Houston Intelligent Transportation System

Preliminary Program Description and Transit Project Listing

Prepared for the
Metropolitan Transit Authority of Harris County

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EXECUTIVE SUMMARY

Maintaining a viable transportation system is critical to the long term economic vitality and quality of life in the Houston area. The agencies responsible for the different elements of the surface transportation system in Houston are utilizing a wide range of approaches to address mobility and congestion problems. The planning, implementation, and ongoing operation of these projects has occurred through the coordinated and cooperative efforts of the various agencies. Utilizing advanced technologies, including those emerging through the intelligent transportation system (ITS)[1], represent an important component of these efforts.

Intelligent transportation systems include the application of a wide range of evolving advanced technologies that share the common goal of improving the efficiency of the overall surface transportation system. More specifically, ITS technologies are directed at improving mobility, enhancing safety, increasing the productivity of the current transportation system, and addressing air quality and environmental concerns. These efforts are being supported by major federal, state, and local programs, private industries, university research institutions, and other groups. In the Houston area, the Texas Department of Transportation (TxDOT), the Metropolitan Transit Authority of Harris County (METRO), the City of Houston, Harris County, the Houston-Galveston Area Council (HGAC), and the Greater Houston Transportation and Emergency Management Center (GHTEMC) are pursuing numerous ITS projects. These include a state-of-the-art traffic management center, the *Smart Commuter* Operational Test, the Priority Corridors Program, and many other projects.

This report has been prepared to summarize many of the current ITS efforts underway in the Houston area and to identify additional transit projects that may be implemented in the future to address critical transportation needs. Further, the report presents a definition of ITS to help facilitate an understanding of the depth, breadth, scope, magnitude, and diversity of ITS technologies. It will be of use to agencies in the development of the Houston ITS Strategic Plan and in the implementation of specific projects. The report was prepared for METRO by the Texas Transportation Institute (TTI), a part of The Texas A&M University System.

The report contains a definition of ITS and summarizes the goal and objectives of the Houston ITS Program. A variety of technologies are being developed, tested, and implemented under the general heading of Intelligent Transportation Systems. ITS includes the application of a wide range of advanced technologies that share the common goal of improving the efficiency of the overall transportation system. More specifically, ITS is directed at improving mobility and transportation productivity, enhancing safety, maximizing current transportation facilities, and enhancing the environment.

Two elements are critical in defining ITS. First, ITS is not a single technology. Rather, ITS represents a diverse group of advanced technologies aimed at improving the operation and

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Formerly called Intelligent Vehicle-Highway Systems (IVHS).

management of the transportation system. Second, ITS is not static. ITS technologies are evolving rapidly and the state-of-the-art is continually improving. Thus, ITS focuses on the use of numerous evolving technologies to enhance the operation and management of all aspects of the surface transportation system.

The goal of the Houston ITS program is to implement programs and projects utilizing advanced technologies to improve the mobility of people and goods on the transportation infrastructure in non-traditional ways, to reduce the environmental impacts of the transportation system, and to enhance the safety and security of travelers. Major components of the transportation infrastructure that will be enhanced by ITS projects include transit, highway, street, terminal, and intermodal systems. The purpose of the ITS program in the Houston area is to:

- Increase transit usage.
- Increase auto occupancy.
- Manage recurrent and non-recurrent congestion.
- Improve the efficiency of urban goods movement.
- Improve the general operation of the transportation system.
- Enhance the safety and security of travelers.
- Enhance the environment and quality of life.

After summarizing existing, planned, and potential ITS projects, the report provides preliminary descriptions of possible transit ITS projects. The following projects are included in this section.

- Real-Time Information Kiosks.
- Integrating Transit into the Greater Houston Transportation and Emergency Management Center.
- Talking Bus Stop for Visually Impaired Riders.
- Automatic In-Home Notification of Bus Arrival.
- Bus Collision Avoidance Warning System.
- Enhancing Enforcement and Safety of HOV Lanes.
- Real-Time Scheduling.
- Automated Reservation System.
- Real-Time Dispatching.
- Personalized Public Transit.

Chapter One

INTRODUCTION

Maintenance of a viable transportation system has long been recognized as a critical component for the economic health of the Houston metropolitan area. The efficient movement of people and goods within and through the Houston urban area is important to its continued vitality. Significant investments have been, and continue to be, made in the transportation infrastructure, support services, and system management capabilities in the Houston area.

In response to the combination of limited resources and increasing demands on the transportation system—including the need to serve an increasing demand for travel, and to improve air quality—the agencies responsible for transportation have utilized innovative approaches to addressing mobility and congestion problems. Houston is considered one of the national leaders in the application of many of these techniques. The regular development and publication of the multimodal Regional Mobility Plan, the extensive system of high occupancy vehicle (HOV) lanes, park-and-ride lots, transit centers and express bus services; the expansion of the freeway and toll road system; the development of a strategic arterial street plan; the automatic vehicle identification (AVI) program; the *Smart Commuter* Operational Test; and the state-of-the-art Greater Houston Transportation and Emergency Management Center (GHTEMC) represent a few of the programs and approaches that have been utilized in Houston. The development of these projects has occurred through the coordinated and cooperative efforts of the different agencies.

In an effort to maintain Houston's quality of life and to support Houston's economic activities within the constraints of recent legislation and an increased awareness of air quality and other environmental issues, public agencies will need to continue to work together to help ensure that the transportation system meets the needs of future generations. Incorporating advances in technology, such as those emerging through various intelligent transportation system (ITS) programs, into the Houston transportation system is an important part of this overall approach. The Metropolitan Transit Authority of Harris County (METRO) and the Texas Department of Transportation (TxDOT) are currently working on numerous ITS projects. These are being funded through a variety of federal, state, and local programs. In addition, numerous approaches are being used to plan, implement, operate, and manage these projects. Further, many private sector businesses are involved in the development and design of the advanced technologies that are being incorporated into the various ITS projects and programs.

Purpose and Organization of this Report

The purpose of this report is to summarize current ITS efforts underway in the Houston area and to identify additional transit projects that may be implemented in the future to help address critical transportation needs. Further, the report presents a definition of ITS to help facilitate the understanding of the depth, breadth, scope, magnitude, and diversity of ITS

technologies. To accomplish this, the report is divided into six chapters. Following this introduction, the second chapter summarizes the major transportation issues in the Houston area. The third chapter outlines the approaches being utilized by the different public agencies to address these problems and presents a definition of ITS and the goals of the Houston ITS program. Chapter Five identifies potential funding sources for ITS activities and summarizes current ITS projects in Houston. The final section provides preliminary descriptions of the transit projects rated highly by representatives from METRO, TxDOT, HGAC, and GHTEMC. The final chapter provides a summary of the major points covered in the report and highlights some of the future ITS activities anticipated in the Houston area. A listing of current, planned, and proposed ITS projects in the Houston area is provided in Appendix A.

Chapter Two

TRANSPORTATION PROBLEMS AND ISSUES IN THE HOUSTON AREA

The Houston area faces numerous transportation issues. These problems arise from an ever increasing demand on the transportation system, constraints on the expansion of transportation capacity, limited funding, and legislative and policy requirements. Major transportation issues in the Houston area include the following:

- Traffic congestion, especially during the morning and afternoon peak periods, continues to be a major problem in the Houston area. Although recent improvements in the transportation system have led to decreased congestion in some corridors, Houston is still ranked in the top fifteen most congested cities in the country.

- The annual cost of congestion in the Houston area, based on the costs associated with time delay and fuel, is estimated to be approximately $1.75 billion.

- Recently, demand on the transportation system has been increasing by approximately 3% per year, and is projected to continue to increase at about this rate.

- Air quality and environmental issues continue to be major concerns. Houston is currently a severe non-attainment area with respect to the Environmental Protection Agency's (EPA) standards for ozone emissions. The requirements of the 1990 Clean Air Act Amendments impose travel restrictions and require the implementation of additional measures designed to control growth in vehicle-miles of travel, including employer trip reduction programs for employers with more than 100 employees.

- There are limited resources and limited right-of-way available for adding capacity to existing freeways, roadways, and other elements of the transportation system.

There are also a number of issues and opportunities associated with the provision of public transportation services in the Houston area. As highlighted below, these focus on increasing the use of transit to address some of the problems noted above, improving the efficiency and effectiveness of transit services, and meeting the needs of specific user groups.

- Although transit ridership has increased in Houston for a number of years, it has remained relatively constant over the past two years.

- Currently, most METRO service is oriented in a radial direction, focusing on downtown Houston, and to a lesser extent on the Texas Medical Center, the Post Oak/Galleria area, Greenway Plaza, and other activity centers. Less service is oriented toward serving the suburb-to-suburb commute market and the central city to

suburb travel market. METRO's Regional Bus Plan includes additional services focused on these markets, however.

- Making transit more convenient and easier to use may increase ridership and may help address the special needs of specific market groups.

- Safety and security are concerns for transit users and operators. Efforts to enhance safety and security may help increase transit ridership.

- The Houston HOV lanes represent an important component of the overall transportation system and utilization levels continue to increase. Enhancing the operation of the HOV lanes, a high priority of METRO, is being accomplished by detecting and preventing vehicles from entering the HOV lanes in the wrong direction and the ongoing monitoring of vehicle occupancy levels and maintaining high levels of services.

- Specific federal requirements related to the 1990 Americans with Disabilities Act (ADA), the Clean Air Act Amendments of 1990, as well as state and local programs, place additional responsibilities and requirements on METRO, other public agencies, and private businesses.

Chapter Three

APPROACH TO ADDRESSING TRANSPORTATION ISSUES

The approach utilized in the Houston area to address the transportation issues noted in the previous section has focused on both the supply of transportation facilities and services and the demand for those facilities and services. Historically, Houston and other metropolitan areas have added capacity through the construction of new freeways and roadways, and the expansion of existing facilities to meet growing demands. This approach is no longer viable in many corridors due to financial constraints, lack of available right-of-way, and environmental concerns.

As a result, the agencies responsible for the surface transportation system in Houston have shifted their focus to providing selected improvements to the infrastructure, better management of the existing transportation system, and managing the demand for use of the system. The elements of the Houston ITS program are compatible with this approach, and address managing both the supply and the demand sides of the transportation system. The components of the Houston ITS system focus primarily on increasing the operating efficiency of the system through improved roadway management practices and enhanced incident management, and managing transportation demand through the utilization of transit, HOV facilities, travel demand management (TDM) strategies, and telecommuting.

