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16. Abstract This report documents a plan to provide advanced traveler information during a six-year period of major construction in downtown Houston. A literature review of Advance Traveler Information Systems (ATIS) with particular emphasis on construction projects is provided. Also documented in the report is the process used to develop the downtown plan through the oversight of an interagency committee. The traveler information plan includes two components: a short-range implementation strategy for the first two years of construction and a longer-range strategy beyond the initial two years. Issues related to data collection, data fusion, and information dissemination are presented for both strategies. The plan identifies improvements in the current process for data collection/fusion and techniques for wider traffic information dissemination downtown travelers. Longer term improvements include options for real-time data collection using detection and surveillance technologies. Resource estimates for capital investment, staffing, and ongoing maintenance and operations are also presented for both plans.			
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**DOWNTOWN/MIDTOWN CONSTRUCTION
TRAVELER INFORMATION SYSTEM PLAN**

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Research Project: Development of a Traveler Information System Plan

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SUMMARY

The purpose of this study is to develop a plan to provide travelers in downtown Houston with information on travel conditions affected by multiple construction projects over the next six years. The research study involves a review of Advanced Traveler Information Systems (ATIS) at the national level, focusing on those that have specific relevance to this project. With the guidance and direction of an interagency committee formed to facilitate coordination of downtown construction work, a short-term implementation plan has been developed. This plan defines data collection, information flow, and technology recommendations for downtown traveler information dissemination in a two-year time frame. In addition, this report presents long-range issues beyond the initial two-year period as they relate to the project objectives.

SHORT-RANGE IMPLEMENTATION PLAN

The near-term plan for improving downtown traveler information involves three critical elements: data collection, data fusion and information dissemination. The current process for data collection and fusion (overlaying the lane closure data onto a single map and into text format) is not optimum, but can be retained in the short term with several modifications to improve the accuracy, reliability and timeliness of information on preplanned lane closures. These improvements include (1) establishing a single clearinghouse for downtown work zone activity, most logically led by the City of Houston, and (2) strengthening contract language and permitting procedures to require greater responsibility and accountability for downtown mobility on the part of the contractor. The latter must be coupled with diligent enforcement. Initial capital and operating costs for improving the current data collection process are estimated at \$75,000, which includes one full-time staff position.

Information dissemination can be accomplished in several ways: traditional media, such as AM/FM radio, newspaper, and television; and other non-traditional methods, such as a web site, email listserv, voice mail system, changeable message signs, and information kiosks. The resources needed for enhanced traffic information dissemination have been estimated separately from data collection improvements described above. Table S-1 shows projected costs for each medium which the report describes more fully. The report also describes an approach to implementing these media using a public/private partnering effort.

TABLE S-1. INFORMATION DISSEMINATION MEDIA

Traveler Information Medium	Estimated Capital Costs (including development)	Annual Staff Resources Required	Estimated Annual Costs to Operate and Maintain	Time Frame for Implementation
Newspaper	\$0	0.05	\$2,250	Immediate
AM/FM Radio	\$0	0.05	\$2,250	Immediate
CMS (existing)	\$0	0.25	\$16,000	Immediate
Television	\$5,000	0.05	\$2,250	30 days
Web Site	\$10,000	0.5	\$23,000	60 days
Traffic Hotline	\$15,000	0.5	\$23,000	90 days
Email Listserv	\$10,000	0.5	\$23,000	120 days
CMS (new)	\$20,000/sign	0 ^s	\$5,000/sign	9 months
Kiosks	\$5,000/kiosk	0.25	\$5,000/kiosk	12 months

LONG-RANGE IMPLEMENTATION PLAN

Opportunities for further improvement in data collection are possible beyond the first two years through real-time methods of detection and surveillance. Providing more accurate and timely downtown mobility information can enhance the effectiveness of the dissemination media described in the short-range plan. Furthermore, as data accuracy and timeliness improve, so will the opportunities for new and innovative means of disseminating traffic information.

Detection of traffic problems in the downtown area can most effectively be achieved through phone calls, either cellular or land line. Establishing a free cellular number and publicizing its availability will increase utilization. In the long term, planned loop detectors installed over time may provide additional means of incident detection.

Part of this study examines a number of different video surveillance options. Preliminary capital costs range from \$ 280,000 to \$ 390,000, depending on the technology. Annual operating costs can run as high as \$ 270,000 per year for a leased fiber option, with the remaining options costing between \$ 77,000 and \$ 87,000 annually to operate and maintain. This does not include the cost of staffing the operations at TranStar. As many as fifteen cameras may be required in order to provide sufficient coverage of the downtown area during construction of the Downtown Transit Streets Project.

In the context of the downtown construction effort, which is a relatively short-term proposition, video surveillance can be used as a tool for incident verification and designed for that purpose alone. However, other long-term uses of camera technology for traffic and parking management are conceivable. A decision on the specific technology and the communication medium for video surveillance will depend not only on the financial resources available, but on the

expected long-term uses of video surveillance if permanent camera installation is desired. Once the goals of downtown video surveillance have been defined, further feasibility analysis and preliminary design work will be necessary in order to provide more detailed cost estimates and expected benefits. The long range plans for regional ATIS initiatives should also be considered in the final decision.



INTRODUCTION

In response to the intense level of planned construction work on downtown streets over the next five years, an interagency committee, referred to as "HOT TOPIC," was designed to be a clearinghouse for construction information. There are several factors influencing the committee in their pursuit of a workable traveler information system for downtown Houston. The initial impetus for both the committee's effort and the traveler information system development was the impending rehabilitation of a significant number of streets and sidewalks in downtown and the need to keep the public informed. The Downtown Transit Streets project funded by Houston METRO will take place over a six-year period beginning in early 1998.

The second factor affecting the pursuit of a traveler information system is Houston's status as a U.S. Department of Transportation (U.S. DOT) funded Priority Corridor site. As a priority corridor site, Houston "will showcase Intelligent Transportation Systems (ITS) concepts and technologies through implementation and evaluation of ITS projects directed at improving transportation systems operation" (1). Although not directly a part of the priority corridor program plan, the objectives of the downtown traveler information system are closely related to the objectives of several elements of the Priority Corridor. It is both logical and prudent that all of these projects proceed in a timely way.

Finally, access and mobility in downtown Houston can be significantly impacted by street or lane closures. Recent experience with the Franklin Street bridge project has demonstrated the value of interagency coordination in the planning and traffic routing associated with that project. The extensive public awareness effort associated with the closure of the Pierce Elevated (I-45) construction demonstrated the value of providing the public with the opportunity to adjust travel to construction activities. As numerous entities begin working on and under the streets of downtown Houston, the opportunity for compounding the impact of closures increases dramatically. In the absence of an effective means of collaborating among the numerous entities in the collection and dissemination of information, there is significant potential for serious disservice to the traveling public. This report will assist the public agencies in formulating an ATIS in downtown Houston during the reconstruction effort.

BACKGROUND

Downtown Houston is a critical center of economic activity in the region. In addition to the more than 130,000 workers concentrated in the central business district (CBD) on a daily basis, the core of the city is a focal point for entertainment and cultural activities. The preservation and expansion of downtown's role in economic development and entertainment activity within Houston is important to the city's long-term vibrancy. With this progress comes the temporary burden of street construction work that has the potential to affect the daily flow of commuters, the delivery of goods and services, and the attractiveness of downtown Houston as a non-work destination.

