanta.olympic.org/travel_info/transport.html

I-95-Net (Virtual Interstate)

This page organizes and presents travel services related information (including lodging, sights to see, activities, travel distances, and food) for cities and counties along the I-95 Corridor.

Address: <http://interstatelink.com/isl/i95/i95-us.html>

The Appalachian Trail

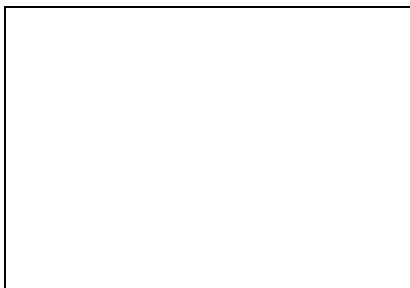
While the Appalachian Trail is intended for foot traffic, it represents an excellent example of how information from a range of states can be organized and presented for the traveler. The trail passes through fourteen states. The main page provides general information on each state and links to user to information regarding the terrain, accommodations, services, and other information required to plan a trip along some part of the trail.

Address: <http://www.fred.net/kathy/at/atstate/html>

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The International ITS Clearinghouse Fact Sheet 12 Commuter and Intercity Passenger Rail Information on the World Wide Web

The following entries represent a sample of the resources related to commuter rail and intercity passenger rail available on the World Wide Web. Some of these sites deal exclusively with rail maps and schedules; others incorporate information on rail technology and operations. Some of the web pages are maintained by the rail service provider; others are maintained outside organizations, sometimes on a volunteer basis. Please see Fact Sheet #10: Multimodal Transit Information on the WWW for listing on a number of related and overlapping sites.

These listings were accurate as of July 27, 1995. New pages may be added, old ones may move or disappear from the WWW.

1. Amtrak Information on the World Wide Web

Amtrak information is provided from two locations; on Amtrak's Homepage, and through the Cyberspace Railway. Amtrak's pages provide information on routes (no schedules), packages, sightseeing, and other information. The Amtrak Schedules page is a collaborative venture of The Railroad List (railroad@cunyv.cuny.edu) provided by the Cyberspace Railway (listed below). The Amtrak Schedules page provides route and schedule information. Color maps available for the United States, and for regions of the United States.

Address: Amtrak Home Page <http://www.amtrak.com>
Amtrak Routes/Schedules: <http://www.mcs.net/~dsdawdy/Amtrak/amtrak.html>

2. Alaska Railway Information

This site contains information on rail services, as well as rail and cruise excursions in Alaska. Information is presented primarily for recreational travelers and tourists.

Address: <http://alaskan.com/akrail.html>

3. Canadian Passenger Rail Services Home Page

The Canadian Passenger Rail home page provides an index to timetables and operational and equipment descriptions for all passenger rail services in Canada. The contents of these pages were developed by rail enthusiasts and have not been authorized by the companies themselves.

The information provided is useful to commuters, as well as tourists and visitors to Canada. Information is organized by railway, province, regions, equipment types, and other categories. Some items of special note include the following: Information for Go-Transit (including information on handicapped access and equipment cycles); connections for travelers between the Via Trains and Prince Edward Island buses are described; and information on VIA rail in English and French.

Address: <http://www.mcs.net/~dsdawdy/Canpass/canpass.html>
For Information: Chris Roberts (aa633@cfn.cs.dal.ca)

4. Chicago Metra Commuter Rail System

The page includes general information on Metra, a Metra Fare Map, color route maps, and schedule information for Metra routes. The Cyberspace world Railroad (see listing below) has entered Metra schedules. All information has been entered and is maintained by the Cyberspace World Railroad (see listing below).

Address: <http://www.mcs.net/~dsdawdy/Schedule/schedule.html>

5. Delaware Area Association of Rail Passengers

This site maintains listing on a number of commuter and intercity rail services. These include: Northeast corridor commuter trains (including those in the Washington DC/Baltimore region, PATCO information, New Jersey Transit trains, DART service in Wilmington, Delaware, and information on going to New York City via SEPTA and NJT.

Address: <http://libertynet.org/~dvarp/schedule.html>

Rail Resources

The following pages provide links to a wide range of rail oriented information including: international routes and schedules; technical information (i.e. equipment rosters, color schemes); and recreational and hobbyists information. A visit to the pages in this section virtually guarantees introduction to most of the rail-oriented WWW resources, including those addressing traveler information.

5. Cyberspace World Railroad

Address: <http://www.mcs.net/~dsdawdy/cyberoad.html>
For Information: Daniel S. Dawdy (dsdawdy@mcs.com)

6. The Virtual Railroad

For Information Yves Beaudoin <ybeaudoi@gpu.srv.ualberta.ca>
Address: http://gpu.srv.ualberta.ca/~ybeaudoi/Virtual_railroad/atlas.htm
http://www.ualberta.ca/~ybeaudoi/Virtual_railroad/home.htm

7. The European Railway Server

For information:

Address: <http://mecurio.iet.unipi.it/home.html>

International Rail Timetables and Information

Australian Rail <http://www.monash.edu.au/ccstaff2/che/bromage/WWW/tt>
<http://www.monash.edu.au/nfs/ccstaff2/ccstaff2/che/bromage/WW>

W/tt

Belgian Railways <http://www.win.twe.nl/win/cs/fm/laan/nmbs>

Dutch Railways <http://mecurio.iet.unipi.it/nsinfo.html>

Eurostar (Chunnel) Trains <http://www.iihe.ac.be/hep/pp/evrard/eurostar.html>

Finnish Railways: <http://www.hut.fi/~ovr/VR-e.html>

German Railways: <http://r2stud1.R2.uni-karlsruhe.de/~uie3>
http://www.bahn.de/index_e.html

Norwegian Railways <http://pc7kihino/timetable/index/html>

Swedish Rail <http://www.dvcs.uu.se/%7Erolandb/SJ/index.html>

Poland <http://www.oa.uj.edu.pl/warcrac.html>

Related Fact Sheets:

Fact Sheet 9- Traffic Information on the World Wide Web

Fact Sheet 10 - Multimodal Transit Information on the World Wide Web

Fact Sheet 11 - Traveler Services Information on the World Wide Web

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Appendix IV

ITS Core Infrastructure

- 1. ATMS/ATIS Infrastructure Summary Description**
- 2. Model Deployment for National CVO Core Infrastructure**

ATMS/ATIS Infrastructure Summary Description

1. Introduction

Many of the functions needed for Intelligent Transportation Systems (ITS) are already being provided or supported by a broad variety of core infrastructure systems or features, which can serve as the building blocks of a full ITS implementation. The core infrastructure refers to those portions of ITS-related hardware, software, services, etc. that today, and increasingly in the future, will manage and support the transportation-related activities in metropolitan areas.

The core infrastructure is generally provided by the public sector, either alone or through partnership with the private sector. The private sector may build upon this core to provide additional, value-added services. The ATIS/ATMS core infrastructure is the basic set of hardware, software and related activities that support the functions of traffic management and control, transit management, incident management, fare/toll payment, and the provision of pre-trip and en-route traveler information. ITS involves applying current and evolving technology to transportation systems and the careful integration of system functions to provide efficient and effective solutions to multi-modal transportation problems. Benefits are derived both from the ability to upgrade system functions with new system components and technologies in a modular fashion and by increasing the level of integration and coordination of system functions and activities across jurisdictions, agencies, and the various core infrastructure systems.