Definition of ITS

ITS represents the use of advanced technologies to address specific problems associated with the surface transportation system. Potential benefits to the traveling public in the Houston area include enhanced mobility and safety. Further, ITS may help improve air quality levels and the environment. Commercial operators may also realize benefits from ITS through safer, more direct, and more convenient delivery of goods and services.

A variety of technologies are being developed, tested, and implemented under the general heading of Intelligent Transportation Systems. ITS includes the application of a wide range of advanced technologies that share the common goal of improving the efficiency of the overall transportation system. More specifically, ITS is directed at improving mobility and transportation productivity, enhancing safety, maximizing current transportation facilities, and enhancing the environment.

Two elements are critical in defining ITS. First, ITS is not a single technology. Rather, ITS represents a diverse group of advanced technologies aimed at improving the operation and management of the transportation system. Second, ITS is not static. ITS technologies are evolving rapidly and the state-of-the-art is continually improving. Thus, ITS focuses on the use of numerous evolving technologies to enhance the operation and management of all aspects of the surface transportation system.

Goal of Houston ITS Program

The goal of the Houston ITS program is to implement programs and projects utilizing advanced technologies to improve the mobility of people and goods on the transportation infrastructure in non-traditional ways, to reduce the environmental impacts of the transportation system, and to enhance the safety and security of travelers. Major components of the transportation infrastructure that will be enhanced by ITS projects include transit, highway, street, terminal, and intermodal systems. The purposes of the ITS program in the Houston area is to:

- Increase transit usage.
- Increase auto occupancy.
- Manage recurrent and non-recurrent congestion.
- Improve the efficiency of urban goods movement.
- Improve the general operation of the transportation system.
- Enhance the safety and security of travelers.
- Enhance the environment and quality of life.

Chapter Four

CURRENT, PLANNED AND PROPOSED ITS PROJECTS TO ADDRESS TRANSPORTATION ISSUES IN HOUSTON

A number of ITS projects have been implemented in Houston. Additional projects have been committed or are in various stages of planning. Further demonstration projects, operational tests, and full deployment activities are appropriate for future consideration. This section provides an overview of the different federal, state, and local funding sources that can be used to support ITS research and development, operational tests, full deployment, and other activities. The major federal programs that may be appropriate to fund different ITS projects are briefly summarized next. Potential state and local funding sources are also noted. This is followed by a summary of existing and planned ITS projects in the Houston area. Appendix A contains a listing of the existing, planned, and potential ITS projects in Houston.

Potential Federal Funding Sources for ITS

Numerous programs at the federal level may be used to fund ITS research and development operational tests, demonstration projects, full deployment, and other activities. These include special ITS programs, as well as the traditional transit and highway programs. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 provides specific funding for ITS and creates other new programs. Further, the ISTEA allows greater flexibility in the use of different program funds in response to local needs. Federal funding sources that may be appropriate for ITS projects are highlighted in Table 1.

The first three programs shown in Table 1—the National Highway System (NHS), the Surface Transportation Program (STP), and the Congestion Mitigation and Air Quality Improvement Program (CMAQ)—are contained in Title I of the ISTEA. Title I, *Surface Transportation*, contains a number of specific programs relating to the highway and roadway system that may be utilized to fund ITS programs. The next three programs listed in Table 1 are from Title III of the ISTEA. Title III, *Federal Transit Act Amendments of 1991*, contains potential funding sources for transit-related ITS projects. These include Section 9, Section 3, and the Transit Planning and Research Program.

- **National Highway System (NHS).** The NHS is envisioned to be comprised of approximately 155,000 miles of the most significant roadways in the country, including all of the Interstate System. The NHS must be proposed by the Secretary of Transportation, in consultation with the states, and designated by law by September 30, 1995. The ISTEA provides flexibility in the use of NHS funds, enabling states to transfer up to 50 percent of NHS funds to Surface Transportation Program projects—including those focusing on ITS—without higher authorization, and up to 100 percent with approval of the Secretary of Transportation.

Table 1. Potential Federal Funding Sources for ITS

Program	Major Components
1. National Highway System (NHS)	• The ISTEA provides for an ultimate system of approximately 155,000 miles of major roadways, including all Interstate routes and many urban and rural principal arterials, the defense strategic highway network, and strategic highway connectors. • The system must be proposed and designated by Congress by September 30, 1995, or authorization will lapse. • States may transfer up to 50 percent of NHS funds to STP projects, including ITS, without higher authorization, and up to 100 percent with approval of the Secretary of Transportation.
2. Surface Transportation Program (STP)	• New block grant program authorized by the ISTEA that can be used by states for roads, including NHS, not functionally classified as local or rural minor collectors. • Bridge and transit capital projects also eligible, as are ITS projects.
3. Congestion Mitigation and Air Quality Improvement Program (CMAQ)	• New program for projects in air quality non-attainment areas to help meet requirements.
4. Section 9	• Formula grant program for capital and operating costs of urban transit systems. • Some flexibility in use of funds for highway projects if all ADA needs are met, MPO agrees, and there is a balanced local approach.
5. Section 3	• Discretionary and Formula Capital Program. • New Starts (40%). • Rail Modernization (40%). • Bus and Other (20%).

6. Transit Planning and Research	• New comprehensive planning and research program funded at 3% takedown of total funding. Breakdown for programs:
	  • Metropolitan Planning.
	  • Rural Transit Assistance Program.
	  • State Planning.
	  • Transit Cooperative Research Program.
	  • National Planning and Research.

7. Intelligent Transportation Systems	• Includes funding for corridors program, operational tests, and research and development activities. • Houston has been designated as one of the priority corridors in the country.

Table 1. Potential Federal Funding Sources for ITS (continued)

Program	Major Components
8. State Planning and Research (SPR)	• Provides funding for state sponsored research, which may include ITS-related projects.
9. ITS Research Centers of Excellence (RCE)	• 3 RCEs established by FHWA through a competitive selection process. • Texas A&M University and TTI selected as one of the 3 RCEs. TxDOT, METRO, and others are providing matching funds.
10. ITS Innovations Deserving Exploratory Analysis (IDEA)	• Funding by FHWA and NTSA and administered by TRB. • Funding of up to $100,000 for projects investigating new and improved concepts for ITS applications and up to $250,000 for projects testing and evaluating new products.
11. Other Potential Federal Funding	• Defense Conversion Program • Congressional earmark.

- **Surface Transportation Program (STP).** The STP represents a new approach that provides states and localities with block grant type funding for projects on roads, including those in the NHS, that are not functionally classified as local or minor collectors. Bridge and transit capital and ITS projects are also eligible for STP funding. The ISTEA further places a number of specific requirements on the use of STP funds. For example, states must set aside 10 percent for safety construction activities and 10 percent for transportation enhancements, which may include a variety of projects designed to improve the environment.

- **Congestion Mitigation and Air Quality Improvement Program (CMAQ).** The CMAQ is another new program established by ISTEA. All states are provided with some CMAQ funds, although the program was designed to direct funding specifically to transportation projects addressing air quality issues in ozone and carbon monoxide non-attainment areas. If a state does not have any air quality non-attainment areas, the CMAQ funds may be used as if they were STP funds. ITS projects may be eligible for funding through the CMAQ program. The Houston area is an ozone non-attainment area.

- **Section 9.** The Section 9 formula grant program provides funding for the capital and operating needs of urban public transit systems, including advanced transit technology projects. The ISTEA provides flexibility in the use of Section 9 funds in metropolitan areas that meet the following requirements: all Americans with Disability Act (ADA) needs are met, the Metropolitan Planning Organization (MPO) approves, and there is a balanced highway and transit system in the area.

- **Section 3.** Section 3 is the formula and discretionary capital funding program for public transportation systems. Funding is split among new start, rail modernization, and other bus and capital projects. Transit ITS projects may be eligible for funding through this program.

- **Transit Planning and Research Program.** Title III also contains a new transit planning and research program funded through a three percent takedown on the total transit authorization. Funding is split between the five programs outlined in Table 1. ITS projects may be included in all five programs.

- **Intelligent Transportation System (ITS).** Title VI, *Research*, of the ISTEA includes the IVHS Act (prior term used for ITS), which establishes funding for IVHS projects. Funding is divided among the priority corridors program and other research and development activities. Houston was designated by the U.S. Department of Transportation in April of 1993 as one of four IVHS Priority Corridors in the country. The ISTEA allocated funding of $71 million to $86 million per year for the corridors program, of which 50 percent must be spent in the four Priority Corridors. TxDOT is the lead agency on this program, but the planning and project selection process has been coordinated with METRO, HGAC, and other local agencies.

- **State Planning and Research (SPR) Program.** Title VI, *Research*, also includes the SPR Program. This program provides funding for a wide range of state-sponsored planning and research studies, including those related to ITS. TxDOT is responsible for the SPR program in Texas.

- **ITS Research Centers of Excellence.** In 1993, the Federal Highway Administration (FHWA) requested proposals for university-based ITS Research Centers of Excellence (RCEs). Texas A&M University (TAMU) and TTI submitted a proposal and was selected as one of the three national RCEs. FHWA provides funding of $1 million a year, which must be matched by an equal amount of local funds. TxDOT, METRO, and other groups have provided the matching funds for the TAMU RCE. The three major focus areas of the TAMU RCE are Public Transportation Services, Traffic Management Services, and International Border Transportation Services. A number of the current projects at the TAMU RCE include the Houston area.

- **ITS Innovations Deserving Exploratory Analysis (IDEA) Program.** The ITS IDEAs program, which is funded by FHWA and the National Highway Traffic Safety Administration (NTSA), and administered through the Transportation Research Board (TRB), was established to produce new concepts and innovative products to help accelerate the development and implementation of ITS. The program provides funding of approximately $100,000 for projects investigating new and unproven concepts that may have ITS applications and up to $250,000 for projects testing and evaluating new products. Projects are selected through a competitive process utilizing technical expert panels and an advisory committee.

- **Other Potential Federal Funding.** Other federal programs and funding may also be appropriate for ITS projects and activities. For example, the Defense Conversion Program is intended to help find consumer applications for defense-related products and to help the defense industry transition into other products and services. Transportation and ITS applications represent possible uses for defense products.