Projects currently underway, being proposed, or being considered in Downtown/Midtown Houston that affect traffic flow include the following:

- the Downtown Transit Streets Project, consisting of the reconstruction of 45 kilometers (28 miles) of downtown streets and sidewalks, and the construction of new bus shelters;
- the Franklin Street Bridge Project, involving replacement of a bridge structure that is a major access point to the CBD;
- the Louisiana Street Project, involving the replacement of a storm sewer and wastewater tunnel;
- the Pierce Elevated reconstruction, consisting of a major downtown freeway rehabilitation at the periphery of the CBD;
- utility relocation and construction associated with the proposed Downtown Stadium;
- the Cotswald Project, which aims to create a water garden and pedestrian mall out of a city street near the proposed stadium;
- planned chilled-water plant with distribution lines throughout the CBD;
- City of Houston storm sewer construction, such as a planned 2.6-meter (102-inch) trunk line down Austin Street;
- pavement reconstruction and retrofitting in preparation for the 1998 Houston Grand Prix; and
- various building construction and utility projects.

These projects represent a wide range of public and private entities, which complicates the ability to coordinate work effectively. Furthermore, poor coordination between the various public and private entities could exacerbate communicating weekly and daily lane closures to the motoring public.

THE CURRENT INFORMATION COLLECTION AND DISTRIBUTION PROCESS

In an effort to preserve downtown mobility to the greatest extent possible during a six-year period of ongoing construction, an informal inter-agency committee was assembled to serve as a clearinghouse for downtown construction information. The committee is referred to as "HOT-TOPIC," which stands for *H*ouston *T*raffic *T*ransit *O*perations *P*lanning *I*ncident *M*anagement *C*ommittee. The group meets monthly to focus on traffic issues associated with projects during the pre-construction and construction phases and hears reports from various entities regarding any projects or special events that affect downtown traffic movement. The agencies most actively

represented are Houston METRO, the City of Houston, and the Houston Downtown Management District, or Downtown District, which is a quasi-public organization that serves the interests of downtown businesses. Participation by the Texas Department of Transportation (TxDOT) occurs when a TxDOT-sponsored project takes place in the downtown area.

Two working subcommittees support the full committee: the Communications Subcommittee, which deals with the coordination of public relations and motorist information efforts, and the Police Subcommittee, which examines how the police can be active and coordinated in traffic control in construction areas. The Communications Subcommittee has established the current format for public information regarding downtown construction: the development and dissemination each week of a map depicting the locations of downtown construction activity. Construction information is solicited by the HOT TOPIC committee and submitted to Traffic Engineering and Design Systems, Inc. (TEDSI), a consultant under contract to assemble the weekly map. The map is then forwarded to the Downtown District for distribution to major building management by broadcast fax. The building management is responsible for determining exactly how they will use or publicize the information. Figure 1 illustrates this process.

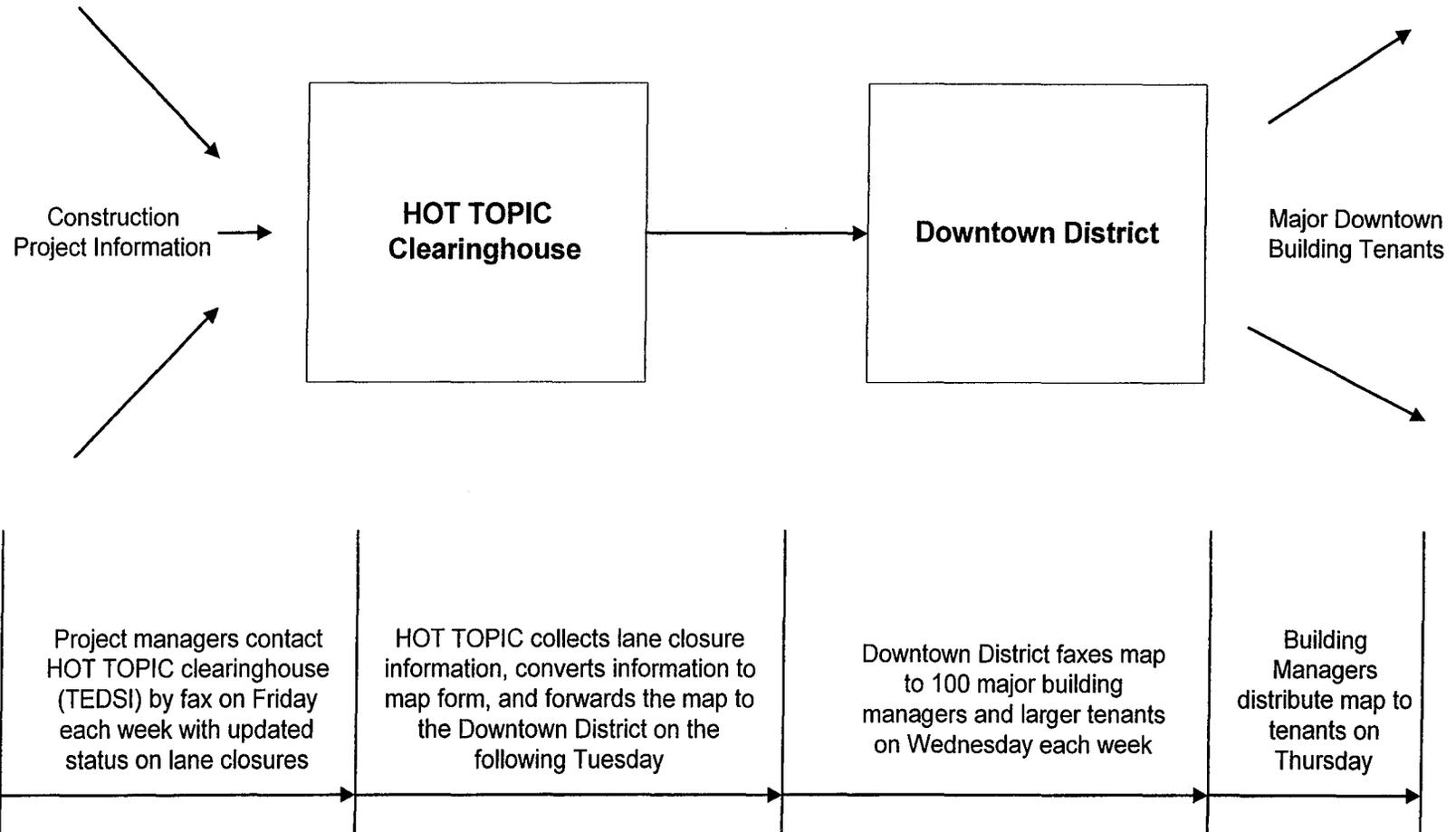
Appendix A includes a sample of the map and corresponding text format.

The current method of notifying the public, while sufficient as an initial approach to project coordination, possesses some inherent limitations:

- The method of information collection is limited to the degree of participation by those directly overseeing construction on downtown streets. Data collection on lane closures is contingent upon those parties contacting the "clearinghouse" on a weekly basis. In the absence of that weekly contact, there are limited resources available to monitor construction zones and assess daily or weekly changes that impact lane closures.
- Given the ever-changing nature of construction work, particularly in older streets where underground utility locations are not as well documented, information published on a weekly time frame can potentially be out-of-date within days.
- It is unknown to what extent the building tenants are providing the lane closure information to employees by either distributing or posting the map.

This research project provides a plan to build upon the positive direction of the current process, address its limitations, and reach a wider audience with relevant, timely information about downtown travel conditions.