Implementation of the core infrastructure features permits efficient operation and management of roadway and transit resources through the integration and use of currently available technologies and with strengthened institutional ties and inter-jurisdictional/interagency coordination. In the near-term, implementation of the core infrastructure features is expected to be led by the public sector, and development of new and/or enhanced capabilities is expected to occur in an evolutionary manner. However, private sector participation is highly encouraged, and appropriate partnership opportunities should be actively sought by State and local implementing agencies. Maturation of the core features in metropolitan areas can be expected to drive private sector development of new/advanced products and industries to provide future ITS user services.

2. ATIS/ATMS Core Features

A. Overview

Seven separate ATIS/ATMS core infrastructure features, for metropolitan areas, are described in the following sections. The features are basic ITS capabilities which are currently available for deployment or are already in operation. These features represent the basic building blocks that will support the deployment of advanced ITS capabilities. It must be emphasized that while significant benefits are derived from the seven individual infrastructure features, even greater benefits can be shown when these features are integrated and operated in a coordinated fashion throughout the metropolitan area or region of interest. Benefits include, but are not limited to, transportation system operating efficiency, personal time savings and productivity increases, environmental (emissions reduction, etc.) and safety improvements. Other benefits will be derived in terms of implementation cost and accelerated deployment potential when open systems standards are applied and when modular systems approaches are followed in the implementation or enhancement of the core infrastructure. The core infrastructure features are defined as follows:

1. Multimodal Traveler Information System(s) (MTIS)
2. Traffic Signal Control System(s)
3. Freeway Management System(s)
4. Transit Management System(s)
5. Incident Management Program
6. Electronic Fare Payment System(s)
7. Electronic Toll Collection (ETC) System(s)

Core infrastructure features support the provision of ITS User Services as identified in the ITS Program Plan and related documents. However there is no direct one-to-one relationship between infrastructure features and the User Services discussed below. To address this issue the following descriptions will briefly discuss the basic functions performed by the infrastructure features (either separately or in combination) and the potential benefits provided. Infrastructure functions (or functional areas) include the following areas: traffic surveillance, information fusion, traffic signal control, variable message (fixed) signing or sign-post/beacon support for in-vehicle signing, fare payment and toll collection, as well as the provision of pre-trip and enroute traveler/driver information.

Each core infrastructure feature is further described in terms of target capabilities which are expected to be available and implemented within the next 15 years. Many of the additional ITS capabilities to be provided over this time frame will be achieved through the successful integration of specific infrastructure features and through the evolutionary upgrade of existing systems and subsystems. The ability to make modular upgrades and improvements to existing systems is critical to the overall success of ITS. Open standards and design modularity are expected to provide payoff in the future in terms of ease of upgrade and in minimizing upgrade or replacement costs. These infrastructure features will be enhanced and integrated within the overall framework provided by the ITS National Architecture as currently being defined.

B. ITS National Program Plan and the ITS User Services

The National ITS Program Plan was published in early 1995 to serve as a guide for the development and deployment of Intelligent Transportation Systems (ITS) in the United States. This plan identifies the numerous activities which must be accomplished to support the successful deployment of ITS. The plan provides an overall framework within which both the public and private sectors can work together as partners in this effort.

The plan also identifies a set of 29 user services (or capabilities) considered key to addressing surface transportation-related problems within our society. These user services are grouped into seven inter-related bundles each with a specific focus. They are identified below, along with the specific user services each comprises. The core infrastructure features are intended to support these user services through the deployment and integrated operation of enabling systems. Of the seven bundles, five are closely associated with the topic of this paper. The five user service bundles related to the ATIS/ATMS Core Infrastructure are highlighted below. In addition to the five service bundles, the user service Hazardous Materials Incident Response, under the CVO service bundle, is also highlighted because it is addressed (in part) through the ATIS/ATMS core infrastructure.

1. Travel and Transportation Management

- C En-Route Driver Information
- C Route Guidance
- C Traveler Services Information
- C Traffic Control
- C Incident Management
- C Emissions Testing and Mitigation

2. Travel Demand Management

- C Demand Management and Operations
- C Pre-Trip Travel Information

- C Ride Matching and Reservation

3. Public Transportation Operations

- C Public Transportation Management
- C En-Route Transit Information
- C Personalized Public Transit
- C Public Travel Security

4. Electronic Payment

- C Electronic Payment Services

5. Commercial Vehicle Operations

- C Commercial Vehicle Electronic Clearance
- C Automated Roadside Safety Inspection
- C On-board Safety Monitoring
- C Commercial Vehicle Administrative Processes
- C **Hazardous Materials Incident Response**
- C Freight Mobility

6. Emergency Management

- C Emergency Notification and Personal Security
- C Emergency Vehicle Management

7. Advanced Vehicle Control and Safety Systems

- C Longitudinal Collision Avoidance.
- C Lateral Collision Avoidance
- C Intersection Collision Avoidance
- C Vision Enhancement for Crash Avoidance
- C Safety Readiness
- C Pre-Crash Restraint Deployment
- C Automated Highway System

While the elements of the core infrastructure may appear more closely associated with certain traffic control, public transportation, and emergency management services in the above list, every user service that is highlighted is dependent upon the core infrastructure in a significant manner. The following sections of this paper describe the ATIS/ATMS core infrastructure features, how these features (or their future enhancements) support the provision of user services, and the benefit areas (or mechanisms) that are anticipated. A more thorough description of ITS benefits can be found in the referenced paper (MITRE MP 95W0000192, June 1995, Donald L. Roberts and Dwight E. Shank).

C. Relationship to the ITS National Architecture.

The National ITS Architecture program, currently in its second phase, is in the process of defining a National ITS Consensus Architecture. When this program is completed in mid-1996 it will provide additional guidance on

how individual core infrastructure features should interact to perform necessary ITS functions. The architecture is considered a broad framework that identifies functions, subsystems, and data flows necessary to support the various ITS services. It is being defined to provide an overall structure within which the existing core infrastructure systems, subsystems, and future extensions, capabilities, and add-ons will operate. The architecture will provide the technical guidance needed to implement and integrate the various core infrastructure systems and features. It is national in scope, in that critical system elements, functions and interfaces are intended to operate and interact seamlessly throughout the country and potentially across international borders, with Canada and Mexico.

3. Multimodal Traveler Information System(s) (MTIS)

A. MTIS Description

Metropolitan areas generally consist of multiple local jurisdictions and state level organizations each responsible for providing some level of traffic surveillance, management, and control. There is a need for a centralized source of roadway and transit information to provide a comprehensive and integrated view of the road and traffic conditions throughout the metropolitan area or region. Potential users of this information include both the end users; the travelers, traffic managers and transit operators, private sector transportation-intensive businesses; and the private sector value added resellers of the information and related traveler services.

The information repository may be either a centralized or an inter-connected set of data management facilities that directly receive roadway and transit information from the various roadway surveillance systems and other information sources, either public or private. The MTIS will have the capability to combine the data from the various sources, package the data in a variety of formats, and provide the information to the users through different distribution channels, such as telephone voice and data services, radio and TV broadcasts, kiosks, computer-based (e.g., Internet) services, etc. Various options exist for either public or private sector distribution of MTIS data.

The MTIS is considered a key feature of the core infrastructure in that it will be the focal point for information collection and dissemination. The information may be provided both directly to the public and to private sector Information Service Providers (ISPs) that will supplement it with additional information, features, and services, and market the enhanced service products. The MTIS will link data from the other core infrastructure features into a comprehensive regional information system, thereby facilitating the timely distribution of critical travel-related information to the traveler and transportation-related commercial users. MTISs do not currently exist, although the concept is currently being

implemented under several ITS Operational Tests. Mechanisms for collecting the critical travel-related data from various sources, fusing those data into meaningful and usable information and disseminating that information to the end-user are being developed. This will result in a capability to provide travelers and other users with accurate and timely data regarding transit status and schedules as well as traffic, roadway, and other travel-related conditions.