In addition to these federal programs, state and local funding sources may also be used to support ITS projects. Many of the federal programs require some kind of local match, usually ranging from 10 to 20 percent of the total project cost. State funds may come from general revenues allocated to TxDOT and other sources. Local sources may include METRO's dedicated sales tax, as well as funding from local units of government.

One of the unique aspects of ITS projects is the involvement of the private sector in funding and project development. These public/private partnerships may take many forms. For example, technology vendors may contribute equipment, in-kind services, or technical expertise. In other cases, businesses may share in the actual project funding. Developing public/private partnerships on ITS projects is not an easy process, however, as it requires both groups to take on new roles and responsibilities.

A number of ITS projects have been implemented in the Houston area and others are in various stages of planning, design, and implementation. Further, METRO, TxDOT, and HGAC are developing a strategic plan for ITS in the Houston area that will enhance the cooperation among the various projects and activities. Brief summaries of the major ITS projects currently underway in Houston are summarized next.

- **Greater Houston Transportation Emergency Management Center (GHTEMC).** The GHTEMC is being designed and constructed through the cooperative efforts of METRO and TxDOT. Both agencies, along with the City of Houston and Harris County, have signed a Memorandum of Agreement creating the GHTEMC, which is responsible for the overall management of the center and the supporting components. The GHTEMC will house not only METRO and TxDOT personnel, but also city and county transportation and enforcement personnel and other groups. The Center will monitor and coordinate all aspects of the traffic management system in the Houston area. An interim center is currently in operation.

- **Computerized Transportation Management System (CTMS).** The CTMS is a freeway corridor management system installed by TxDOT which will ultimately cover 231 miles of freeway in the Houston area. The CTMS represents a critical component of the ITS system in Houston. The CTMS is comprised of three separate, yet integrated subsystems: mainlane Freeway Traffic Management (FTM), HOV Surveillance, Communications, and Control (SC&C), and frontage road Signal Coordination System (SCS). Elements of CTMS include:

- Vehicle detectors (speed, lane occupancy, and flow)
- Changeable message signs
- Highway advisory radio
- Closed circuit television
- Ramp metering
- Intersection signal control
- Fiber optic communications medium
- Intermediate processors
- Central processors

- **Freeway Traffic Monitoring—Automatic Vehicle Identification (AVI).** TxDOT is installing a network of AVI readers on 227 miles of freeway and 70 miles of HOV lanes in Houston. The real-time travel information provided by this system is essential for many of the ITS applications under development in Houston. The readers are spaced at one- to four-mile intervals and transmit transponder tag information at one-minute intervals. Average speeds are calculated and presented on a graphics display in 10 mph increments for use by GHTEMC operators. Travel time information is also provided in tabular and graphic form to other agencies responsible for reporting travel information. The applications noted next are being explored for further application of AVI technology.

  - Additional AVI readers will be installed on one freeway to test the use of this technology for incident detection. Spaces in the test section will vary from 0.5 to 1.0 miles.

  - AVI readers will be installed within park-and-ride facilities to monitor the arrival and departure of the transit vehicles.

  - Portable AVI readers will be temporarily installed at park-and-ride facilities and at bus loading facilities to monitor special event shuttle bus operations.

  - AVI readers will be installed on one arterial facility to test the use of AVI information.

- **Houston *Smart Commuter* Operational Test.** The *Smart Commuter* ITS Operational Test is examining the potential for increasing utilization of high-occupancy commute modes, shifts in travel routes, and changes in trip departure times through use of advanced technologies. By providing quick and easy access to up-to-the-minute traffic conditions, bus schedules, and instant ride-matching services, travelers will be more likely to use high-occupancy commute modes.

  The *Smart Commuter* project includes two different, but compatible components intended to better utilize Houston's HOV system. The I-45 North bus component

focuses on the traditional suburban-to-downtown travel market. Current traffic and transit information will be provided in the home and work place to enable changes in travel mode, route, or trip departure time.

The second component focuses on the suburb-to-suburb travel market in the I-10 West corridor to the Post Oak/Galleria area. A real-time carpool matching system will be used to encourage a mode shift from driving alone to carpooling.

- **Regional Computerized Traffic Signal System (RCTSS).** RCTSS is a joint effort of local governments to modernize and coordinate control of some 2,800 traffic signals in the Houston area. Funding for the project is being provided by METRO, the City of Houston, and FTA. The system will handle day-to-day traffic management of signalized intersections and will be responsive to traffic diverted from freeways onto the arterial and frontage road system as a result of freeway incidents. The RCTSS will also permit emergency vehicle and transit priority handling at individual intersections.

- **Priority Corridor.** As noted previously, Houston was designated by the USDOT as one of the four ITS Priority Corridors in the nation. The Houston District of TxDOT is administering the program, which includes the development of a twenty-year Houston Priority Corridor Program Plan. This will outline all of the projects anticipated to be developed as part of the program. Approvals have been received for three early deployment projects. These are a CCTV system for special event traffic management near the Houston Astrodome, expansion of the AVI system to provide broader area coverage, and a dynamic lane assignment system for selected frontage roads.

- **Smart Bus Project.** The Smart Bus Project is being developed by METRO, with funding from the FTA. The project incorporates numerous advanced technology features into regular route buses. Elements of the Smart Bus include an automatic vehicle location (AVL) system, an advanced radio communication system, automatic passenger counting, automated fare collection, a silent alarm, automated fuel and engine monitoring, an automated stop annunciator system, and other components.

Appendix A provides a listing of existing ITS projects in the Houston area, as well as some transit-related projects that might be appropriate for future implementation. The ITS projects are categorized according to function; projects that address both transportation demand and supply, as well as supporting elements such as enforcement and safety, are included.

The initial project listing was rated by representatives from METRO, TxDOT, HGAC, and GHTEMC. The composite ratings are included in the tables in Appendix A. This process was used by METRO to identify ten projects for further development. Preliminary descriptions of these projects were prepared and are provided in Chapter Five. The list of ITS projects in Appendix A does not purport to be exhaustive, although it does attempt to address the breadth

and variety of projects appropriate for implementation in Houston. Further, the list may not include all the applications directed at internal agency functions. Rather, it focuses on ITS applications that have a more direct impact on services provided to the public.

Many of the projects listed in Appendix A cannot be fully deployed until basic elements of the ITS infrastructure are in place. For example, real-time traffic information cannot be provided without some type of traffic monitoring system. Further, real-time transit information cannot be provided without an automatic vehicle location (AVL) system. Thus, some of the projects outlined depend on the deployment of other elements. Other projects are less dependent on ITS infrastructure elements and could be implemented as stand alone projects.

Chapter Five

PRELIMINARY DESCRIPTION OF SELECTED PROJECTS

Ten possible transit ITS projects were identified for more detailed examination and implementation. Preliminary descriptions have been prepared on each to help facilitate the development and deployment of these projects. The following project descriptions are intended to illustrate the basic concept and scope of each, along with a general approach, cost, and schedule. Each summary includes a discussion of the project objective, the project description, the project evaluation, possible funding sources, and an anticipated schedule. These preliminary descriptions can be used to develop more detailed proposals for submission to different funding agencies. It is realized that the information presented in this chapter may be modified and updated as specific proposals are prepared. The ten projects included in this chapter are noted below.

- Real-Time Information Kiosks
- Integrating Transit into the Greater Houston Transportation and Emergency Management Center
- Talking Bus Stop for Visually Impaired Riders
- Automatic In-Home Notification of Bus Arrival
- Bus Collision Avoidance Warning System
- Enhancing Enforcement and Safety of HOV Lanes
- Real-Time Scheduling
- Automated Reservation System
- Real-Time Dispatching
- Personalized Public Transit

1. Real-time Information Kiosks

Project Objective: Currently, real-time traffic information (average speeds and travel times) is available through the AVI system in the Houston Interim Transportation and Emergency Management Center. A major intent of this system is to provide real-time information on traffic conditions to commuters, travelers, and commercial operators. For example, this system is being used in the Houston *Smart Commuter* project to provide real-time traffic information to a small group of commuters in the I-45 North corridor in their home and work place. In addition, METRO will be implementing an automatic vehicle location (AVL) system with their regular route bus system in the near future. This will provide the opportunity for bus passengers and potential riders to obtain real-time information on the status of buses. The potential exists to greatly expand and enhance the availability of real-time traffic and transit information to a wide range of users, allowing them to make more informed travel choices. Further, the real-time transit information could be provided in both visual and audio formats to enhance the ability of visually impaired or disabled individuals to use the bus.

This project will focus on expanding the availability of real-time traffic and transit information to commuters and travelers in the Priority Corridor area. Specifically, the project will deploy and test the use of real-time kiosks at activity centers to enhance the travel decision making process of commuters and travelers. Thus, the focus of the demonstration is on providing improved information to transit and roadway system users to help them select the best travel mode, travel route, and time of travel based on current traffic conditions and transit options. The use of these kiosks will be monitored and evaluated as part of the project.

Project Description: This demonstration will focus on deploying ten real-time information kiosks in the Priority Corridor. Development of the systems will build on the experience gained in Houston through the Digiplan Maps, the U.S. 59 reconstruction information displays at Greenway Plaza, and the *Smart Commuter* Operational Test, as well as on the experience in other areas, such as California. This demonstration will include the development and evaluation of real-time information kiosks. AVL data will be used to provide the real-time bus information. If the AVL data is not available upon implementation of the kiosks, or if the AVL data is not available due to system failure, then the kiosks will provide static bus information. Bus information provided will include arrival and/or departure times. In addition, the bus information system may include recent route/schedule changes, special event services, promotional events, fare information, and other information needed by the transit rider. Thus, individuals will be able to access all the information needed to make their trip. The information will be provided in both visual and audio format at one location where visually impaired travelers are known to visit, to address the requirements of the American with Disabilities Act (ADA). Real-time traffic information will include the AVI graphic and text information, incident information, and construction/maintenance information.