Figure 1. Current System Information Flow



LITERATURE REVIEW

ATIS CASE STUDIES

Currently, there are sixteen federally-funded field operational tests (FOTs) being conducted throughout the United States that involve evaluation of Advanced Traveler Information Services (ATIS) and the potential of relieving congestion by having better informed motorists through the use of advanced technologies. The infancy of most demonstration projects and the process of phasing in technologies as money becomes available have limited the amount of depth of evaluations that have taken place thus far. Only two operational tests, Pathfinder and TravTek, have had any kind of extensive evaluations conducted at this date. Both demonstrations projects are reviewing the applicability of in-vehicle route guidance systems within limited test vehicles. Documentation of these two demonstration projects are admittedly oriented toward promoting a self-produced product. True user acceptance values or information regarding impacts to trip decision making are a little questionable because of the orientation of the articles (2). SmarTraveler in Boston, Massachusetts has had some preliminary evaluations reviewing the impact of marketing strategies to promote the system and the potential of having users pay for real-time, route specific traffic and transit information. Other demonstration projects have conducted pre-study evaluations of the potential acceptance of new technologies within the motoring community. These projects are documented in greater detail below.

Furthermore, there is very limited specific information within the literature on the potential of ATIS technologies relieving congestion or delays that may be generated by scheduled road construction. Advanced notice of scheduled road construction is consistently acknowledged as important pre-trip and en-route travel information within the literature. Road construction schedules, though, are generally considered a known entity within the literature that can be handled through more traditional media, such as radio road reports, television, and newspapers. Most of the literature involving the 16 field operational tests are concerned with non-recurrent congestions problems, such as accidents or breakdowns, rather than providing detailed discussion of static traffic information, such as road construction.

Appendix B provides case studies of seven FOTs using ATIS technologies relevant to this study.

EXAMPLES OF CONSTRUCTION PROJECTS UTILIZING ATIS

As mentioned previously, the literature is limited with respect to ATIS field operational tests and traffic management at construction zones. A few examples of traffic management plans using ITS technologies exist within the literature reviews of traffic management and road construction. Site specific road construction articles provide some insight into coordinating the use of advanced technologies with traditional traffic management strategies, such as travel demand management and mass media communications.

Road construction can influence driver behavior, traffic patterns, and roadside safety in several fashions. Specific literature regarding road construction and maintenance projects review broad concerns related to traffic management and construction zones. Some of the most common concerns associated with interaction between road construction and traffic are:

- an increase in driver frustration and stress;
- an increase in congestion levels and delay, especially during peak periods;
- compromised safety to both motorists and construction workers; and
- an increase in neighborhood traffic with the re-routing of through traffic, formally or informally, from the main corridors.

Highlights of three construction related articles, Kalanianaola Highway, Hawaii, the City of Columbus, Ohio, and the Ventura Freeway, California, follow.

Kalanianaola Highway, Hawaii

In Hawaii, the DOT is using six closed circuit television (CCTV) cameras to monitor traffic conditions along a 4.8 kilometer (three mile) section of the Kalanianaole Highway (2). The cameras monitor traffic during construction periods and during peak periods. Construction is limited to the hours between 9:00 a.m. and 3:00 p.m.. The cameras are also used to determine when and if traffic patterns warrant adjusting traffic signals along that stretch of roadway.

A special hotline has been established that allows callers to receive up-to-the-minute traffic reports. A DOT employee, who monitors the cameras, uses a voice mail system to provide timely information about delays and congestion during construction hours. The report from Hawaii acknowledges two things about this system. First, the hotline has had a dramatic effect on the number of registered complaints regarding construction — complaints have decreased significantly regarding construction and roadway maintenance activities since the program was implemented. Second, the report notes that the cameras used in combination with the hotline have not had an impact on relieving construction-related congestion, but has primarily taken the guess work out of motorists who travel along that corridor. The cameras will eventually be incorporated into a network of CCTV cameras positioned at street intersections throughout Honolulu.

Other programs and strategies that have been implemented to educate the public about the Kalanianaola Highway construction project include mass mailings to 40,000 households in the area, a newsletter, press releases, and a video detailing the project.

Columbus, Ohio

The City of Columbus, Ohio has undertaken an aggressive public relations campaign regarding road construction to overcome negative public scrutiny of the public works projects (3). The public relations campaign relies heavily upon traditional multi-media approaches, such as news releases, press conferences, construction updates that are faxed to businesses, a 100-page fact book that is updated annually and distributed to influential leaders and businesses, and public service announcements (PSAs) on local television and radio stations. The entire program has been dubbed "Paving the Way."

Aside from the traditional multi-media approach, Columbus uses city owned cameras to provide real-time video feeds that are used for television newscasts. The use of live video feed for television news spots has been credited for the steady increase in traffic-related stories. Police use cameras placed along the highways to react to incidents, such as accidents, and to formulate messages on several changeable message signs placed along the highways. The CMSs help provide advanced warning to motorists of incidents and impending congestion along the corridor. The signs also provide information about alternative routes when needed.

Two traffic hotlines are also in place. The hotlines are manned by volunteers and report the latest information on traffic and construction. The hotlines are well used, with a reported number of calls exceeding 10,000 during a three-year review of the program (1990-1993). Electronic kiosks are used to provide information on alternative transportation modes in the city.

A comprehensive research study was also completed as part of this effort to determine the impacts of the "Paving the Way" program. Some of the findings include: greater public acceptance of road construction activities and declines in the number of accidents occurring during the construction season in the city (non-winter months). Most people surveyed indicated that they had chosen alternative routes, modes, or times at one time or another based on the information they had received from this program.

Ventura Freeway, California

Similar to the other lengthy construction projects previously discussed, Caltrans hired a public relations firm to increase public awareness concerning road closures, re-routing of traffic, and construction schedules (4). For two years between 1988 and 1990, Caltrans expanded and resurfaced several miles of the Ventura Freeway in Los Angeles. Press releases, pamphlets, circulars to local newspapers, a low-frequency radio information service, and special phone numbers were all strategies implemented as part of the public information campaign.

Caltrans also used other traffic management strategies to keep traffic moving in and around the construction zones. A majority of the construction activity was completed at night because of the sheer volumes of vehicles that use the Ventura Freeway. During construction, though, Caltrans was able to utilize existing systems to help manage traffic around the construction zone. An

Automated Traffic Surveillance and Control System (ATSAC) monitors traffic conditions on Ventura Boulevard, a parallel facility, and adjusted signal times accordingly. Existing CMSs were used to advise motorists of delays and traffic conditions. A Freeway Advisory Radio was also updated with current traffic information to keep motorists informed. A 24-hour hotline was established by Caltrans to provide updated information about the project. A person familiar with the project was also available during certain times to answer questions directly. Information concerning the public's response to these strategies is not well documented, though.

CONCLUSIONS DRAWN FROM LITERATURE REVIEW

Information on ATIS and ATMS systems is abundant in the literature. Currently, there are sixteen field operational tests being conducted throughout the United States evaluating ATIS systems. The literature to date, though, has yet to examine how communication technologies being utilized in the operational tests can impact driver response to construction related information. Only two of the FOTs have been evaluated, and these evaluations are relatively new and incomplete. Information on road construction is acknowledged as important en-route and pretrip information. However, road construction is given little more than cursory mention beyond its importance to motorists.