B. MTIS Benefits

The MTIS will provide part of the mechanisms for the sharing of regional traveler and traffic related information among the transportation managers and the travelers/drivers who are the end users of this information. This process will permit the traveler to either adjust travel schedules or mode choice, in response to the information being provided. In addition, the MTIS will facilitate the sharing of information and coordination of traffic control and incident response actions both within jurisdictions and across neighboring jurisdictional boundaries in the metropolitan area. These capabilities will produce important benefits in the travel efficiency and safety areas.

C. MTIS Target Deployment

The MTIS will be capable of providing automated feeds of traffic, transit, and other transportation-related information to the appropriate distribution channels. Basic information may be made available directly to communications outlets, such as Highway Advisory Radio (HAR), while specialized feeds to users will be provided by private sector information service providers. The type and volume of information can be tailored to the user population, the type of distribution media that is employed, and the user's special devices (e.g., pagers, radios, telephone, in-vehicle navigation devices, etc.) for receiving and displaying that information. A key capability within the MTIS will be the automated handling of real-time traffic and transit information, to reduce delays in disseminating critical traveler information to the end user. The MTIS or its derivative (ISP) services will also support the collection and dissemination of real-time link travel time data, whereby vehicles equipped with navigation and route guidance equipment will report link travel time to the MTIS (using Cellular Digital Packet Data (CDPD) or other mobile data communications services) and in turn the MTIS will broadcast this information to all equipped cars via a wide-area broadcast system such as an FM Subcarrier channel. Provision of real-time traffic information will require automated input and processing of data from the various traffic surveillance systems, as well as relevant information collected from manual sources such as cellular phone call-ins and reports from police and roadway maintenance activities.

The MTIS will also support inter-jurisdictional coordination involving activities such as incident response, special traffic control, or vehicle rerouting actions that impact large segments of the metropolitan area (i.e., HAZMAT incident response, special events, weather-related or maintenance operations, etc.) Managers of the traffic network, as well as the organizations responsible for incident/emergency response and maintenance, will be able to share data and more efficiently coordinate plans, assisted by common access to the information within the MTIS databases.

Information distribution channels will include telephone, TV, Kiosks, radio (standard AM/FM and specialized subcarrier), HAR/AHAR, etc. as implemented by private or public sector information and service providers.

The MTIS will provide/support a level of data integration (fusion) to clearly reflect the status of the road network (travel times, environmental conditions, special events or conditions, etc.) and transit schedule information. In more advanced systems, real-time traffic modeling capability will permit the near-term projection of traffic conditions in response to incidents and/or special traffic control activities.

D. Projects and Activities Related to MTIS Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- C TravInfo,
- C TransCal,
- C Swift,
- C Minnesota Guidestar Projects,
- C Atlanta OPTEST,
- C Houston Intelligent Transportation System (HITS) including the Houston Transportation and Emergency Management Center
- C Montgomery County Traffic Management Center, Montgomery County, Maryland

4. Traffic Signal Control System

A. Traffic Signal Control System Description

Current state-of-the-art traffic signal control systems have the capability to dynamically modify the signal timings in response to changing traffic

demand and to coordinate operation between adjacent signals to maximize the roadway (network) throughput. Coordination of adjacent signals allows the traffic manager to establish green wave timing, in which vehicles can move through selected portions of the traffic network with less delay. At a minimum, these coordinated signal control systems can provide for the selection of several time-of-day or special signal timing patterns that can optimize operations along major arterial routes and over traffic networks. The capability to adjust the traffic signal timing includes computer-generated timing plans and supports manual operation by a skilled and knowledgeable operator when required. The "open architecture" hardware/software systems are designed to be upgraded in capability, enabling relatively inexpensive installation of improved products. This open architecture approach also supports the potential extension and integration of capabilities, such as the coordinated operations with adjacent freeway and arterial systems.

To be effective, advanced signal control systems require an accurate current picture of the traffic loading and status on the traffic network. This information will consist of real-time inputs from traffic sensors (magnetic loops, video cameras, etc.), status and incident reports from police and cellular call-ins, etc. Historical demand information, such as time-of-day specific data, would at a minimum, permit the establishment of separate time-of-day signal control strategies.

The various jurisdictional systems should be capable of electronically sharing traffic flow information with the signal systems of adjoining jurisdictions in order to provide metropolitan-wide signal coordination. This information sharing supports coordination of traffic signal systems along major corridors, and results in smooth traffic flows across jurisdictional boundaries.

B. Signal Control Systems Benefits

Traffic flows will be smoothed by the use of coordinated traffic signals on major arterials. Overall network efficiency and throughput can be increased dramatically by these traffic control techniques. Emergency response can also be expedited through centralized, coordinated control of the signals. Signal preemption may also be used in selected situations to improve transit system performance, by extending green cycles to permit transit vehicles to maintain their schedules.

C. Signal Control Systems Target Deployment

Advanced capabilities are characterized by the deployment of adaptive/predictive traffic management systems that can quickly react to new traffic situations and implement new signal timing plans based upon a current view of roadway and traffic conditions as well as the predicted

conditions expected under the new signal timing plan in a 30-60 minute period.

Advanced traffic/network simulation models and signal control algorithms combined with more complete and accurate surveillance data will allow the traffic manager to react to incidents and other traffic flow anomalies quickly and appropriately. Traffic signal control, in this time-frame, involves the integration of advanced surveillance systems with control and short-term forecasting algorithms and support systems that will facilitate traffic management functions. The traffic manager will be supported by data fusion algorithms combining surveillance data from various sources, with historical (time-of-day) information to present a clear picture of the current roadway and traffic situation. In conjunction with the facilities of the MTIS, the target deployment of signal control systems will establish the mechanisms for regional coordination of traffic management functions among adjacent jurisdictions and will facilitate incident/special event management and response.

The traffic management capabilities will be modular to permit enhancement and evolutionary growth without the need to do major system replacements as new technologies and system-level capabilities are developed. Traffic signal control will also be modular and flexible so that real-time control strategies could be implemented selectively for any portion of the traffic network, as required by the conditions being experienced on roadway.

D. Projects and Activities Related to Signal Control System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- C FASTRAC-Oakland County, MI,
- C Houston Transportation & Emergency Management Center (TEMC)
- C Santa Monica, CA,
- C Montgomery County, MD

5. Freeway Management System (FMS)

A. FMS Description.

Freeway traffic managers in a metropolitan area have the capability to:

- C monitor traffic and other environmental conditions on the freeway system,
- C identify recurring and non-recurring flow impediments,
- C implement various control and management strategies (such as ramp metering and/or lane control, or traffic diversion),
- C provide critical information to travelers through infrastructure-based dissemination methods, such as variable message signs and highway advisory radio.

Methods for monitoring freeway conditions include magnetic loop (speed) detectors, video cameras (with and without signal processing capability), and microwave radar and ultrasonic speed monitors. Other sources of information on the freeway include the traditional inputs from police and maintenance personnel as well as the increasing number of cellular phone reports from drivers. As discussed later, relevant information will also be available to support incident management and congestion mitigation activities on the freeway and to coordinate these actions with adjacent traffic signal control systems. With video coverage of incidents on the freeway, the incident management agency can determine the severity and type of incidents that have occurred and can direct the appropriate resources to the scene. This will permit both faster response and better utilization of the incident/emergency response resources through a tailored response.