These kiosks will be located at ten major activity centers, such as transit centers, shopping centers, truck terminals, major office buildings, and other employment centers. It is envisioned that three different kiosk applications would be deployed, tailored to the type of

locations and type of traveler served. Kiosks with only transit information would be employed at transit centers and park-and-ride lots, while only traffic information would be provided at CBD parking garages and commercial vehicle terminals (e.g., package delivery company, taxi dispatch). Both traffic and transit information would be provided at such locations as office buildings, shopping centers, or the Texas Medical Center. The experience gained from this demonstration will be used to expand the use of information kiosks in the Houston area. It will also be used to enhance the development of interactive information kiosks in the future.

The following tasks are proposed as part of the project:

1. Finalize a detailed implementation, evaluation plan, and request for technical proposal (RFTP).
2. Procure real-time visual and audio kiosks.
3. Install kiosks at ten locations throughout the Priority Corridors area.
4. Operate the kiosks for a one-year period of time.
5. Conduct an evaluation to determine the utility and effectiveness of kiosks.
6. Prepare a final report on the kiosk demonstration project.

Project Evaluation: The evaluation of the utility and effectiveness of the real-time information kiosks will be a major element of the demonstration. The project evaluation will be conducted focusing on the following objectives:

- To determine the technical feasibility of the provision of real-time traffic and transit information through visual and audio kiosk technology.
- To assess the effect of real-time traffic and transit information on changes in commute modes, travel routes, and time of travel of system users.
- To enhance the understanding of information display technology for visually impaired individuals.
- To enhance the understanding of customer preferences related to different types of technologies for receiving real-time traffic and transit information through the testing of the real-time information kiosk.

Budget Estimate: The estimated cost to undertake the design, implementation, and one-year operation of the system is estimated to be $500,000. Conduct of the study needs, development of the system requirements, and evaluation are estimated to be $250,000 for a total project cost of $750.000. The general breakdown of costs by tasks is as follows.

Task 1:	$100,000
Task 2:	$400,000
Task 3:	$ 50,000
Task 4:	$ 50,000
Task 5:	$125,000
Task 6:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include the Priority Corridor Program, CMAQ, and Section 9.

Table 2. Anticipated Schedule: Real-time Information Kiosks, Duration 24 months

Task	Year 1		Year 2	
1. Finalize implementation and evaluation plan, and develop system requirements.	6 months			
2. Procure real-time kiosks.		6 months		
3. Install kiosks at ten locations.		3 months		
4. Test kiosks for one year.			12 months	
5. Conduct evaluation.			12 months	
6. Prepare a final report.				3 months

2. Integrating Transit into the Greater Houston Transportation and Emergency Management Center

Project Objective: The Greater Houston Transportation and Emergency Management Center (GHTEMC) is currently being developed in the Houston area. This facility, which is being developed jointly by METRO and TxDOT, will provide a state-of-the-art advanced transportation management system (ATMS) for the Houston area. In order to ensure that the benefits of the center are fully realized, the center must be an integrated multimodal management system, with all modes included. Ensuring that public transportation is fully integrated into the GHTEMC is critical to achieving the desired goals of the center.

A research project conducted by the Texas A&M University ITS Research Center of Excellence (RCE) is focusing on the functional, operational, and informational needs of public transit operators within advanced traffic management systems and central control centers. It is also examining the potential use of transit vehicles to provide real-time traffic information to ATMS, the current state-of-the-art practices associated with transit integration into advanced traffic management systems, and the identification and resolution of potential institutional issues and other concerns associated with multimodal approaches to ATMS. This project is being jointly funded by FHWA, METRO, and TxDOT. The results of this research will be the development of general guidelines to be considered when integrating transit into advanced traffic management systems.

This project will develop detailed specifications to integrate transit operations into the GHTEMC, which will be based on the general guidelines resulting from the RCE research project. It will also develop a standard interface for linking into the GHTEMC, enhancing the ability to integrate additional transit components or other elements in the future. METRO transit operations that will be evaluated for integration into the GHTEMC include the regular route transit system, the METROLift paratransit system, and the rideshare system. The project will outline the steps and activities necessary to accomplish this integration, and will identify any special equipment that will be needed to ensure the integration of transit operations into the advanced traffic management system.

Project Description: The results from the study being conducted through the RCE will provide the basis for the work to be conducted in this project. The RCE study is developing a set of general conceptual guidelines for integrating transit into ATMS and central control centers, such as the GHTEMC. This project will utilize this information and will develop detailed specifications for the integration of METRO transit functions into the GHTEMC. The transit operations to be integrated will focus on the regular route, METROLift, and rideshare services. Transit functions considered in this process will include scheduling, dispatching, operations, public information, emergency response, and other support services. In addition, the project will develop a standard interface for linking additional transit components or other elements into the GHTEMC.

The detailed specifications will identify which functions should be located within the GHTEMC, which functions can be located off-site, and how communications among modes will be integrated within the center and to other locations. It will also outline the hardware and software necessary to integrate these functions into the GHTEMC and will develop a standard interface. This effort will be coordinated with the development of the system architecture for the GHTEMC.

The following tasks are proposed as part of this project:

1. Develop a detailed implementation and evaluation plan.
2. Prepare a detailed assessment of the METRO services and functions to be included in the GHTEMC.
3. Prepare detailed specifications for hardware and software needs to integrate METRO services into the GHTEMC and develop a standard interface.
4. Coordinate with the system architecture efforts to assure that the system architecture can accommodate the integration of transit.
5. Evaluate the costs and benefits of integrating transit into the GHTEMC.
6. Prepare a final report documenting the detailed specifications.

Project Evaluation: The evaluation of the integration of transit into the GHTEMC will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To determine the costs and benefits of integrating Houston METRO transit operations into the GHTEMC.
- To enhance the understanding of the institutional and technical issues associated with the integration of transit into ATMS and the development of multimodal transportation management centers.
- To determine the hardware and software needs to fully integrate METRO transit operations into the GHTEMC and to develop a standard interface.

Budget Estimate: The estimated cost to undertake the development of detailed specifications, a standard interface, and evaluation is $400,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$ 50,000
Task 3:	$200,000
Task 4:	$ 50,000
Task 5:	$ 50,000
Task 6:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include the Priority Corridors Program, STP, CMAQ, and Section 9.

Table 3. Anticipated Schedule: Integrating Transit into the GHTEMC, Duration 18 Months

Task	Year 1	Year 2
1. Finalize implementation and evaluation plan.	3 months	
2. Detailed assessment of services and functions to be included in GHTEMC.	3 months	
3. Detailed assessment of hardware and software needs, and develop standard interface.	6 months	
4. Coordinate with system architecture.	Ongoing	
5. Evaluate costs and benefits of integration.	6 months	
6. Prepare final report.		3 months

3. Talking Bus Stop for Visually Impaired Riders

Project Objective: The Americans with Disabilities Act (ADA) of 1990 represents a far reaching law designed to prohibit discrimination against individuals with physical or mental disabilities. The ADA, and subsequent regulations promulgated by federal agencies, place a number of requirements on public transit systems. These regulations require the provision of both regular route accessible services and specialized paratransit services, the announcement of stops on regular route systems, the availability of information to all disabled groups, and accessible facilities. Transit systems throughout the country are implementing a wide range of services and programs to better address the needs of disabled individuals. ITS technologies offer the opportunity to greatly improve the provision of transit information to disabled individuals, thus enhancing their mobility.

This project will focus on the development and testing of a talking bus stop to provide static or real-time bus information in an audio format to visually impaired persons. The project will be coordinated with the real-time information kiosks and other activities being conducted by METRO and TxDOT, and the development of a *Best Bus Route* by METRO, which is applying ITS technologies on one route. The demonstration project will develop a talking bus stop that will provide static transit information and that can be linked into METRO's automatic vehicle location (AVL) system in the future to provide real-time bus status information. The use of a talking bus stop will be monitored and evaluated as part of this project.

Project Description: This project will focus on the development of a talking bus stop along a selected bus route which is utilized by visually impaired individuals. Possible routes to be considered include the 3 Langley-West Gray, the 1 Hospital, and the 15 Fulton-Hiram Clark Route, which is the *Best Bus Route* being implemented by METRO. Development of the talking bus stop will build on the experience gained in Houston with the use of transit information displays, as well as projects in other parts of the country. The demonstration will include the development of the talking bus stop technology, the implementation of the talking bus stop at a stop along the selected route and the evaluation of the system. AVL data may be used to provide the real-time bus and route information or static information will be used if the AVL system is not in place. A stop with a significant number of visually impaired passengers and potential riders will be selected to implement the project.

The following tasks are proposed as part of this project:

1. Develop a detailed implementation and evaluation plan.
2. Prepare a detailed assessment of the services and functions to be included in the talking bus stop, and a detailed specifications or RFTP for equipment and software needs for the talking bus stop.
3. Procure talking bus stop and locate at one stop.
4. Operate and evaluate the talking bus stop for one year.
5. Evaluate the use, cost, and benefits of the talking bus stop.
6. Prepare a final report on the talking bus stop demonstration project.

Project Evaluation: The evaluation of the talking bus stop for visually impaired riders will be a major element of this project. The project evaluation will be conducted focusing on the following objectives:

- To determine the technical feasibility of the provisions of static or real-time audio information at a bus stop.
- To determine the effectiveness of providing static or real-time audio information on the status of buses to visually impaired riders.
- To enhance the understanding of informational needs of visually impaired transit riders.

Budget Estimate: The estimated cost to undertake the development of detailed specifications for a talking bus stop, implementing a test of the system, and evaluating the test is $500,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$ 50,000
Task 3:	$300,000
Task 4:	$ 25,000
Task 5:	$100,000
Task 6:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include Section 9, Section 3, and the Priority Corridors Program.

Table 4. Anticipated Schedule: Talking Bus Stop for Visually Impaired Riders, Duration 24 Months

Task	Year 1	Year 2
1. Develop a detailed implementation and evaluation plan.	3 months	
2. Prepare detailed assessment of the services and functions to be included in the talking bus stop, and detailed specifications for equipment and software needs for the talking bus stop.	3 months	
3. Procure talking bus stop.	6 months	
4. Operate and evaluate the talking bus for one year.		Ongoing
5. Evaluate the talking bus stop.		3 months
6. Prepare a final report documenting the project.		3 months

4. Automatic In-Home Notification of Bus Arrival

Project Objective: Transit systems throughout the country are exploring different ways to enhance the convenience of all types of transit services to maintain current ridership levels and to attract new patrons. In comparison with the private automobile, one of the less convenient aspects of using public transit services is waiting for the vehicle at bus stops or stations. This can be especially inconvenient during inclement weather. Additionally, the uncertainty associated with not knowing when the transit vehicle will arrive adds another disincentive to using public transportation. Providing automatic notification to individuals in their home that the bus they wished to take is approaching their stop represents one way to enhance the convenience of public transit services.