The 16 field operational tests do provide insight into utilizing new and existing technologies to provide motorists with up-to-date traffic information. The literature also provides a great deal of information on organizational structure and information exchange architectures. The FOTs reviewed in this document generally have been established to evaluate a number of objectives:

- evaluate customer acceptance of information;
- evaluate changes in driver behavior as a result of receiving information;
- evaluate timeliness and accuracy of information being delivered to motorists;
- evaluate new and existing technologies of delivering timely, accurate, and geographically specific traffic information (both static and real-time);
- evaluate system architecture developed for operational test;
- evaluate system costs; and
- evaluate institutional and organizational issues associated with field test.

Another, less ubiquitous, test is to evaluate the potential and willingness of drivers to pay for up-to-date traffic information. This evaluation has been limited to only a few FOTs and is nothing more than conjecture at this time.

More specific information regarding road construction and traveler information is available in the literature on road construction projects. These examples highlight the need for and desire for advanced (pre-trip and en-route) information regarding construction and maintenance of roadways. Motorist acceptance of roadway construction projects increased when a comprehensive public relations campaign was used in conjunction with some common highway surveillance and reporting technologies, such as CCTV cameras, loop detectors, CMSs, alternate route signage, HAR, and transportation hotlines.

The Hawaii and Columbus, Ohio examples also indicated that a major objective for implementing the public relations program was a reduction in the number of complaints from the motoring public regarding delays typically resulting from road construction. Traditional media, such as road radio reports, television updates, faxes to businesses/major employers, information hotlines, and press releases, were all relied upon heavily to help bridge the information gap between the motoring public and scheduled road construction and maintenance activities.

Based on these articles, traditional media has been used as the foundation for long term information regarding road construction projects. The length of road construction and maintenance activities can be measured in months and years with little change in road capacities or geometries. Consequently, motorists used traditional media sources to make informed long term travel decisions along routes affected by construction and maintenance activities. ATIS technologies, though, can provide real-time traffic and transit information along those impacted routes that could potentially affect travel decisions on a daily basis. The information could include travel time, the attractiveness of alternative routes, incidents (such as accidents), and the cost of competing modes along those routes.

It appears that neither public relations campaigns nor ATIS systems can be implemented as stand alone strategies. Rather, the success is achieved by coordinating these two techniques to inform the motoring public of current or planned construction activities, as well as events that may occur along these routes during scheduled construction and maintenance periods.

DOWNTOWN TRAVELER INFORMATION SYSTEM PLAN DEVELOPMENT PROCESS

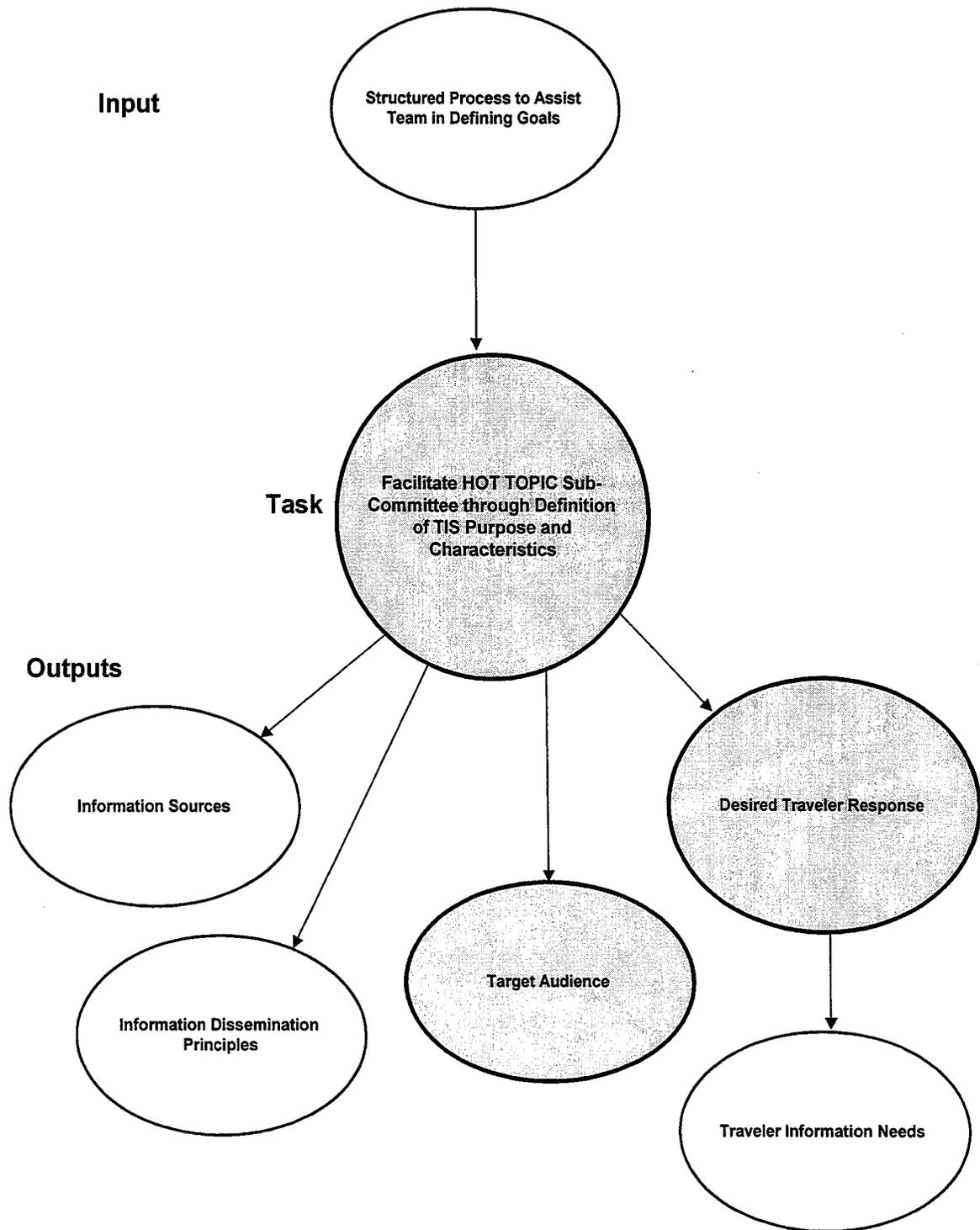
Planning and decision-making for an ITS application must be grounded in an identifiable need in order for the application to be relevant. Once that need has been pinpointed, decisions can be made toward achieving the ultimate goal: getting the right information into the right hands at the right time. With this premise in mind, a planning framework was defined so that the decision-making process centered first around the stated objectives, and then proceeded with a clear determination of "who" (the target audience) needs "what" (specific information) "when" (at what point in time during the trip).

The HOT TOPIC Communications Subcommittee was the primary goal-setting body in this process, with emphasis on the identification of objectives, the target audience and the desired traveler response. Figure 2 illustrates the process. The "◆" symbol denotes specific objectives, characteristics, and guidance provided by the subcommittee.

The proposed system objectives were defined by the subcommittee as follows:

- ◆ Minimize the use of capacity-restricted routes downtown, and increase awareness of their condition.
- ◆ Focus on capacity restrictions that are predictable and are affected for long durations.
- ◆ Provide an opportunity for motorists to avoid impacted routes.
- ◆ Maximize the use of available capacity on underutilized routes.
- ◆ Maintain the ability to respond to changing needs.