The freeway management system(s) include(s) a Freeway Management Center (or multiple centers when responsibility for the freeway system is shared by more than one jurisdiction) and information links to the MTIS and other transportation management and control systems in the metropolitan area. These capabilities can provide or be enhanced to provide for the coordination of emergency response and incident management, and to support the management of special-event situations. Examples of integrated/cooperative management include regular analysis and updating of control and incident response strategies and coordination with other local traffic management systems in the area for handling special events.

B. FMS Benefits

With the use of surveillance capabilities associated with freeway management systems, the freeway manager can improve incident response through rapid detection of problems that are causing congestion. Major safety benefits are also associated with the rapid detection and clearing of congestion-producing incidents on the roadway. During periods when congestion is present on the freeway the use of ramp metering access control will reduce the traffic loading on the freeway and will help to smooth traffic flow, thereby lowering the risk of accidents on the affected segments of the roadway. Another benefit of smoother traffic flow is a

decrease in most vehicle emissions relative to the congested roadway condition.

Drivers can also be alerted to the incidents and resulting traffic backups through the use of Variable Message Signs (VMS), HAR, or area-wide traffic information broadcasts. In addition to alerting drivers to problems in the roadway, the traffic broadcasts can also provide information regarding the length of expected delays and possible alternative routes to bypass the problem and minimize congestion on the roadway. To be effective this advisory and routing information must be both timely and accurate. Additional advantages can be demonstrated when management of freeways and adjacent arterials are coordinated to provide alternative routes to drivers experiencing incident-related delays.

C. FMS Target Deployment

An additional source of data on freeway travel times will be available in this period when cars equipped with navigation and route guidance equipment report link travel times to the MTIS. This information will be available to the Freeway Management Center for monitoring the travel (traffic flow) conditions. Also as described under the MTIS target deployment, link travel times based upon up-to-date information will be transmitted to vehicles equipped with route navigation and guidance systems.

D. Projects and Activities Related to FMS Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- C San Antonio, Texas, Advanced Traffic Management System (TransGuide)
- C Minneapolis, MN
- C Houston Intelligent Transportation System (HITS) Programs, Houston, TX
- C Maryland State Highway Authority- CHART Program

6. Transit Management System

A. Transit Management Systems Description

Transit fleet management systems for metropolitan areas, include hardware/software components on buses and in dispatching centers, radio communications systems, and operations and maintenance facilities and personnel. Many additional capabilities are being considered, depending upon the specific needs of the jurisdiction's fleet management system. These capabilities include automatic vehicle location, advanced voice and data communications, automatic passenger counting, driver information (voice and visual), vehicle diagnostics, geographic information system databases for schedule management and emergency response, as well as computer aided dispatching.

The advanced vehicle location systems provide reliable bus position information to the dispatcher. The dispatcher with computer assistance can compare the vehicle's actual location with schedule information to track schedule adherence and when necessary take corrective actions to either get the vehicle back on schedule or to dispatch additional resources to cover the route. In addition, any pertinent schedule information would be provided to the MTIS for dissemination in near-real-time to the traveler, either via kiosks or at home or office. Consideration also has been given to in-vehicle display of information on routes and schedules for transit passengers. Other capabilities include in-vehicle sensors to monitor information such as passenger loading, fare collection, vehicle diagnostics, etc., to support efficient management of the transit system. In the event of an emergency, the dispatcher can notify the police or other support services of the situation and direct the responding vehicle(s) to the exact location of the incident.

B. Transit Management System Benefits

Benefits will be derived from the transit system's ability to better adhere to published schedules, and to be able to recover from enroute delays through coordination with a traffic management signal control system. Improved scheduling and schedule maintenance have been credited with yielding substantial staff and equipment cost savings for the implementing jurisdictions. Providing accurate real-time schedule information to travelers will increase their feeling of security and potentially increase ridership. Traveler and transit system security is also increased by the capability of the driver to directly call for help in an emergency and by the transit operator ability to quickly locate the vehicle (using the AVL features) to facilitate police or other types of response.

Obtaining more accurate passenger loading data will permit the transit system manager to better manage resources in the system. Given a more accurate statistical picture of route and vehicle loading will permit the system operator to adjust routes and schedules to optimize service for the ridership. An overall benefit will be obtained from the integrated management of transit resources for the metropolitan area, improving the convenience to the traveler when making multimodal trips. Benefits will

also accrue when the mode shift is away from private automobile to transit or other HOV options.

C. Transit Management System Target Deployment

Target deployment will include mature implementation of the currently available position location systems, route and schedule tracking software, and schedule status information dissemination capabilities. More emphasis will be placed upon real-time display of transit schedules and transfer points at kiosks and within transit vehicles. Many of the advanced capabilities will be applied to improve transit system management (including day-to-day operations and maintenance activities).

Other capabilities of the transit system are the use of flexible routing to permit deviations from planned routes for passenger pick up and discharge.

These improved services, such as dial-a-ride, are expected to be implemented using AVL systems and computerized dispatching and schedule systems. Another key capability of the advanced transit management system will be to manage and coordinate the activities of a variety of transit (fixed-route and para-transit) and other resources (e.g., ride-share) to provide improved (demand response) service in the metropolitan area. The goal of these activities is to improve the efficiency and safety of the traveler and to make multimodal transportation resources more convenient to the traveler.

Another important aspect of transit management systems is the application of computerized maintenance and repair systems to track and manage routine servicing of transit vehicles and other required repair and maintenance activities. On-board automated diagnostic systems can provide either real-time or daily read-out of vehicle subsystem performance. This information can then be used to schedule special or routine maintenance for the vehicle. This computer-based, maintenance management capability can significantly reduce vehicle down-time and reduce the number of unexpected failures within the fleet, thereby reducing operating costs, improving service, and maintaining customer satisfaction with the transit system.

D. Projects and Activities Related to Transit Management System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- C Potomac and Rappahanock Transportation Commission-OmniRide Smart Flexroute Integrated Real-time Enhancement System (SaFIRES)
- C Denver, CO, Regional Transportation District (RTD) projects

7. Incident Management Program

A. Incident Management Program Description

Metropolitan areas currently have programs for quickly identifying and responding to incidents that occur on freeways and major arterials. The objectives are to rapidly respond to incidents with the proper personnel and equipment, to aid accident victims, and to facilitate the rapid clearance of the accident from the roadway. Timely execution of these activities will save lives while minimizing the buildup of queues and reducing the delays and frustrations of the traveling public. In this manner the involved public agencies and individuals can satisfactorily meet their requirements and responsibilities. To accomplish incident management, real-time input from the freeway and arterial surveillance systems and the agencies responsible for managing them is critical. Also, by equipping emergency response vehicles with AVL capabilities, these assets can be more efficiently managed. Assignments of response vehicles to cover reported incidents can be based on vehicle location, when, for instance, they are not at their station, and the routing of these vehicles to the incident scene can be accomplished more effectively, based upon accurate knowledge of current vehicle location. Use of a common regional digital map system by the various traffic and incident management organizations will allow the incident management team to better locate the reported incident, and will facilitate the coordination among the several agencies involved in the incident response.

The various jurisdictions and agencies responsible for operations and enforcement in the metropolitan area work together to develop policies and operating agreements that define specific responsibilities for all aspects of incident management, including detection, verification, response, clearance, scene management, traffic control, and information dissemination. These multi-jurisdictional operating agreements ensure routine cooperation, coordination and communications among all agencies, including enforcement, fire, ambulance, highway traffic control and maintenance, environmental (as well as HAZMAT response teams) and other public agencies. Improved surveillance augmented by rapid and accurate reporting of incidents, allows the rapid dispatch of appropriate equipment and personnel to the incident scene.