This project will focus on the development and testing of an in-home bus status notification system. The demonstration will test the use of this system along the 15 Fulton-Hiram Clark Route, METRO's *Best Bus Route*. Thus, the project will examine the impact of an in-home bus notification system on retaining existing transit users and attracting new riders. The use of this system will be monitored and evaluated as part of this project.

Project Description: This demonstration will develop and test the use of an in-home bus status notification system along the 15 Fulton-Hiram Clark Route. The system will link AVL data on the location of buses to an in-home notification device. This system will allow individuals to obtain real-time information on the status of the specific bus they wish to take. It is anticipated that the system will provide both visual and audio information. For example, a video device may be used so that a rider can monitor the status of a vehicle approaching their stop. In addition, the potential of designing the system so that individuals can request a page to notify them that the bus they wish to take is approaching their stop will be explored. This system will enhance the convenience and safety of using the bus. It is anticipated the demonstration will provide this system to approximately 25 homes along the 15 Fulton-Hiram Clark Route.

The following tasks are proposed as part of this project:

1. Develop a detailed implementation and evaluation plan.
2. Prepare a detailed assessment of the services and functions to be included in the automatic notification program and develop a request for technical proposals (RFTP).
3. Procure an in-home bus arrival notification system.
4. Install the bus arrival notification system in approximately 25 homes along the 15 Fulton-Hiram Clark Route and test for one year.
5. Monitor and evaluate the use of the in-home bus arrival notification system.
6. Prepare a final report documenting the findings of the demonstration.

Project Evaluation: The evaluation of the in-home bus arrival notification system will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To determine the hardware and software needs for an automatic in-home bus status notification system.
- To assess the technologies utilized in the automatic bus notification system.
- To test the use of an automatic bus notification system.
- To enhance the understanding of the institutional and technical issues associated with the automatic in-home and in-office notification.
- To determine changes in travel characteristics related to the use of the bus notification system.

Budget Estimate: The estimated cost to undertake the development, implementation and evaluation of the automatic in-home and in-office notification is $850,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$100,000
Task 3:	$500,000
Task 4:	$100,000
Task 5:	$100,000
Task 6:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include Section 9, Section 3, the Priority Corridors Program, and CMAQ.

Table 5. Anticipated Schedule: Automatic In-Home or In-Office Notification, Duration 24 Months

Task	Year 1	Year 2
1. Develop a detailed implementation and evaluation plan.	3 months	
2. Prepare detailed assessment of the services, functions to be included in the automatic notification program.	6 months	
3. Procure in-home bus arrival notification system.	9 months	
4. Install system in approximately 25 homes and test for one year.	1 year	
5. Monitor and evaluate.	1 year	
6 Prepare a final report documenting the findings of the project.		3 months

5. Bus Collision Avoidance Warning System

Project Objective: Public transit buses are susceptible to being hit from behind by other vehicles and to other types of accidents. This is due to the fact that buses make numerous stops to pick up and drop off passengers and accelerate slower than automobiles. Further, articulated buses make wider turns at intersections. All of these factors contribute to increasing the likelihood that public transit buses may be hit by other vehicles or involved in accidents and incidents. This may result in property damage, personal injury, and increased repair, replacement, and insurance costs for the transit agency.

Utilizing ITS and other advanced technologies for in-vehicle crash avoidance systems and enhancing vehicle safety represent a major focus of current ITS research and development, demonstration projects, operational tests, and full scale deployment activities. To date most of these efforts have focused on commercial vehicles, however. This project will examine the use of ITS technologies for bus collision avoidance warning systems and will develop and test a collision avoidance system on METRO vehicles.

Project Description: This project will examine and test ITS technologies for use in a bus collision avoidance warning system. It will analyze the different technologies being utilized by commercial vehicle operators and will develop a system for use in public transportation vehicles. A prototype system will be designed and tested first in a limited environment and then in regular METRO service. Issues to be examined in the development of the system include identifying technologies for longitudinal, lateral, and intersection collision avoidance. This will include examining technology to sense the potential of impending collisions, monitoring the operator's avoidance actions, and temporarily controlling the bus. The project will develop, test, and evaluate a prototype bus collision avoidance system in an urban environment. The monitoring and evaluation of the prototype bus collision avoidance system on one to five buses will be a major component of the project.

The following tasks are proposed as part of this project:

1. Develop a detailed implementation and evaluation plan for the project.
2. Develop a prototype bus collision avoidance system based on an examination of available ITS technologies on current commercial vehicle applications.
3. Prepare detailed specifications for hardware and software needs for the prototype system and develop requests for technical proposals (RFTP).
4. Procure the prototype bus collision avoidance warning system.
5. Test the prototype system in a limited environment and in regular METRO service.
6. Evaluate the performance of the prototype collision avoidance warning system as well as the costs and benefits.
7. Prepare a final report documenting the project.

Project Evaluation: The evaluation of the prototype bus collision avoidance warning systems will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To determine the applicability of collision avoidance warning systems with public transit vehicles.
- To assess the technology utilized in a bus collision avoidance warning system.
- To develop and test a prototype bus collision avoidance warning system.
- To enhance the understanding of the technical and human factor issues associated with the implementation and operation of a bus collision avoidance warning system.
- To assess the reduction in accidents related to the use of a bus collision avoidance warning system.

Budget Estimate: The estimated cost to undertake the development of detailed specifications, implementation, and evaluation of the bus collision avoidance warning system is $900,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$100,000
Task 3:	$ 50,000
Task 4:	$500,000
Task 5:	$100,000
Task 6:	$100,000
Task 7:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include Section 9, Section 3, IVHS IDEA Program, and the Priority Corridors Program.

Table 6. Anticipated Schedule: Bus Collision Avoidance Warning System, Duration 36 Months

Task	Year 1	Year 2	Year 3
1. Develop a detailed implementation and evaluation plan.	3 months		
2. Develop a prototype bus collision avoidance warning system.	6 months		
3. Prepare detailed assessment of the hardware and software and RFTP.	6 months		
4. Procure the prototype bus collision avoidance system.		6 months	
5. Test the prototype system in a limited environment and in regular service.		1 year	
6. Evaluate performance of the prototype bus collision avoidance system, as well as the costs, benefits, and human factor issues.		1 year	
7. Prepare a final report documenting the findings of the project.			3 months

6. Enhancing Enforcement and Safety of HOV Lanes

Project Objective: Houston has the most extensive system of barrier-separated HOV lanes in the country. Currently, approximately 65 miles of a planned 105-mile system are in operation. The HOV lanes, and associated support facilities, have been jointly developed by METRO and TxDOT. METRO is responsible for the day-to-day operation and enforcement of the HOV lanes. Ensuring that the HOV lanes are operated in a safe and efficient manner is critical. This includes ensuring that the vehicle occupancy requirements are being enforced, that speed limits are adhered to, and that wrong way movements are prevented. The utilization of ITS and other advanced technologies may help enhance enforcement and safety of HOV facilities.

This project will examine the potential application of ITS and other advanced technologies to enhance the enforcement of vehicle occupancy requirements on the Houston HOV lanes. It will also explore the use of ITS to prevent wrong way movements in the HOV lanes. The most realistic technologies will be identified and prototype systems will be developed and tested. These demonstrations will be monitored and evaluated as part of the project.

Project Description: Historically, enforcement of the Houston HOV lanes, and other HOV facilities throughout the country, have relied on visual observation techniques. Enforcement personnel visually monitor vehicle occupancy levels and pull violators over into an enforcement area. The implementation of an HOV enforcement system that utilizes advanced technology may augment the current system, which would provide benefits by enhancing the effectiveness, efficiency, and safety of the officers. It would also serve as a deterrent to potential violators, because enforcement would be provided not only by officers, who are generally very visible in patrol cars, but also through advanced technologies in use whenever the lanes are open. Further, ITS technologies will be examined for use in monitoring the overall status of the HOV lanes, for preventing wrong way movements, and for identifying and responding to incidents and accidents.

On a national level, a variety of potential HOV enforcement applications utilizing advanced technology have been identified which may be appropriate for implementation in this project. This project will be coordinated with other activities underway throughout the country, including the study being conducted by TTI, DART, and TxDOT evaluating automated enforcement techniques on the East R. L. Thornton HOV lane in Dallas. A number of technologies will be examined including video enforcement, AVI enforcement, machine vision enforcement, and other approaches. The most realistic technologies will be identified for testing, and one technology will be selected for limited demonstrations on the Houston HOV lanes. The demonstrations will be implemented and evaluated over a one-year time period.

The following tasks are proposed as part of this project:

1. Develop a detailed implementation and evaluation plan for assessing the use of ITS technologies for enhancing HOV enforcement and safety.
2. Evaluate potential ITS technologies for enhancing enforcement and safety on HOV facilities, including a review of existing projects, and identify a realistic demonstration project.
3. Prepare a detailed assessment of the functions and capabilities needed for an ITS HOV lane enforcement and safety system, prepare detailed specifications for equipment, hardware and software needs for the demonstration, and the RFTP.
4. Issue RFTP and secure system for the demonstration.
5. Implement the demonstration project and operate over a one-year time period.
6. Monitor and evaluate the demonstration.
7. Prepare a final report documenting the project.

Project Evaluation: The evaluation of the demonstrations of ITS technologies to enhance HOV lane enforcement and safety will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To assess ITS and other advanced technologies that may be appropriate for use to enhance HOV lane enforcement and safety.
- To test the use of ITS technologies to enhance HOV lane enforcement and safety.
- To determine the equipment, hardware, and software needs for HOV lane enforcement.
- To determine the costs, benefits, and effectiveness of the ITS technologies tested.
- To enhance the understanding of the institutional and technical issues associated with enhancing HOV lane enforcement and safety.

Budget Estimate: The estimated cost to undertake the development of detailed specifications, implementation of the demonstration, and evaluation of the test using ITS to enhance HOV lane enforcement and safety is $600,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$ 25,000
Task 3:	$ 50,000
Task 4:	$ 25,000
Task 5:	$400,000
Task 6:	$ 50,000
Task 7:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include NHS, STP, CMAQ, and the Priority Corridors Program.