Figure 2. HOT TOPIC Communications Subcommittee Process



Target Audience

Definition of "who" should receive information related to downtown traffic conditions helps to narrow the range of possible dissemination technologies. The target audience for both the morning and evening peak periods were defined since the groups of travelers may have different attributes and information needs.

- ◆ *Morning Peak Period*
 - Commuters who work downtown
 - Commuters who are traveling through downtown
 - School travelers
 - Transit/buses
 - Commercial vehicles, both passing through and destined for downtown
 - Emergency response
 - Pedestrians

- ◆ *Evening Peak Period*
 - Commuters
 - Shoppers
 - Patrons of entertainment activities downtown

The emphasis of the committee's direction is on downtown commuters. These travelers come from all parts of the metropolitan area, so effecting a change in travel behavior would initially be more fruitful through various forms of mass media, particularly radio. En-route changes resulting from an on-highway medium, such as changeable message signs, can also be an effective way of informing and reminding motorists of lane closures on the typical routes through downtown. A reliable, timely mechanism for communicating the existing map (on a web site, for instance) could assist public agencies (such as transit and emergency services) as well as commercial vehicle operations. Both pre-trip and en-route media can aid non-work travelers to downtown as they navigate the street system on their way to the entertainment activities. Finally, pedestrians would benefit from direct access to street and sidewalk conditions from walk-up information sites, such as downtown kiosks.

Desired Traveler Response

Identification of the preferred outcome of a cognitive decision on the part of the traveler helps determine "what" information will be relevant and "when" the information will be useful during the trip. In making a decision, all prior knowledge and experience of the traveler will be combined with whatever information on lane closures can be made available. The desired responses were defined as:

- ◆ Change in route,
- ◆ Change in departure time,
- ◆ Change of mode, and
- ◆ Continue traveling downtown despite construction activity.

Information Dissemination Principles

Clear definition of the qualities or attributes of the disseminated information is an important factor in the plan development process. This section explores in detail two fundamental characteristics of the information disseminated to the target audience.

Preplanned and Real-Time Information

There are at least two types of information that may be appropriate to collect and disseminate to the traveling public—preplanned and real-time. Preplanned information is related to activities that can be anticipated and typically have a duration of more than a few minutes. Construction projects and maintenance work in the roadway are examples of preplanned activities. Traffic accidents, stalled vehicles and signal malfunctions are examples of unplanned activities. The only useful means of communicating the impacts of these unplanned activities to the traveler is through real-time information systems.

The collection and dissemination of preplanned versus real-time communication also differs. Because the nature and location of unplanned incidents cannot be predetermined, the scope of real-time information collection is limited to the portions of the network that are under "surveillance," using primarily detectors in or along the roadway and video cameras mounted above the roadway at strategic locations. Live reports from police, traffic services, and the public can supplement these data.

In contrast, collection of information about preplanned activities is generally dependent upon the entities involved voluntarily sharing information about anticipated and ongoing lane and street closures. Real-time sources may supplement this information, but when that mechanism is the only source of information, then dissemination is limited to real-time methods as well.

Providing advance information to the public is valuable because it allows travelers to make informed choices about their planned trip. In general this is more true with preplanned activities than

with incidents. In the case of information about preplanned blockages or closures, the traveler can choose to change route, mode of travel or departure time in a way that best suits the travelers' needs. Incident-related information will most often be made available en-route, significantly limiting the options available to the traveler, who will frequently choose either minor re-routing or waiting out any resulting delays. Even if the travelers' options in response to real-time information are limited, the value of making the traveler aware of abnormal conditions and reducing the potential for accidents more than compensates for the limited impact on trip-making.

- ◆ Based on direction from the subcommittee, this study focuses on the collection and dissemination of information related to preplanned activities.

Information Accuracy and Age

The credibility of information supplied to the traveler is of critical importance in two ways. First, the objective is for travelers to make informed decisions so that downtown mobility can be maintained. Erroneous information does not serve this objective. Second, the danger of distributing information about traffic conditions without sufficient accuracy can result in a long recovery process of rebuilding credibility.

In theory, the ability to supply accurate, credible information on preplanned lane closures should not be a challenge. However, in a setting of multiple entities performing different kinds of construction work within the street network, combined with the lack of staff resources available to monitor that construction work, the challenge of providing accurate information is great.

The age of the information is another important attribute. Not only must the information have a fairly high level of accuracy, but it must also reach the traveler in time to make an informed decision. This is a particular challenge in a downtown construction environment where changes in work sequencing can occur unexpectedly due to discovered subsurface conditions.

- ◆ Based on direction from the Communications Subcommittee, the age and level of accuracy of the information will be dictated by the reliability and timeliness of data supplied by the agencies overseeing their individual projects. Occasional field verification of the information will be made at a frequency of no more than once per week. The weekly map is marked "Subject to Change" as a disclaimer to data accuracy and age concerns.

Collection and Fusion of Information

Theoretically, the collection of information on preplanned activities would be simpler than collecting real-time information. In practice, maintaining accurate information about lane and street closures for construction and maintenance is at least as difficult as real-time surveillance. The primary reason for the difficulty is that while numerous agencies, utilities and contractors have the "right" to work in the street, only two or three have the mission of mobility. Therefore, maintaining public mobility is an afterthought for most players, if it is thought of at all, and dependence on all

players to voluntarily submit lane closure data is tenuous. Likewise, in the absence of a mandate, keeping a central repository informed of closures and blockages is not part of the normal course of business. Collecting the information will be a bigger challenge than disseminating it.

◆ The HOT TOPIC data collection process of voluntary submission of lane closure data on a weekly basis will continue to be the primary mode of operation. Concerted efforts will be made to increase voluntary compliance by the public agencies. The fusion process, or the method of overlaying the information, involves the consolidation of the data onto a downtown map, development of text descriptions of new projects and detours, and occasional field verification of data with appropriate adjustments to the map.

DISSEMINATION OF INFORMATION

There are numerous means of communicating advance information to travelers and would-be travelers. Table 1 lists those media that appear to be worth considering for this project. In evaluating the suitability of individual media for implementation, several factors were examined. The following paragraphs discuss those factors.

Message Format

The existing/ongoing database of construction activities is captured in the graphical format of a map. This format is well suited to visual communications and was initially faxed from a central source to all downtown office buildings. Future applications of graphics will need to consider the medium used and the effectiveness of quickly communicating intended information. Text messages will be appropriate in numerous media, where information is either heard or read. For example, conversion of the graphic information to text immediately improved the usefulness of existing information to traffic services, such as Shadow Traffic and Metro Traffic.

Implementation Time Frame

This factor examined the speed with which a particular medium could be deployed. Estimated time frames assumed that the existing means of collecting and fusing information was sufficiently accurate to proceed with the development of a dissemination system. If METRO later decides to revise the collection scheme, these schedules represent an approximate time frame after an information collection design system has been established. In estimating the time frames, several factors were considered:

- nature of information and message structure,
- approvals required,
- procurement of hardware/software,
- programming of equipment,
- testing of messages,
- establishing appropriate interagency protocols, and
- marketing of service availability.

Relative Cost

This factor is intended to help identify those media where the cost of the strategy requires budgeted funding, which is distinguished from those that could potentially be funded within existing budgets. Low costs are generally under \$10,000 to implement, intermediate costs are estimated at \$10 - 20,000, and high costs at above \$20,000. These costs are for capital and procured services only. It was assumed that some staff or existing contractor time would be available to assist in implementation.