B. Incident Management Program Benefits

Benefits will accrue in the safety and travel efficiency areas due to the ability to quickly react to incidents, to provide aid to injured travelers, to more quickly warn other drivers on the affected roadway (this would involve coordination with the freeway and arterial traffic system managers) thereby reducing the potential for additional (secondary) accidents triggered by the congestion on the roadway. Finally the rapid response to incidents will help authorities to more quickly clear the incident from the roadway, minimizing the buildup of queues. A key problem addressed by the incident management system is the rapid and accurate assessment of the situation and the determination of the proper levels and types of equipment and personnel to dispatch to the incident scene. This problem will be mitigated by improved surveillance of the freeways and arterials, including mechanisms for quickly and safely determining the types of materials involved in HAZMAT incidents (e.g., electronic bill-of-lading or placarding with remote readout). In addition, the coordination among the numerous agencies and operations personnel to facilitate this rapid response involves many aspects of the core infrastructure described herein. This integrated view, supporting coordinated planning and actions across the infrastructure elements, is the central aspect of ITS.

C. Incident Management Program Target Deployment

In this period there will be improvements in the tracking of HAZMAT materials on the roadways, as well as improvements in the detection of and response to HAZMAT incidents. Mechanisms, such as electronic placarding, will be implemented to remotely (at a safe distance) determine the contents of a HAZMAT carrier involved in an accident, permitting a more rapid and tailored response to HAZMAT incidents.

Other incident management capabilities will include emergency vehicles equipped with navigation and route guidance equipment, use of common map database systems across all jurisdictions in the metropolitan area, and improved coordination across jurisdictional boundaries, to reduce incident response times. Surveillance coverage of the freeway and arterials will be expanded to provide better detection, classification (precise location, severity, type of vehicles involved, etc.), and response to incidents. As is the case with other core features, the target capabilities are substantially improved through closer integration of the functions performed by the traffic signal control, freeway management, and traffic information center functions, and incident management. Coordinated actions in response to the incident and the provision of real-time warnings and alternate route information will improve safety and will permit drivers to bypass the affected sections of roadway.

D. Projects and Activities Related to Incident Management System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- C Maryland CHART Program,
- C Minnesota Highway Helper Program
- C Houston Transportation and Emergency Management Center (TEMC)

8. Electronic Fare Payment System

A. Electronic Fare Payment System Description

Electronic fare payment systems will be in operation within metropolitan areas for collection of transit fares, parking lot fees, etc. The systems will include hardware and software for roadside, in-vehicle, and in-station use; and passenger/driver payment cards, which possibly would include financial and card accounting systems. Electronic fare collection eliminates the need for travelers to carry exact fare (change) amounts and facilitates the subsequent implementation of a single fare payment medium for all public transportation services.

The system could include both debit and credit card capabilities, although a card with stored-value capability is considered to be a basic requirement. Manual cash payment would continue to be supported. Where appropriate, the system would facilitate private company participation in programs where the employer subsidizes employee work-related travel on the transit system by directly depositing funds in employees' transit accounts .

B. Electronic Fare Payment Systems Benefits

Electronic fare payment systems will facilitate transit vehicle boarding by eliminating the need for exact change or manual payment. The transit operator will continue to maintain the cash fare system but there would be less expense associated with the collection and counting of receipts. Electronic fare payment systems will make the use of the public transit system more convenient to the traveler and may potentially increase traveler use of the transit system.

Electronic fare payment systems for public transit will also provide the transit manager with information regarding ridership (system usage) which will aid in managing resources (bus routes and schedules).

C. Electronic Fare Payment Systems Target Deployment

Advanced versions of the smart (payment) card will be in wide use, providing a single medium for paying travel-related fares and parking fees. Another potential capability is the advance reservation and payment for parking (or other facilities/services) prior to the start of a trip.

D. Projects and Activities Related to Electronic Fare Payment System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

C Fare media tests in Washington, DC, and Los Angeles area.

9. Electronic Toll Collection (ETC) System

A. Electronic Toll Collection System Description

Electronic payment systems are in operation within or around a number of metropolitan areas (and on segments of rural interstate systems) for automated toll collection. The systems include hardware and software for roadside and in-vehicle use, including payment cards or tags and a communications system between the vehicle and the roadside. Toll payment is processed as the vehicle passes the toll station at a safe speed (ultimately at normal highway speed), thereby decreasing delays and improving system productivity.

The system may include any combination of debit, credit, or stored value toll tag capability. ETC systems can be installed in various configurations, including mainline barrier plazas and systems where tolls are based on entry and exit points. Specific functional components of the system would include automatic vehicle identification, automatic determination of toll amount for differing classes of vehicles, automated enforcement of financial violations and flexibility in financial arrangements (e.g., prepaid debit tag, payment cards).

B. Electronic Toll Collection System Benefits

There are several major benefits derived from electronic toll collection systems, both for the driver using the toll facility and for the facility

operator. The driver would experience less delay and inconvenience at the toll collection point, since the transaction would be accomplished at normal highway speeds through an automatic debiting of the toll tag. The facility operator would require fewer manually operated lanes, hence fewer personnel would be required to operate the toll collection facilities. Savings as high as ninety percent of the cost of operating a single lane of a toll collection point (fully staffed vs. ETC technologies), have been reported by the Oklahoma Toll Authority. Additional benefits will be derived in terms of air quality in the areas adjacent to the toll facility, where the long queue build-ups, experienced with manual toll lanes, would be eliminated.

C. Electronic Toll Collection System Target Deployment

A major objective for the deployment of ETC systems is the use of common toll readers and tags, that will work in multiple jurisdictions across the U.S. as well as systems deployed in Canada and Mexico. A further goal of the target deployment systems will be to implement a standardized Vehicle to Roadside Communications (VRC) interface (as called for by the ITS National Architecture Program) that can support additional applications, such as commercial vehicle roadside clearance programs and possible intermodal applications. While no major modifications of the toll tag concept will be required, the ETC systems can also be used to implement demand/congestion pricing programs.

D. Projects and Activities Related to ETC System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- C Illinois DOT ETC System
- C New York State Thruway Authority
- C Houston Toll System
- C Oklahoma Toll System

Annexes: Examples of Current ATIS/ATMS deployments

These examples are currently being expanded:

- A. Maryland Statewide Operations Center (SOC)
- B. Montgomery County, Maryland Transportation Management System
- C. San Antonio, Texas Advanced Traffic Management System (TransGuide)
- D. Houston Intelligent Transportation System (HITS)
- E. Denver RTD AVL/Kiosks
- F. Examples of ATIS Projects (Trilogy, SWIFT, TravInfo, TransCal)
 - F1 SWIFT
 - F2 TravInfo
- G. Boston Smart Traveler
- H. Houston Toll System
- I. Oklahoma Toll System.

Houston Transportation and Emergency Management Center (TEMC)

The Houston TEMC is planned to be a fully integrated center to conduct transportation and emergency management for the greater Houston area. The center will be responsible for the management of a variety of freeway and arterial systems. Components to be managed by the Center include:

- 300 mile Freeway Management System,
- Freeway and Arterial Street Incident Management,
- Ramp Metering,
- Closed Circuit Television Surveillance (CCTV),
- Changeable Message Signs,
- 105 Mile HOV Lane System,
- Regional Traffic Signal System (2800 Signals),
- Emergency Management Operations for Evacuations and Disasters,
- Other ITS initiatives, such as "Smart Commuter" and Motorist Assistance Program (MAP).

Within the Management Center, both the systems, operations personnel and work functions are integrated across functional and jurisdictional boundaries. The center will integrate agency personnel and responsibilities into a single unit that creates a seamless implementation effort, under one management structure. Significant benefits are anticipated due to this integrated structure which will create an effective environment in terms of responsiveness, elimination of administrative, jurisdictional, and organizational constraints and the pooling of financial, personnel, and equipment resources.