Table 7. Anticipated Schedule: HOV Enforcement, Duration 24 Months

Task	Year 1	Year 2
1. Develop a detailed implementation and evaluation plan.	3 months	
2. Evaluate potential ITS technologies and identify realistic demonstration project.	3 months	
3. Prepare detailed assessment of the functions and capabilities, hardware and software specifications and RFTP.	6 months	
4 Issue RFTPs and procure system.	6 months	
5. Implement demonstrations over a one-year time period.		1 year
6. Monitor and evaluate demonstration projects.		1 year
7. Prepare a final report documenting the project.		3 months

7. Real-time Scheduling

Project Objective: Today's demand-responsive systems in the United States require advance scheduling of trips by clients. This includes services oriented toward elderly and disabled individuals, as well as those oriented toward the general population. In many cases, reservations for a trip must be made 24 hours in advance. This requirement is needed by demand-responsive systems to allow time to match the origins and destinations of trip requests with available vehicles. This advanced notification requirement is inconvenient for riders. Further, operators have a difficult time responding to changes in passenger schedules, such as doctor's appointments taking longer than anticipated. As a result of the ADA and a desire to improve specialized services, many transit systems are exploring ways to reduce or eliminate advance reservation requirements.

The use of real-time scheduling systems represent one approach to significantly cut down the advance booking time now required by most transit agencies. The ability to implement a real-time scheduling system is dependent on the ability to locate and monitor the status of shared-ride vehicles. Thus, an AVL system represents a critical component of a real-time scheduling system. METRO is currently using an AVL system with its specialized services system. The real-time scheduling system will improve the productivity of fleets and provide better services to its client.

This project will focus on the design and testing of a real-time scheduling system for demand-responsive transit. It will include an evaluation of available paratransit and taxicab scheduling packages, integrating these with the AVL system, and implementing and testing the system. The costs and benefits, and the impacts on clients, dispatchers, and operators will be monitored and evaluated as part of this project.

Project Description: This project will design and implement a real-time scheduling system with the specialized services offered by METRO. It will include an assessment of available scheduling packages, the design of an integrated real-time scheduling system linked to the AVL system, and the testing of the system over a one year period. The real-time scheduling system will be monitored and evaluated as part of the project. This evaluation will focus on the costs and benefits of the system; any design and development issues; and the impacts on and reactions of demand-responsive service clients, dispatchers, and operators.

The following tasks are proposed as part of this project:

1. Develop a detailed work program, implementation strategy, and evaluation plan.
2. Assess the state-of-the-art in paratransit and taxicab scheduling packages and develop a design for integrating these with the METRO AVL system into a real-time scheduling system.
3. Prepare a detailed assessment of the functions and capabilities for a real-time scheduling system and an RFTP.
4. Issue RFTP and secure a real-time scheduling system for demand responsive transit.
5. Implement and test the real-time scheduling system over a one-year time period.

6. Monitor and evaluate the real-time scheduling system.
7. Prepare a final report documenting the project.

Project Evaluation: The evaluation of the costs, benefits, and impacts on demand-responsive service clients, dispatchers, and operators of a real-time scheduling system will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To design an integrated real-time scheduling system using the AVL system.
- To determine the hardware and software needs for a real-time scheduling system.
- To determine the most cost effective and efficient method to implement and operate a real-time scheduling system.
- To enhance the understanding of the institutional, technical, and human factor issues associated with the development and implementation of a real-time scheduling system.
- To determine the impact of a real-time scheduling system on demand-responsive service customers, dispatchers, and operators.

Budget Estimate: The estimated cost to undertake the development, implementation, and evaluation of a real-time paratransit scheduling system is $900,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$ 50,000
Task 3:	$ 50,000
Task 4:	$500,000
Task 5:	$150,000
Task 6:	$100,000
Task 7:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include Section 9, the Transit Planning and Research Program, the IVHS IDEA Program, the Priority Corridors Program, and the RCE.

Table 8. Anticipated Schedule: Real-time Scheduling, Duration 24 Months

Task	Year 1	Year 2
1. Develop detailed work program, implementation strategy, and evaluation plan.	3 months	
2. Assess paratransit scheduling packages and develop design integration with AVL system.	6 months	
3. Prepare detailed assessment of functions and capabilities and RFTP.	6 months	
4. Issue RFTP and secure real-time scheduling package.	6 months	
5. Implement and test over one-year time period.		1 year
6. Monitor and evaluate real-time scheduling system.		1 year
7. Prepare final report document project.		3 months

8. Automated Reservation System

Project Objective: Currently, reservations for many paratransit systems, including specialized services, are taken manually. This requires dispatchers to record the trip request, and then match the origin, destination, and time with available vehicles. This project would build on the real-time scheduling system developed in the previous project to design and test an automated reservation system. This would allow specialized transit users to use an automated system to request and cancel rides. This could provide enhanced services to customers and greater efficiencies to transit agencies. This project will examine the use of an automated reservation system with the demand-responsive services and will develop and test a demonstration system in a selected area of Houston. The use of the automated reservation system will be monitored and evaluated as part of this project.

Project Description: This project will focus on the development and testing of an automated reservation system for the demand-responsive transit. It will include an assessment of the needs and capabilities of specialized transit users, the capabilities of existing automated reservation systems, and linking the reservation system to the real-time scheduling system and the AVL system. The costs and benefits of different technologies and approaches will be evaluated and a system will be designed for the specialized services offered by METRO. This system will be implemented and tested in a selected area in Houston. The use of this system will be evaluated over a one-year time period to determine its impact on specialized transit users, dispatchers, operators, and the cost and efficiency of the system. The monitoring and evaluation of the automated reservation system represents a significant component of the project.

The following tasks are proposed as part of this project:

1. Develop a detailed implementation and evaluation plan.
2. Prepare a detailed assessment of the services and functions to be included in the automated reservation system based on needs of demand-responsive transit users, dispatchers, and operators and the link to the real-time scheduling system.
3. Examine state-of-the-art automated reservation systems, prepare detailed specifications for hardware and software needs, and develop RFTP for a demonstration system.
4. Issue RFTP and procure demonstration demand-responsive automated reservation system.
5. Test automated reservation system in selected area for one year.
6. Evaluate the impact on demand-responsive transit users, dispatchers, and operators, and the costs and benefits of the demonstration.
7. Prepare a final report documenting the project.

Project Evaluation: The evaluation of the automated reservation system will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To determine the hardware and software needs for an automated paratransit reservation system.
- To determine the most cost effective and efficient method to provide an automated transit reservation system.
- To enhance the understanding of the institutional, technical, and human factor issues associated with the use of an automated paratransit reservation system.
- To enhance the understanding of the impact of an automated reservation system on specialized transit customers, dispatchers, and operators.

Budget Estimate: The estimated cost to undertake the development of detailed specifications, implementation, and evaluation is $900,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$ 50,000
Task 3:	$ 50,000
Task 4:	$500,000
Task 5:	$150,000
Task 6:	$100,000
Task 7:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include Section 9, the Transit Planning and Research Program, the IVHS IDEA program, the Priority Corridors Program, and the RCE.

Table 9. Anticipated Schedule: Automated Reservation System, Duration 30 Months

Task	Year 1	Year 2	Year 3
1. Develop detailed implementation and evaluation plan.	3 months		
2. Prepare detailed assessment of the services and functions based on needs of specialized transit users, dispatchers, and operators, and link to real-time scheduling system.	3 months		
3. Prepare detailed specifications for hardware and software needs and RFTP.	6 months		
4. Procure demonstration system.		6 months	
5. Test automated reservation system in selected area for one year.		1 year	
6. Evaluate the demonstration.		1 year	
7. Prepare a final report documenting the project.			3 months

9. Real-Time Dispatching

Project Objective: The scheduling and dispatching of regular route transit buses is not an easy process. The number of vehicles needed on a specific route will depend on the route length, passenger demand, headways, traffic conditions, and other factors. All of these elements are interrelated, and changes in one variable may impact the others. Most transit agencies attempt to maximize vehicle productivity by linking routes together, operating vehicles out of different facilities, and other strategies. Thus, a vehicle may be used on a number of different routes over the course of a day. Historically, vehicle scheduling or "run cutting" has been done manually. More recently, computerized scheduling packages have been used to try to improve this process and to maximize the productivity of all vehicles in the fleet.

There are a number of issues associated with manual and real-time scheduling. First, if a problem, such as an incident or accident, is encountered by a transit vehicle, service on the specific route may be disrupted along with service on other routes the bus was assigned to. Second, revising schedules in response to changes in demand, the need to add new service, and making other modifications is a somewhat time consuming process. The application of ITS, GIS, and other advanced technologies may provide the opportunity to greatly enhance the scheduling of regular route transit vehicles and to develop real-time scheduling capabilities. This project will examine the potential to improve current bus scheduling through the use of ITS technologies and will develop and test a real-time aided dispatching system with METRO regular route services. The system will be implemented and tested by METRO.

Project Description: This project will assess the current regular route scheduling system used by METRO, examine available advanced scheduling and dispatching packages, and design a real-time computer aided dispatching system. This system will be tested by METRO for one year. The assessment will include an examination of METRO's current and future scheduling needs, as well as how the scheduling program can be linked with the AVL system and the new traffic management system. The monitoring and evaluation of the regular route real-time computer aided dispatch system represents a major part of this project.

The following tasks are proposed as part of this project:

1. Develop a detailed study and evaluation plan.
2. Prepare detailed assessment of the services and functions to be included in a real-time computer aided regular route dispatching system including documentation of METRO's needs.
3. Assess the state-of-the-art in regular route scheduling and dispatching packages and design a system for METRO that links into the AVL, Smart Bus, and other advanced technology projects.
4. Prepare detailed specifications for hardware and software needs for regular route computer aided dispatching system and RFTPs.
5. Issue RFTP and procure system.
6. Test real-time computer aided dispatching system for one year.