Table 1. Characteristics of Alternative Traveler Information Media

Medium	Message Format	Implementation Time Frame (w/existing info)	Relative Cost	Relative Market Size	Flexibility (for future real time info)	Potential Trip Modification	I?
Newspaper	Graphics / Text	Immediate	Low	Large	None	Time, Route, Mode	A
AM/FM Radio	Text	Immediate	Low	Large	Medium - High	Route, Time, Mode	P
CMS (exist)	Text	Immediate	Low	Small (targeted)	High	Route	P
Broad Fax	Graphics / text	15-60 days	Low	Small - Medium	Low	Time, Route	A
Television	Graphics / text	~ 30 days	Low	Large	Medium - High	Time, Route, Mode	P
Web Site	Graphics / text	~ 60 days	Low	Small	Medium - High	Time, Route, Mode	A
Voicemail/ Hotline	Text	~ 90 days	Moderate	Medium	Medium	Time, Route, Mode	A
Email Listserv	Text / Graphics	~ 120 days	Low	Small - Medium	Medium - High	Time, Route, Mode	P
CMS (new)	Text	~ 6-9 months	High	Small (targeted)	High	Route	P
Kiosks	Graphics / Text	~ 9-12 months	Low	Medium	Medium - High	Time, Route	A

I? = identifies whether information requires active (A) search by traveler, or confronts traveler without search (P).

Relative Market Size

Because many of the available dissemination media are technology-dependent, the market size for them will be limited to those travelers that have appropriate technology available and are willing and able to use it. Established media cover large markets. Medium markets are available through media that can be accessed using commonly available technology, such as a touch-tone telephone, or that are accessible like kiosks. Smaller markets are represented by those that have computers and can access electronic mail or Internet sites, or are part of a traveling stream that receives en route information from roadside signs or radios. While the absolute numbers of those markets may be relatively small, the proportion of the target market may be very high.

Flexibility

If the next phase in traveler communication is the dissemination of real-time information, then the adaptability of a particular medium should be considered when deciding on the plan for dissemination of preplanned information. The continuum of flexibility ranges from low for newspaper to high for roadside devices. The key factor in estimating adaptability to real-time information was the time frame between time the travelers received information via this medium and the time they would need to act on that information; in the real-time setting, conditions change very rapidly. If the interval between information and action is long, then it is likely that the action may no longer be appropriate, thus damaging the credibility of the information and the source. It is very appropriate to have different media delivering different information. In deciding directions to pursue, it is also appropriate to understand the current limitations of each.

Potential Trip Modification

One of the goals of a traveler information system is to give the traveler as many options as possible. In reviewing the candidate media, the options potentially available to the informed traveler were identified. When a traveler receives pre-trip information at the home end of the trip, he or she has maximum options available, including changing departure time, changing route or changing mode. When the trip is in progress, either en route, or already at a destination, such as work or shopping, then the number of available options is reduced.

Nature of Information

The final characteristic of the individual candidate media addressed the nature of the effort required on the part of the traveler. "Passive" media deliver information to travelers with little or no overt effort on their part, such as AM/FM radio or roadside signs. Where travelers must seek out information, such as newspaper or Internet, that medium is characterized as "active." In general, the passive media will get greater exposure because travelers may not take the effort to access active media.



FINDINGS

The findings of this research study consist of a recommended implementation plan separated into two phases: a short-range implementation plan for the next two years, and a long-range plan for three years and beyond.

SHORT-RANGE IMPLEMENTATION PLAN

Information Dissemination Technologies

Traditional Media

Various public information officers will use three established media the at the appropriate future time to disseminate information about planned and ongoing construction activities. Each offers significant benefits.

- **AM/FM Radio**—This medium is already in use and only needs fine-tuning to be highly beneficial. Its cost is low and coverage is high, and it is proven to be one of the most preferred methods by motorists for receiving information on travel conditions (32). Its flexibility to real-time information is in the medium to high range, limited only by the frequency of traffic reports and the amount of information that can be covered in each report. If the information is received by the traveler at home, then all of the pre-trip options are available; if received en route, then rerouting is about the only option available. Since many AM and FM stations carry traffic reports, most of the intended information will find its way to most travelers. If there are opportunities to improve the existing service, they would lie in understanding from the traffic services and radio stations what types or formats of information would make downtown-oriented information more attractive to the radio stations.
- **Newspaper**—This medium offers immediate opportunity and immediate context because TxDOT is already publishing county-wide information in graphic form in the *Houston Chronicle*. It would be prudent for the downtown information to be in close proximity for easy locating. The information should be presented in both graphics and text. If published as a public service, then the cost would be minimal; if agencies were required to buy space on a weekly basis, the costs over the period of a year could be somewhat expensive. The market is large, but newspapers would probably never be a useful media for real-time or near real-time information. Newspapers are good sources for detailed information, but travelers would have to seek out the appropriate section and page to receive the desired information. Because of its presumed low cost, existing context, and ability to carry detail, newspapers should be pursued as soon as possible.

- **Television**—The use of television for pre-trip information is virtually identical to AM/FM radio, especially since many employ simultaneous broadcasts on both media. The only additional effort required would be development of television-suitable graphics. Because of the limited focus on downtown construction, those graphics would need to be highly tailored to the television medium. Three major factors will affect the potential for the use of television as the dissemination medium. First, are the television stations willing to devote sufficient public service time during the a.m. peak to accurately depict the details of downtown street or lane closures? Direct communication between METRO and the appropriate stations should answer this question. Second, is the information being collected of sufficient accuracy for the sponsoring agencies to display each day? This is a judgment call to be made by METRO. From the outside, it appears that the current data collection process is not well suited to daily updates of construction information. Finally, will the viewers materially change their driving behavior based on this pretrip information? This is unknown and can be estimated only with a direct sampling of likely travelers, using a stated preference survey or interview. Therefore, further review of the potential of this market is warranted before significant investment is made.

Web Site

Widespread use of the Internet is making graphic web sites increasingly attractive. The existing Houston Traffic Map is being accessed by users at a rate 350,000 times per month, or over 11,000 times per day, indicating significant attraction. Whether the attraction to such a medium would be sufficient to actually affect travel behavior remains to be determined. A web site could be operational in 90 days or less. The cost is modest at low usage rates. If usage rates get very high, a dedicated computer could be needed to assure a continued high level of service. A web site could be beneficial for real-time information, although it is subject to some change in conditions between viewing and driving.

A key decision related to cost and implementation time concerns the use of the existing TranStar web server. Remote map or text updating capability, which would be advantageous given the number of different agencies involved, would necessitate a change in procedures regarding web server security. It should be noted that TxDOT's construction information is maintained at the district web server and linked to the TranStar site.

Figure 3 depicts the schedule for implementing a traveler information system web site based on existing information collection. The key element that drives the schedule is the marketing of the web site availability. Six weeks has been allocated. If less time is required, then the schedule could be shortened.

E-mail Listserver

This type of service is gaining popularity. Many businesses, especially travel services and airlines, are using this type of service to continually update registered customers on specials and promotions. A listserver sends updated email from a central source to registered users immediately

upon being updated. One of the key advantages of this approach is that travelers would be notified instantly if they were connected to email. If not, then they would have to seek out the mail. Depending on the volume of traffic, a modest expense for a server and e-mail package would be expected. Figure 4 shows a draft schedule for implementing an e-mail listserv. Procurement of hardware and software are the most time-consuming elements for this medium.