The Command Center building will include a central control operations room, communications room, telephone switch room, briefing and operations room for special events and emergency conditions, and three floors of office space for the staff of the participating agencies.

One major part of the TEMC is the Freeway Management System known as the Computerized Transportation Management System, which will monitor, and in some cases control traffic flows. Plans call for the region to have more than 230 miles of computer managed systems in most major freeway corridors. The computerized Transportation Management System is a collection of technologies that form three separate, but integrated subsystems--main lane freeway traffic management; HOV lane surveillance, communications, and control; and the frontage road signal coordination system. Elements of this system include:

- Vehicle detectors for measuring speed, occupancy, and flow,
- Changeable message signs,
- Highway advisory radio,
- Closed circuit television,
- Ramp metering,
- Intersection signal control,

Fiber optic communications network, and
Intermediate and central computers.

This initiative is a cooperative effort between the City of Houston, Harris County, Metropolitan Transit Agency (METRO), and Texas Department of Transportation (TXDOT).

MD Statewide Operations Center

The Maryland State Traffic Control Center is a central part of the Maryland CHART (Chesapeake Highway Advisories Routing Traffic) Program. This program is an advanced traffic management and information program which includes the functions of surveillance and detection, traveler information, incident management, and traffic management. The heart of the CHART program is the Statewide Operations Center (SOC), which is expected to be one of the most advanced and sophisticated statewide command and control centers in the nation. The emphasis is on the integration of highway engineering and maintenance functions, as well as supporting the close coordination of activities with State and local enforcement personnel; through inter-agency agreements and on-site representation.

This system is also capable of distributed command and control operations through several satellite Traffic Operations Centers located in other regional areas of the state. These operations centers can provide localized control during peak traffic periods or major incidents. The architecture provides for a centralized information clearinghouse function within the Statewide Operations Center. Information on the major state roadways will be collected through conventional means as well as many new techniques such as video cameras and fixed radar detectors located along the roadway. Other sources of information will be the traditional call-ins from state police and maintenance organizations, cellular call-ins reporting incidents, and close coordination with private sector traffic information providers. Another key element of this program is a communications resource sharing initiative, in which selected communications companies will be permitted to use State highway right-of-ways to install fiber optic cable and in return will provide the State with telecommunications capacity, which will support, among other things the communications requirements for traffic surveillance and operations. Warnings and advisories are provided to travelers through variable message signs, traveler advisory radio, and other conventional means such as private sector traffic information reports over AM/FM radio.

The SOC provides state-of-the-art communications, information processing, and operator interface (video display, control, and communications) capabilities for situation monitoring, coordination and control, and provides facilities for meetings, briefings, and for disseminating status and advisory information to the public.

Montgomery County, Maryland- Transportation Management System

The Advanced Traffic Management System (ATMS) provides traffic surveillance, real-time control and information capabilities for managing the Montgomery County road network. The county has encouraged and supported inter- and intra-agency coordination as part of their transportation management program. The ATMS provides the tools to implement an effective and comprehensive transportation management program. It emphasizes the sharing of information with multiple agencies, the media, and the public.

The ATMS features an open architecture that allows for new technologies to be added to the system. Some of the major components of the ATMS include;

- N Advanced traffic responsive traffic signal control for up to 1500 signals (currently all 600+ traffic signals in the county are under computer control),
- N Automated variable message and route guidance sign control. (This is currently under testing in controlled areas during 95/96),
- N Video surveillance system capable of accommodating 200 cameras. (currently there are 16 cameras operational, with 60 planned for operation by the end of 1995, with an additional 30-50 planned to be added in each subsequent year),
- N Capability to monitor 3000 sampling detectors of various types. (1000 loop detectors are planned for operation during 95/96. Machine vision and other detector technologies currently under test.),
- N Time critical Geographic Information System (GIS)
- N Automated Transportation Information System to include;
 - Travelers Advisory Radio (TARS)
 - Live transportation broadcasts on cable television's County Cable 55,
 - Direct connection to television broadcast stations,
 - Coordination and information sharing with traffic information services (Metro Traffic and Shadow Traffic)
 - Internet connection (Under development during 1995/96),
 - Telephone based voice recognition transportation information system (development and implementation during 1995/96),
 - Kiosks and information centers (Development and implementation during 1995/96).
- N Integrated transit and traffic operations and management. (Testing during 1995, full implementation by end of 1996),
- N GPS-based automatic vehicle locating system. (Operational--being enhanced),
- N Automated incident detection and management system. (Operational--being enhanced.),
- N Aerial surveillance program including capability to directly coordinate response with multiple agencies and the capability to transmit "live" video from aircraft to the transportation Management Center. (Operational),
- N Automated integration with police/fire computer-aided dispatch system. (operational-1995.),
- N Automated transportation planning support (Operational--being enhanced).

Montgomery County has constructed a communications system throughout the county to support the communications requirements of the computerized signal system and the ATMS. The system includes twisted pair copper wire plus fiber optic cable. The fiber optic cable uses the Synchronous Optical Network (SONET) standard to support data, voice, and video requirements. The fiber optic network is being implemented to support all government, public schools, and college facilities in the county.

The key to the successful operations of the county's transportation program has been the coordination and cooperation of multiple agencies. These include the police, fire and rescue, environmental, planning, and transportation at the federal, state, and local levels. This coordination is enhanced through the capabilities of the ATMS.

The county has an extensive program to provide critical information to the users of the transportation system. Real-time and accurate information is distributed in a variety of formats, by public agencies, the media, and private

information companies. This information is used both by the operators of the system and the users of the system.

Another important aspect of the transportation management system is the integration between transit and traffic management. The county's Transportation Management Center will house both traffic and transit personnel. These personnel will share a central system to more effectively manage transportation. Advanced technologies will monitor the location of the county's RIDE-ON bus fleet using the Global Positioning System (GPS) and can automatically adjust traffic signals on a system-wide basis to provide priority to buses that are behind schedule. Full implementation of this capability on the county's 250 RIDE-ON buses is scheduled to be completed by the end of 1996.

The ATMS is also key to the county's transportation incident management program. Through the system's control, monitoring, and information capabilities, incidents can be quickly detected, responded to, adjusted for, and cleared as safely and effectively as possible. The computerized signal system and the county's aerial surveillance program have proven to be critical tools in managing incidents. Other enhancements in detector (technology) capabilities will further improve incident detection performance.

The county also uses the ATMS capabilities to manage special events to minimize the impacts of road closures and high traffic volumes. The system is used both to aid in the planning and in the managing of special events.

Based on materials provided by Montgomery County, Maryland

San Antonio, Texas Advanced Traffic Management System (TransGuide)

The Transportation Guidance System (TransGuide) project is the first phase of a major Advanced Traffic Management System program for the San Antonio, Texas, metropolitan area. Construction on this project began in early 1993. The project provides for instrumentation of a total of 26 miles out of 191 miles of metropolitan area freeway, plus construction of the complete Operations Control Center, mainframe computer system, application software, communication switching equipment, and all necessary supporting hardware.

This system is designed to provide transportation and enforcement officials the capability to rapidly (within two minutes) react to accidents and incidents on the freeways. The system provides for comprehensive surveillance, automated incident detection and alarms as well as computer-aided analysis and decision support for the traffic manager. The system is highly integrated to support all processes from surveillance/detection through the analysis and response to an incident.