7. Monitor and evaluate the system.
8. Prepare final report documenting the project.

Project Evaluation: The evaluation of the costs, benefits, and impacts of the transit real-time computer aided dispatching system will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To assess the state-of-the-art in transit computer aided dispatching systems.
- To assess the suitability of real-time computer aided dispatch for transit-applications.
- To determine the hardware and software needs for a transit real-time computer aided dispatching system.
- To design and test a computer aided dispatching system with METRO services.
- To assess the costs and benefits of a real-time dispatching system with transit services.
- To enhance the understanding of the institutional and technical issues associated with the development and implementation of a real-time computer aided transit dispatching system.

Budget Estimate: The estimated cost to undertake the development of detailed specifications, implementation, and evaluation of a computer aided dispatching system is $825,000. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$ 50,000
Task 3:	$100,000
Task 4:	$ 50,000
Task 5:	$400,000
Task 6:	$100,000
Task 7:	$ 75,000
Task 8:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include Section 9, the Transit Planning and Research Program, the IVHS IDEA Program, the Priority Corridors Program, and the RCE.

Table 10. Anticipated Schedule: Regular Route Computer Aided Dispatching System, Duration 24 Months

Task	Year 1	Year 2
1. Develop detailed study and evaluation plan.	3 months	
2. Detailed assessment of services and functions and METRO needs.	3 months	
3. Assess state-of-the-art and design system for METRO.	6 months	
4. Prepare specifications and RFTP.	3 months	
5. Issue RFTP and procure system.	6 months	
6. Test system for one year.		1 year
7. Monitor and evaluate test.		1 year
8. Prepare final report.		3 months

10. Personalized Public Transit

Project Objective: It is difficult to provide high levels of public transportation services in many suburban and low density areas. From the standpoint of a service operator, the demand is often too low to provide cost-effective regular route services. On the other hand, limited or infrequent service may not meet the travel needs of many potential customers. At the same time, paratransit services oriented toward both special user groups and the general population, are expensive to provide. One approach being considered in a few areas around the country is personalized public transit. A small publicly operated vehicle could provide on-demand services through automated reservations using the real-time scheduling and dispatching systems developed in the previous tasks. The main concept behind this approach is to maximize all available transit services in an area and to match the most appropriate service to the needs of the rider and available vehicles.

This project will utilize and build on the technologies developed under the previous projects. Automated reservation systems and real-time scheduling and dispatching, together with AVL systems, offer the potential to better allocate vehicle resources by continuously optimizing vehicle routing and maximizing the use of available capacity. This project will incorporate all the elements into a personalized public transit demonstration project. This demonstration will be implemented and evaluated in a selected area of Houston.

Project Description: This project will develop, implement, operate, and evaluate a personalized public transit demonstration project in a selected area of Houston. This will be accomplished by incorporating the automated reservation, the dynamic scheduling, the real-time dispatching, and the AVL system, as well as other advanced technologies. The demonstration will be operated in a selected area of Houston for one year.

The following tasks are proposed as part of this project:

1. Develop a detailed implementation and evaluation plan.
2. Prepare detailed assessment of the services to be included in the personalized public transit system.
3. Prepare detailed specifications for hardware and software needs for demonstrating personalized public transit system and develop RFTP.
4. Issue RFTP and procure demonstration personalized transit system.
5. Implement personalized public transit system in a selected area for one year.
6. Monitor and evaluate the costs and benefits of the personalized public transit demonstration.
7. Prepare a final report documenting the project.

Project Evaluation: The evaluation of the personalized public transit demonstration will be a major element of the project. The project evaluation will be conducted focusing on the following objectives:

- To determine the most cost effective and efficient method to provide personalized public transit.

- To determine the hardware and software needs to maintain a personalized public transit system.

- To enhance the understanding of the technical and institutional issues associated with the provision of personalized public transit.

- To determine the impact on ridership and transit operators from a personalized public transit system.

Budget Estimate: The estimated cost to undertake the development of detailed specifications, implementation, and evaluation of a demonstration personalized public transit system is $1.3 million. The anticipated cost breakdown by task is as follows.

Task 1:	$ 25,000
Task 2:	$ 50,000
Task 3:	$100,000
Task 4:	$500,000
Task 5:	$500,000
Task 6:	$100,000
Task 7:	$ 25,000

Potential Funding Sources: Potential funding sources for this project include Section 9, the Transit Planning and Research Program, the IVHS IDEA program, the Priority Corridors Program, and the RCE.

Table 11. Anticipated Schedule: Personalized Public Transit, Duration 24 Months

Task	Year 1	Year 2
1. Finalize implementation and evaluation plan.	3 months	
2. Detailed assessment of services to be included in the provision of personalized public transit.	3 months	
3. Detailed assessment of hardware and software needs for the provision of personalized public transit and RFTP.	6 months	
4. Procure demonstration system.	6 months	
5. Implement demonstration personalized public transit system.		1 year
6. Evaluation.		1 year
7. Prepare final report.		3 months

Chapter Six

CONCLUSIONS

This report has summarized current ITS efforts underway in the Houston area. It has also described projects in the planning and implementation stages. A definition of ITS was presented to help facilitate an understanding of the depth, breadth, scope, and diversity of ITS. The goals of the Houston ITS program were also outlined. The report described some of the federal, state, and local funding sources available for ITS projects. Preliminary descriptions of ten potential transit ITS projects were provided. Finally, a listing of current, planned, and possible ITS projects is provided in Appendix A.

The information in this report should be of use to all agencies and groups interested in enhancing the management and operation of the surface transportation system in Houston through the development and deployment of ITS. The document helps establish a common understanding of the goals of the Houston ITS program and provides an overview of current and planned projects and activities.

In addition, the report should be of use in the development of a more detailed ITS Strategic Plan for Houston, as well as the Priority Corridor Plan. Both of these efforts are being conducted through the coordinated and cooperative efforts of METRO, TxDOT, HGAC, and GHTEMC, with assistance from TTI. These plans will outline in greater detail the goals and objectives, projects, and schedule for the ITS program in Houston and in the Priority Corridor.

Appendix A

EXISTING, PLANNED, AND FUTURE ITS PROJECTS IN HOUSTON

Tables 12 through 19 provide a listing of existing ITS projects in the Houston area, as well as transit-related projects that may be appropriate for future implementation. The ITS projects are categorized according to general function. Projects dealing with transportation supply are presented first followed by those addressing the demand for transportation.

The tables provide information on the current status of projects and potential funding sources for those not yet implemented. The tables also highlight the composite rating of projects by representatives from METRO, TxDOT, HGAC, and GHTEMC. The legend for the information presented in the tables is provided on page 56.

The list of ITS projects does not purport to be exhaustive, although it does attempt to address the breadth and variety of projects appropriate for implementation in Houston. Further, the list may not include all the applications directed at internal agency functions. Rather, it focuses on ITS applications that have a more direct impact on services provided to the public. Some of the projects listed cannot be fully deployed until basic elements of the ITS infrastructure are in place. Thus, some of the projects outlined depend on the deployment of other elements. Other projects are less dependent on ITS infrastructure elements and could be implemented as stand alone projects.

Table 12. Supply—Operational Improvements

Item	Status[1]	Rating[2]	Potential Funding[3]
Transportation Management System			
• Interim Transportation and Emergency Management Center	E-M,T	--	--
• Greater Houston Transportation and Emergency Management Center	P-M,T	--	--
• Assessment of transit integration into Advanced Transportation Management System*	E-RCE	--	--
• Fully integrate transit and traffic operations	P-M,T	--	--
• Develop and utilize database for transportation planning and management	N	H	1,3
Development of a Corridor Program Plan	E-PC	--	--
Implementation of CCTV at Astrodome for special events	E-PC	--	--
Dynamic lane assignment controls			
• Demonstration - Dynamic lane assignment controls on frontage roads	E-PC	--	--
• Expand use of dynamic lane assignment controls	N	M	2,3
AVI for monitoring traffic and transit conditions	E-PC	--	--
• Demonstration - Test AVI in one or two arterial street corridors	N	H	2,3-b,c
• Expand AVI real-time traffic information collection to arterials	N	M	2,3-b,c
Monitoring/warning systems for freeway to freeway connections			
• Automated truck speed monitoring at ramps	E-T	M	--
Smart diamond intersection control			
• Develop design and initial tests	E-RCE	M	--
• Demonstration - Develop US 290 as a test bed for advanced traffic control	N	M	2,3
• Expand to other locations	N	M	2,3
Applications at Texas Medical Center			
• Real-time parking and transit information for non-Houstonians	N	M	1,2,3-b,c
• Dynamic guide signs	N	M	1,2,3-b
• Real-time shuttle service	N	M	1,2,3-b,c
• Pedestrian and bus user video camera surveillance	N	M	1,2,3-b
• Advanced traffic control at intersections	N	M	2,3-b,c
Signal priority for buses			
• Demonstration - One/two signals	N	H	1,2,3
• Demonstration - Corridor with high volume of buses	N	M	1,2,3
• Expand to other locations	N	M	1,2,3
Commercial vehicle applications			
• Demonstration - weigh in motion for trucks	N	M	2,3-a,b

* Note: The integration of transit into Advanced Transportation Management Systems is being examined in the Research Center of Excellence work task *Integrate Transit into Advanced Traffic Management Systems.*

See Legend, page 56.

Table 13. Supply—Incident Management

Item	Status[1]	Rating[2]	Potential Funding[3]
AVI probes for incident management of freeways	E-PC		--
Dynamic lane assignment system for traffic diversion within the priority corridor	E-PC		--
AVL for incident management	E-PC		--
Advanced railroad grade crossings monitoring	P-RCE	H	--
AVI probes for incident management on arterials			
• Demonstration - Test in selected arterial street corridor	N	M	2,3-b,c
• Expand to other arterial street corridors	N	M	2,3-b,c
• Demonstration - Portable AVI for shuttle buses	N	M	1,2,3-b,c
Video imaging for incident detection			
• Demonstration - Test in selected location	N	H	2,3
• Demonstration - Test in selected corridors	N	M	2,3
• Expand to full system	N	M	2,3
Incident management on arterials			
• Demonstration - Test in one or two corridors	N	M	2,3-b,c
• Expand to other areas	N	M	2,3-b,c
Weather impact, advanced notification of flooding problems			
• Demonstration - Test site along US 290 frontage roads	N	M	2,3-a,b
• Expand to other areas	N	M	2,3-a,b
• Advanced weather advisories (hurricane, thunderstorms, tornadoes)	N	M	2,3-a,b
Roadside aid station/smart call box	N	M	2,3-a,b
AVL for emergency vehicles	N	M	2,3-b
FM highway advisory radio	N	H	2,3
Mobile incident management vehicle for special events/incidents	N	M	2,3-b,c
Smart METRO police vehicle	P		--
• Demonstration - Enhanced in-vehicle capabilities	N	M	2
Motorist Assistance Program (MAP) expansions and enhancements	N	H	3-c

See Legend, page 56.