Hotline

A phone-in hotline offers significant attraction because it puts traveler information at the disposal of virtually all travelers, since its only requirement is access to a touch-tone phone. Initially the hot line could be "chained" to allow callers to reach successive messages to access the information message they need. After some experience with that, the more popular information messages could be provided with their own dial-in line. This type of system, referred to on some projects as information hotlines, has been a popular approach among the construction project experiences cited in Chapter 3. Procurement and marketing are the longest elements of the hotline development (see Figure 5).

Expansion of Current Broadcast Fax

The existing service has been moderately effective. For nominal expense that service could be broadened in a relatively short time. The first step would be to determine the spare capacity of existing equipment. Then the expansion potential would be estimated by sampling other businesses or potential recipients. If there appears to be potential, then the service could be promoted.

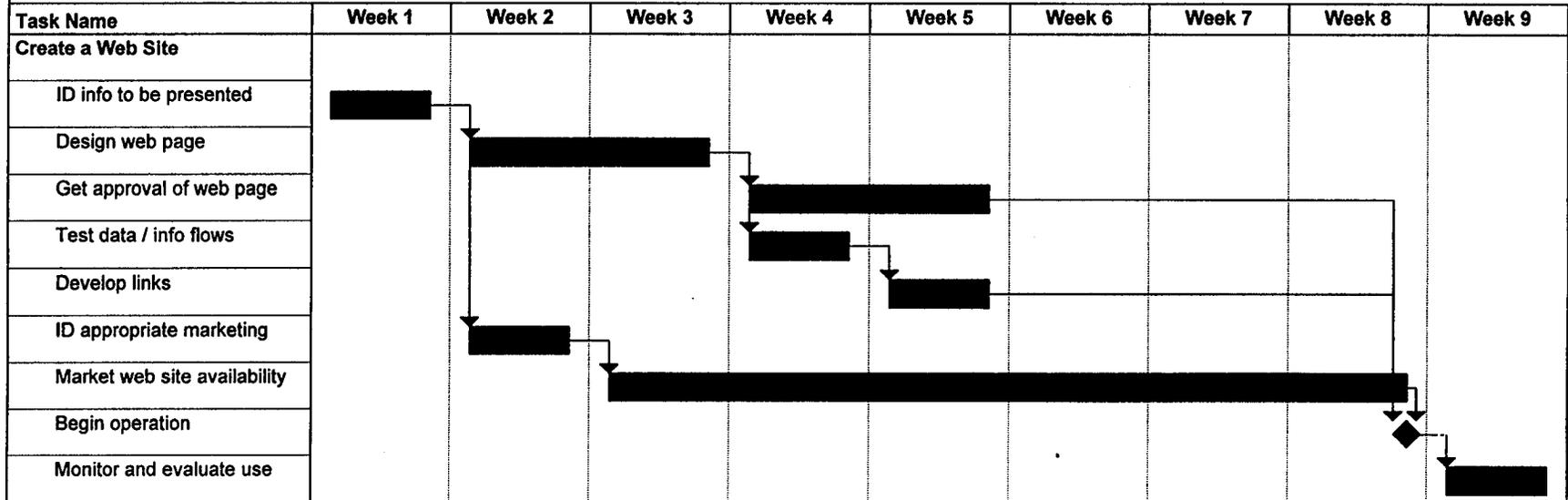
Effective Use of Existing Changeable Message Signs

One of the most cost-effective early actions should be improved use of the existing changeable message signs. They address a target audience and would easily transition to real-time information since this is the concept behind their design. Because of the length of exposure at typical speeds, the messages would need to be short. The time line for making use of these signs is highly dependent on the TxDOT approval process. The first step would be to develop message templates that TxDOT would approve. After TxDOT has approved the templates, all affected parties would need to work out a protocol for use of the signs for non-emergency purposes and a protocol for override for emergency purposes (Figure 6). Those protocols would need to address, as a minimum, the approved message sets, time of day, and frequency of use.

Plan for Using Information Kiosks

Information kiosks play an important role in the Priority Corridor Short and Intermediate Range Programs. The planned availability of those devices presents an important opportunity. If kiosks are available in the downtown area, then there will be an important source of information to outbound travelers. They may also be of service to other non-home based trips destined for downtown (from uptown, for example). Existing kiosks downtown that continuously display the Houston-area real-time traffic map are located at 1001 Preston in the 1st floor lobby of the Harris County Courthouse Annex, and at 900 Bagby in the lobby of the City Hall Annex. If existing kiosks will be used, they could be in service within 60 days, potentially using the same display as the web site. If they must be purchased, implementation time would be 9-12 months. Figure 7 illustrates the time line, which is driven by approvals and procurement.

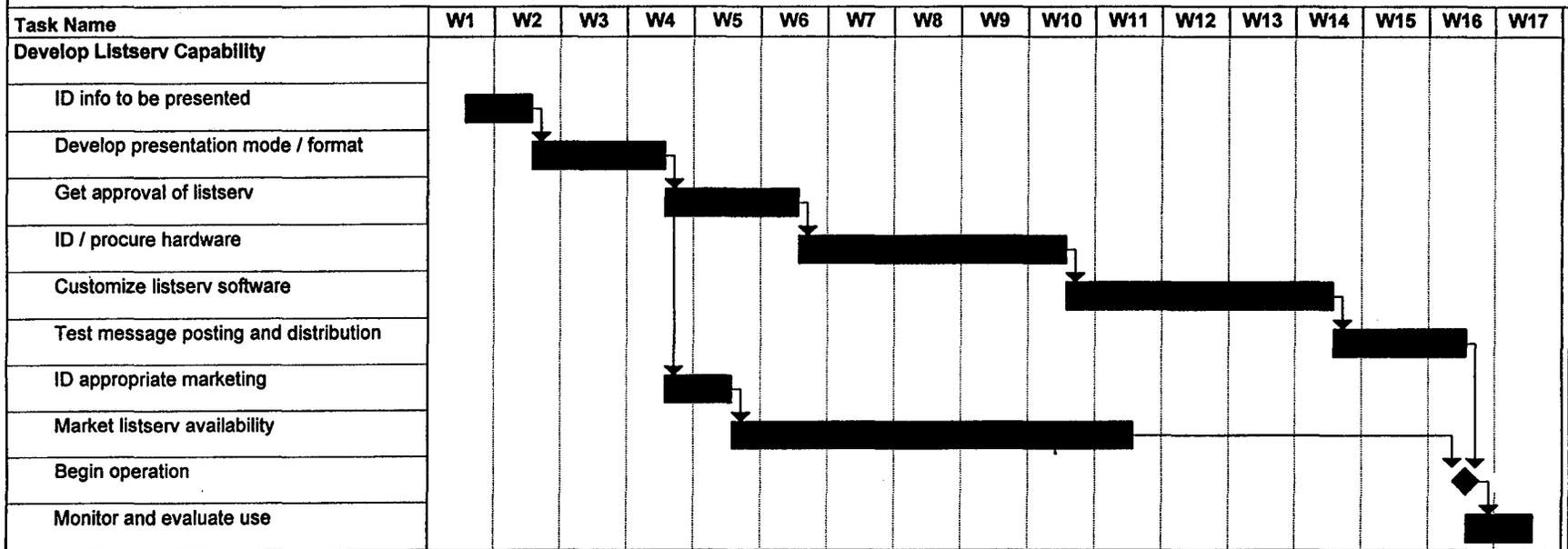
Figure 3. Schedule for Implementing a Traveler Information System -- Developing a Website