The goals of the system are as follows:

- N** Incident detection within two minutes of occurrence,
- N** Changes to all affected traffic control devices within 15 seconds from identification of an alarm,
- N** Ability for police officers to dispatch appropriate response from the Operations Control Center,
- N** Designed in system reliability and expandability,
- N** Ability to support future ATMS and ITS functional capabilities.

Freeway system components include inductive loop detectors, high resolution color video cameras, variable message signs, and lane control signs. The inductive loop detectors are installed in configurations that will provide information regarding vehicle speed, lane occupancy and traffic volume. The high resolution camera will provide 750 lines of horizontal resolution and remotely controlled zoom capability. Field of view at one-half mile is 20 feet vertical by 30 feet horizontal. The variable message signs permit the display of strings of alphanumeric text, using fiber optic bundles to provide bright, easily read characters. The lane control signals are designed to be visible at a distance of a quarter mile under normal atmospheric conditions. Again fiber optic technology is used to produce bright, clearly legible signs.

A digital communications network is used to transport (full motion) video, data, and voice information from the field equipment to the Operations Control Center. This network utilizes SONET standard communication protocols over a fully

redundant single mode fiber optic system. The network employs a number of digital matrix switches, a virtual circuit switch, a communications systems switch and a network management switch, as well as digital loop carriers, video codecs, and multiplexors to provide a flexible and reliable digital transmission system.

The mainframe software system supports event detection, routing, analysis, display, and storage and archiving features of the TransGuide system. The software is an integration of tailored Commercial-Off-The-Shelf (COTS) products and custom code developed for the TransGuide system. The software system is key to the operation of the ATMS, supporting the requirement to quickly identify and respond to incidents on the freeway, and to support the traffic manager, with expert systems analysis of data, display of current information and video, as well as supporting remote control of video cameras and VMS and lane control signals.

The ATMS mainframe is the heart of the TransGuide system. It supports the detection, analysis, display, and storage/archiving of the incident data. It monitors the status and provides control of the field equipment, as well as controlling the configuration of the digital communications network equipment. In addition the system employs a network management system to provide status monitoring of all equipment in the digital communications network. All system alarm points are monitored to permit rapid identification and location of malfunctions.

Seattle Wide-area Information for Travelers (SWIFT)

SWIFT is an Advanced Traveler Information System Operational Test, that was selected for implementation during 1994. The project team consists of the following members:

- Delco Electronics Corporation (General Motors Corp. subsidiary)
- ETAK, Inc.
- Federal Highway Administration (FHWA)
- International Business Machines (IBM)
- King County Dept. of Metropolitan Services
- Metro Traffic Control
- Seiko Communications Systems, Inc.
- University of Washington
- Washington State Department of Transportation

Swift is planned to provide an ATIS capability for the Seattle metropolitan area using a high speed data (FM-Subcarrier radio) system communicating to receiver devices capable of receiving the FM-Subcarrier communications. These devices will receive a variety of traveler information types, including traffic advisories, personal pages, transit locations and schedules, and other relevant information.

The receiver devices being tested are:

- Delco radio receivers
- IBM portable computers
- Seiko Message Watch (TM)

The portable computer devices will be capable of receiving a map display of current traffic information, bus positions and schedules, and ride-share information . The other planned devices will not support this capability.

The pertinent SWIFT data will be collected by a variety of organizations and processed (validated, integrated and/or fused and formatted) by the University of Washington. The data types being collected are Freeway loop-sensor information, Ride-share information, Traffic advisories, incidents, scheduled events, etc., Bus locations and schedules, and personal paging messages, as well as Differential GPS data. The processed data will be formatted and placed into message frames, for transmission to the appropriate receiver devices.

The radio transmission system provides a wide-area capability which incorporates forward error correction and multiple transmission of data to increase the probability of correct reception of data. The system has a raw transmission rate of 19,200 bits per second, which after error correction and overhead, provides usable information transmission rates of approximately 8000 bits per second. If multiple transmissions of data are included the final "real" information rate will be further reduced accordingly. Messages will be able to be individually addressed as in current pager systems, or group addressed to a common set of receiver devices.

Plans call for the test to include a total of 700 devices, made up of 500 SEIKO Message Watches (TM), 100 Delco radios, and 100 IBM portable computers. Users will be recruited to participate in the test, according to an evaluation plan developed by the evaluation contractor. A variety of technical performance, institutional, and user acceptance issues will be studied during this OPTEST.

Appendix V
Early Deployment Studies
(cost in thousands)

Atlanta, Georgia	\$450	Kern County, California	\$350
Austin, Texas	400	Las Vegas, Nevada	400
Baltimore, Maryland	456	Lexington, Kentucky	200
Birmingham, Alabama	400	Louisville, Kentucky	410
Boston, Massachusetts	360	Memphis, Tennessee	400
Buffalo, New York	400	Nashville, Tennessee	220
Charleston, South Carolina	320	New Castle County, Delaware	400
Charlotte, North Carolina	400	New Haven, Meriden, Connecticut	350
Chicago, Illinois	400	New Orleans, Louisiana	400
Cleveland, Ohio	400	New York City/Northern New Jersey	750
Columbus, Ohio	188	Northern Virginia, Washington, D.C.	400
Dallas, Texas	600	Omaha, Nebraska	400
Dayton/Springfield, Ohio	400	Orange County, California	450
Denver, Colorado	713	Orlando, Florida	400
Des Moines, Iowa	275	Philadelphia, Pennsylvania	400
Detroit, Michigan	400	Phoenix, Arizona	400
El Paso, Texas	336	Pittsburgh, Pennsylvania	400
Fort Worth, Texas	400	Portland, Oregon	400
Grand Rapids, Michigan	400	Providence, Rhode Island	400
Greensboro, North Carolina	150	Raleigh area, North Carolina	250
Greenville, South Carolina	200	Richmond, Virginia	400
Hampton Roads, Virginia	486	Rochester, New York	400
Hartford, Connecticut	400	Sacramento, California	400
I-10, New Orleans/San Antonio	250	Salt Lake City, Utah	400
I-279/376, Pennsylvania Turnpike	300	San Antonio, Texas	397
I-40, Northern Arizona	130	San Diego Border, California	200
I-5, Los Angeles-San Diego	150	San Francisco, California	450
I-5, Seattle-Portland	300	San Juan, Puerto Rico	400
I-5/90, Seattle-Vancouver-Spokane	240	Scranton/Wilkes Barre, Pennsylvania	350
I-70, Denver	168	Springfield, Massachusetts	350
I-71, Columbus-Cleveland	200	St. Louis, Missouri	280
I-79, Erie-Pittsburgh	300	Syracuse, New York	350
I-94, Portland-Boise	320	Tampa, Florida	80
I-90/94, Milwaukee-Minnesota	240	Tucson, Arizona	400
Garden State Parkway, New Jersey	198	Washington, D.C.	400
Indianapolis, Indiana	400	Washington, D.C. (umbrella)	200
Jacksonville, Florida	400	Westchester Co-White Plains, New York	400
Kansas City, Kansas	400	TOTAL	\$26,567

The above funds reflect Federal contribution only. Each locality is required to provide a minimum 20 percent match to Federal funds.