Table 14. Demand—Transit*

Item	Status[1]	Rating[2]	Potential Funding[3]
Advanced paratransit scheduling systems	E-M		--
Automated passenger information display systems			
• Digiplan maps	E-M		--
• Demonstration - Test real-time or next bus arrival information kiosks at high volume locations	N	H	2,3-b,c
• Demonstration - Expand to interactive kiosks	N	M	2,3-b,c
Smart Commuter real-time traffic and transit information			
• I-45 North Initial Telephone System	P-RCE	--	--
• I-45 North visual display device	P-M,T	--	--
• I-45 North additional device	P-RCE	--	--
• Expand to other corridors	N	M	1,2,3-b,c
Automated bus headsigns (with route name and number)	P-M	--	--
Vehicle automated stop annunciator system	P-M	--	--
Smart bus	P-M	--	--
Automatic vehicle location system			
• Demonstrate - Metrolift AVL system	E-M	--	--
• Demonstration - Add/test additional technologies	P-M,RCE	--	--
• Expand to full bus fleet	N	H	1,2,3-b,c
• Expand to all METRO vehicles, police, etc.	N	M	1,2,3-b,c
• Expand to Galveston and Woodlands Express	N	M	1,2,3-b,c
Automated refueling system	P-M	--	--
Automated passenger counting	P-M	--	--
Computerized bus routing and scheduling information system	N	H	1,2,3-b,c
Automated advanced passenger telephone information system	P-M	--	--
• Demonstration - Transit route network decision aid	N	M	1,2,3-b,c
• Expand to full system	N	M	1,2,3-b,c
• Expand to Galveston and Woodlands Express	N	M	1,2,3-b,c
Talking bus stop for visually impaired riders			
• Demonstration - test at one or two bus stops	N	H	1,2,3-b,c
• Expand to corridor	N	M	1,2,3-b,c
• Expand to full system	N	M	1,2,3-b,c
Smart card - automated fare collection			
• Demonstration - Smart METRO fare card	P-M	--	--
• Demonstration - Smart METRO multipurpose card	N	M	1,2,3-b,c
• Demonstration - Multivendor (taxi, etc.) smart card	N	M	1,2,3-b,c
• Demonstration - Expand to Galveston and Woodlands Express	N	M	1,2,3-b,c

* Note: Possible projects in this area will be explored in more detail through the Research Center of Excellence work task *Enhance Transit Operations and Innovative Services* in FY95.
See Legend, page 56.

Table 14. Demand—Transit* (Continued)

Item	Status[1]	Rating[2]	Potential Funding[3]
Real-time alternative bus route demonstration	N	M	1,2,3-b,c
Personalized public transit	N	M	1,2,3-b,c
Passenger bus stop enhancements			
• Demonstration - Video monitoring of selected bus stops	N	M	1,2,3-b,c
• Demonstration - Personal help call button at selected bus stops	N	H	1,2,3-b,c
• Demonstration - Motion activated lighting/video monitoring at selected stops	N	M	1,2,3-b,c
• Demonstration - Automatic in-home or in-office advanced notification of approaching bus at selected stops	N	M	1,2
Bus route enhancements			
• Demonstration - Test all concepts on one route	P-M	--	--
• Demonstration - AVL to track off-route vehicles	P-M	--	--
On-vehicle enhancements			
• Demonstration - On-vehicle video monitoring	N	M	1,2,3-b,c
• Demonstration - AVL, silent witness, and other advanced technologies to provide enhanced on-vehicle safety	P-M	--	--
Park-and-ride lot enhancements			
• Demonstration - Video monitoring of selected lots, both parking areas and passenger waiting areas	N	H	1,2,3-b,c
• Demonstration - Personal help call button at waiting area	N	H	1,2,3-b,c
• Personal help pager/emergency beeper	N	M	1,2,3-b,c
Transit center enhancements			
• Demonstration - Video monitoring of selected lots, both parking areas and passenger waiting areas	P-M	--	--
• Demonstration - Personal help call button at waiting area	N	H	1,2,3-b,c
• Personal help pager/emergency beeper	N	M	1,2,3-b,c

* Note: Possible projects in this area will be explored in more detail through the Research Center of Excellence work task *Enhance Transit Operations and Innovative Services* in FY95.

See Legend, page 56.

Table 15. Demand—TDM*

Item	Status[1]	Rating[2]	Potential Funding[3]
Rideshare enhancements			
• Advanced ridematching system	P-M	--	--
• Smart Commuter I-10 West real-time ridematching	P-M,T	--	--
• Expand real-time ridematching to other corridors/areas	N	M	1,2,3-b,c
• Integrate beeper/paging system to notify rides/riders	N	M	1,2,3-b,c
• Guaranteed ride home program enhancement	N	H	1,3-c
Parking management			
• Demonstration - Smart multipurpose card (parking, transit, commercial)	N	M	1,2,3-b,c
• Demonstration - AVI/smart card to track HOV mode use and ETR programs at one or two employers	N	M	1,2,3-b,c
• Demonstration - Verification of vehicle occupancy for reduced rideshare parking charges	N	M	2,3-b,c
Congestion pricing			
• Develop concept and approach to sell excess capacity to SOVs in one HOV lane	P-M,T	--	--
• Demonstration - implement and evaluate HOV congestion pricing test on one HOV lane	N	M	2,3-b,c

* Note: Possible projects in this area will be explored in more detail through the Research Center of Excellence work task *Enhance TDM and Transportation Control Measures* in FY95.

See Legend, page 56.

Table 16. Demand—HOV

Item	Status[1]	Rating[2]	Potential Funding[3]
HOV priority access			
• Demonstration - Use AVI to give HOVs priority access at one or two park-and-ride lots	N	M	2,3-b,c
• Expand to all lots in a corridor	N	M	2,3-b,c
Managing HOV lane demand			
• Demonstration - meter 2+ HOVs, allow 3+ HOVs and buses to pass at selected ramps	N	M	1,2,3-b,c
• Expand to other locations	N	M	1,2,3-b,c
Detection of wrong way movement in HOV lane			
• Ramp Control Signals - Test on Katy and Northwest	P-M	--	--
• Ramp Control Signals - Expand systemwide	P-M	--	--
• Infrared beam wrong way detection - Test on one or two HOV lanes	P-M	--	--
• Infrared beam wrong way detection - Expand to all HOV lanes	P-M	--	--
• Slip ramp automated closure devices - Initial test	P-M	--	--
• Slip ramp automated closure devices - Expand to other locations	P-M	--	--
Arterial Street Priority Access for HOV			
• Demonstration - Test in one arterial street corridor	N	M	1,2,3-b
• Expand to additional corridors	N	M	1,2,3-b

See Legend, page 56.

Table 17. Information Systems

Item	Status[1]	Rating[2]	Potential Funding[3]
In-vehicle navigation system			
• Demonstration - Commuter information in one corridor	N	M	2,3-b,c
• Expand to additional corridors	N	M	2,3-b,c
Commercial vehicle information systems			
• Demonstration - Real-time information for freight activities at the Houston Port	N	M	2,3-b,c
• Demonstration - Monitor container shuttle operations from Houston to Galveston, and from railroad terminal to port	N	M	2,3-b,c
• Demontration - In-vehicle and roadside Dynamatic Warning System	E	--	2
• Expand in-vehicle and roadside Dynamatic Warning System	P	M	2,3
Changeable message signs			
• Changeable message signs at limited locations	E	--	--
• Expand to additional locations	P,N	--	2,3
• Expand to incorporate real-time information	N	H	2,3
• Demonstration - Real-time HOV and general purpose travel time information at freeway entrance points	N	H	2,3

See Legend, page 56.

Table 18. Demand—Environmental

Item	Status[1]	Rating[2]	Potential Funding[3]
Monitoring and information systems for environmental conditions	N	M	2,3
Air quality analysis/air monitoring			
• Demonstration - Automated vehicle monitoring	N	M	2,3
• Demonstration - Automated detection of high polluting vehicles	N	M	2,3
• Ozone alert day	N	H	--

See Legend, page 56.

Table 19. Demand—Roadway/Vehicle Safety

Item	Status[1]	Rating[2]	Potential Funding[3]
Railroad grade crossing monitoring system	P-PC, RCE	--	--
Automated speed monitoring			
• Demonstration - automated monitoring and enforcement in one corridor	N	M	2
• Expand to other corridors	N	M	2
AVL for emergency vehicles	N	H	2
Enhanced motorist safety			
• Demonstration - Mayday systems for motorists in distress	N	M	2
• Expand mayday system region wide	N	M	2
• Demonstration - Roadside automated call box using cellular technology	N	M	2,3-b
• Crash avoidance for buses	N	M	1

See Legend, page 56.

Legend

[1] E = Existing.
P = Proposed.
N = New project.

-PC = Priority Corridor Project.
-M = METRO Project or Lead.
-T = TxDOT Project or Lead.
-RCE = Research Center of Excellence.

Note: Projects are identified as "new" if they are not currently being funded and are not currently programmed for funding in Houston. Thus, this includes applications of new technologies, applications of technologies that have not previously been used in Houston, as well as other projects that are not currently funded.

[2] Indicates ratings by METRO, TxDOT, HGAC, and GHTEMC staff as High (H), Medium (M), or Low (L). Only new projects are rated.

[3] 1 = FTA.
2 = Priority Corridor.
3 = FHWA/TxDOT

-a = National Highway System (NHS).
-b = Surface Transportation Program (STP).
-c = Congestion Mitigation and Air Quality Improvement (CMAQ).

Additionally, some of the listed projects can be funded as FHWA IVHS Operational Tests depending on specific types of IVHS user services included in subsequent program calls and ultimate selection by FHWA.

Also, most of the listed projects can be funded through METRO, and projects related to public roads can be funded through TxDOT. Eligibility would be based on project specifics and policies and procedures promulgated by the entities.

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