Appendix VI Priority Corridors

CORRIDOR	FUNDING* by FISCAL YEAR (FY) (mil)			MEMBERS	ACCOMPLISHMENTS
	FY '93	FY '94	FY '95		
I-95 Northeast	\$10.500	\$ 1.000	\$ 7.500	Members of Coalition: Departments of Transportation in Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, New York City, Pennsylvania, Rhode Island, Vermont, and Virginia. Also members are the Delaware River & Bay Authority, Delaware River Port Authority, Delaware Turnpike Administration, Maine Turnpike Authority, Maryland Transportation Authority, Massachusetts Turnpike Authority, New Jersey Highway Authority, New Jersey Turnpike Authority, New York State Thruway, Pennsylvania Turnpike Commission, Port Authority of New York & New Jersey, and Triborough Bridge & Tunnel Authority.	<p>The Coalition completed development of an initial "Business Plan" in May 1993. Updated in 1995, the Plan is the cornerstone of the Coalition's program management. The Coalition also completed the Strategic Plan in 1995. Current projects include:</p> <ul style="list-style-type: none"> ! Creation of an "Information network" for communications and purposes throughout the Corridor. ! Development of incident response procedures and support system which addresses the needs of the Corridor. ! Development of a coordinated provision of traveler information; improved holiday traveler advisories and real time information are already up and running. ! Development of a program for vehicle operations in the Corridor, including the existing institutional issues study by the Department of Transportation. ! Focus on improved intermodal and efficiency.
Houston, Texas	3.105	2.000	2.250	The Texas Department of Transportation (TxDOT), Houston METRO, the City of Houston, and Harris County. The Corridor is located in Harris County, Texas.	<p>The Houston Smart Commuter project, a real-time traffic and transit information system, is being coordinated with other efforts in the Corridor. These efforts include:</p> <ul style="list-style-type: none"> ! Development of a Corridor Management System ! Evaluation of Astrodome area television lease ! Automatic vehicle identification systems and incident detection ! Real time information kiosks ! Railroad Grade Crossing Detection System ! Automatic vehicle location for management ! On-vehicle navigation/information systems ! Environmental Conditions Monitoring Systems ! Integrated Corridor Advanced Management System/ Advanced Traveler Information System
Southern California	3.105	2.000	2.250	Steering Committee: California Department of Transportation (Caltrans) New Technology, Caltrans District 7, Caltrans District 8, Caltrans District 11, Caltrans District 12, Southern California Association of Governments, San Diego Association of Governments, San Bernardino Association of Governments, Orange County Transportation Authority, City of San Diego, California Highway Patrol, and the South Coast Air Quality Management District. The Southern California Corridor lies within the major urbanized and adjacent non-urbanized areas of Ventura, Los Angeles, San Bernardino,	<p>Three major efforts operate in the Southern California Priority Corridor: field operational tests, strategic deployment planning, and a major demonstration of an intermodal transportation management and information system, known as the "Showcase."</p>

Appendix VI Priority Corridors

CORRIDOR	FUNDING* by FISCAL YEAR (FY) (mil)			MEMBERS	ACCOMPLISHMENTS
	FY '93	FY '94	FY '95		
				Riverside and San Diego Counties and all of Orange County.	
Midwest Corridor	0.000	.810	4.090	The Technical Committee: Chicago Area Transportation Study, the Illinois Department of Transportation, the Indiana Department of Transportation, Illinois State Toll Highway Authority, Milwaukee County Public Works, Northern Indiana Commuter Transportation District, Northwest Indiana Regional Planning Committee, Regional Transportation Authority, Southeast Wisconsin Regional Planning Committee, Wisconsin Department of Transportation, Argonne National Laboratory, Chicago Transit Authority, City of Chicago Department of Transportation, City of Milwaukee, Marquette University, Metra, Milwaukee County Transit and Pace. The Midwest Corridor is located in Lake, Porter and Laporte counties in Indiana; McHenry, Lake, Kane, Cook, DuPage, and Will counties in Illinois; and Washington, Ozaukee, Waukesha, Milwaukee, Walworth, Racine, and Kenosha in Wisconsin.	The Coalition selected a consultant team that began work in July 1994 to assist with the development of a Corridor Program Plan (CPP). The initial CPP was approved by the Corridor Executive Committee in June 1995. The CPP include 5, 10, and 20 year scenarios for the implementation, management, and evaluation of a multi-state, multi-modal corridor program of projects. The real time acquisition and sharing of information across the corridor, useful to both the multi-modal system operators and travelers, constitute the core projects in the initial CPP.
<p><i>*Funds listed in the table are matched by a minimum 20 percent state-local-private sector matching share. In addition to the above funds, the Midwest Corridor is preparing to submit a Corridor Program Plan that includes a request for \$12.5 million for each of Fiscal Years 1995 and 1996. The I-95 Corridor Fiscal Year 1996 Business Plan includes a request for \$12.5 million. The Southern California Priority Corridor has submitted an initial business plan that includes a proposed \$44 million Showcase project that is scheduled for completion in 1997.</i></p>					

Appendix VII List of Acronyms

AATC	Advanced Automatic Train Control
ACN	Automated Collision Notification
AHS	Automated Highway System
AIBS	Automated Identification and Billing System
APTS	Advanced Public Transportation Systems
ARPA	Advanced Research Projects Agency
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVC	Automatic Vehicle Classification
AVCSS	Advanced Vehicle Control and Safety Systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
BSMS	Bus Service Management System
CAD	Computer-aided Dispatching (system)
CCTV	Closed Circuit Television
CDLIS	Commercial Driver's License Information System
CDPD	Cellular Digital Packet Data
CMS	Changeable Message Sign
CVISN	Commercial Vehicle Information Systems Network
CVO	Commercial Vehicle Operations
DASCAR	Data Acquisition System for Crash Avoidance Research
DOT	Department of Transportation
EMS	Emergency Medical Services
ETC	Electronic Toll Collection
ETTM	Electronic Toll and Traffic Management
FHWA	Federal Highway Administration
FMS	Freeway Management System
FOCAS	Forward Crash Avoidance Systems
FTA	Federal Transit Administration
GIS	Geographic Information Systems
GPS	Global Positioning Systems
HAR/AHAR	Highway Advisory Radio/Advanced HAR
HAZMAT	Hazardous Materials
HELP	Heavy Vehicle Electronic License Plate Program
ICC	Intelligent Cruise Control
IFTA	International Fuel Tax Agreement
IRP	International Registration Plan
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
ITS America	The Intelligent Transportation Society of America [formerly IVHS America]
IVHS	Intelligent Vehicle-Highway Systems
IVSAWS	In-Vehicle Safety Advisory and Warning Systems
JPO	Joint Program Office [for ITS]
LIDAR	Light Detection and Ranging

MCSAP	Motor Carrier Safety Assistance Program
MTIS	Multimodal Traveler Information System
NAFTA	North American Free Trade Agreement
NAHSC	National Automated Highway System Consortium
NHTSA	National Highway Traffic Safety Administration
NTCIP	National Traffic Control Interchange Protocol
OBC	On-Board Computer
O&M	Operations and Maintenance
PATH	Partners for Advanced Transit and Highways
PCD	Personal Communications Device
PDA	Personal Digital Assistant
PL	Public Law
RBDS-TMC	Radio Broadcast Data Service - Traffic Message Channel
R&D	Research and Development
RDS	Radio Data Service
RF	Radio Frequency
RSPA	Research and Special Programs Administration
RTD	Regional Transportation District
RT-TRACS	Real Time Traffic Adaptive Control System
SAFER	Safety and Fitness Electronic Records System
SCA	Subsidiary Communication Authorization
SDOs	Standards Developing Organizations
SDTS	Spatial Data Transfer Standard
STIC	SCA Traffic Information Channel
TMC	Traffic [or Transportation] Management Center
TRP	Technology Reinvestment Program [ARPA]
VDTV	Variable Dynamics Test Vehicle
VME	Vehicle Motion Environment
VRC	Vehicle-to-Roadside Communications
VSAT	Very Small Aperture Terminal [satellite]
WIM	Weigh in Motion
WMATA	Washington Metropolitan Area Transit Authority