Downtown Traveler Information System
Date: 1/9/98

Task █ Milestone ◆

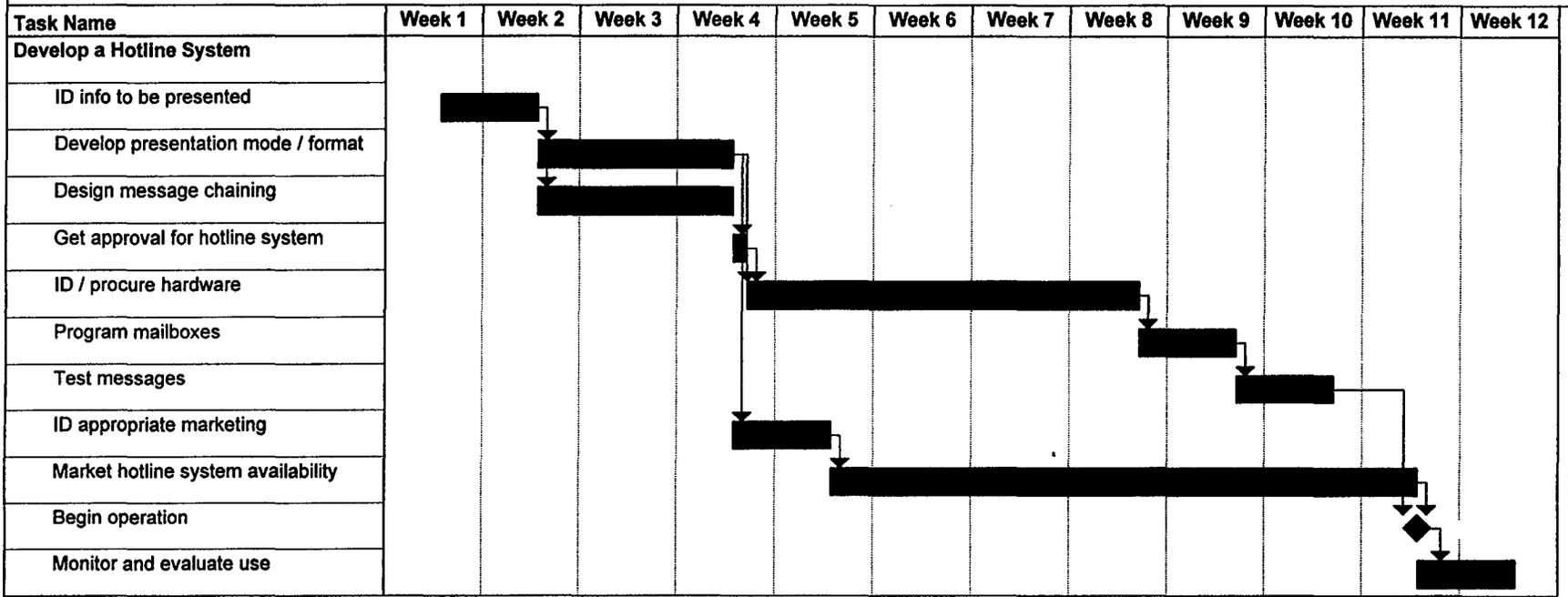
Figure 4. Schedule for Implementing a Traveler Information System -- Email Listserv Technology



25

Downtown Traveler Information System Date: 1/9/98	Task █ Milestone ◆
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Figure 5. Schedule for Implementing a Traveler Information System -- Hotline Voicemail System



Downtown Traveler Information System
Date: 1/9/98

Task



Milestone



Figure 6. Schedule for Implementing a Traveler Information System -- Improved Use of Existing CMS

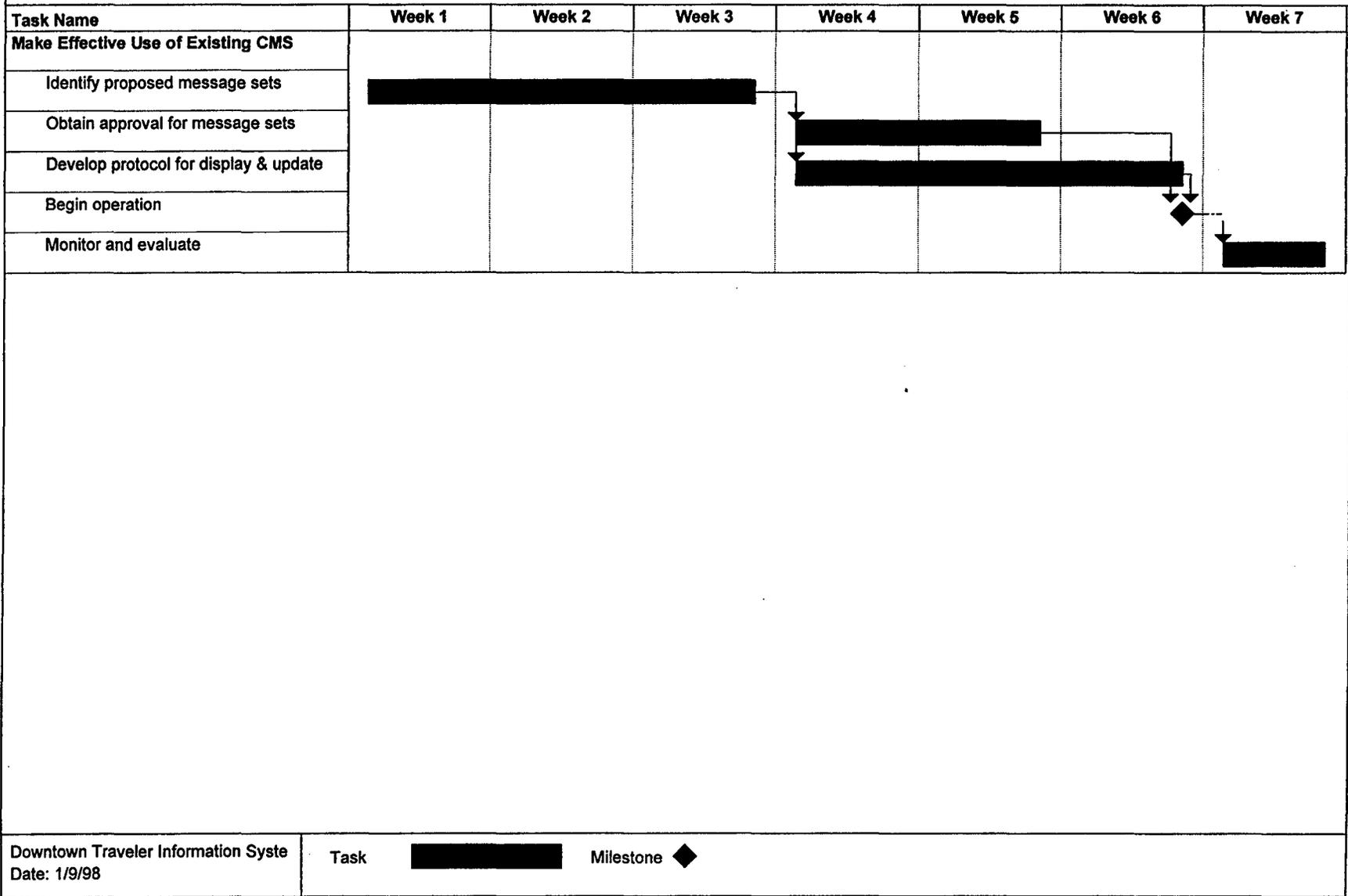
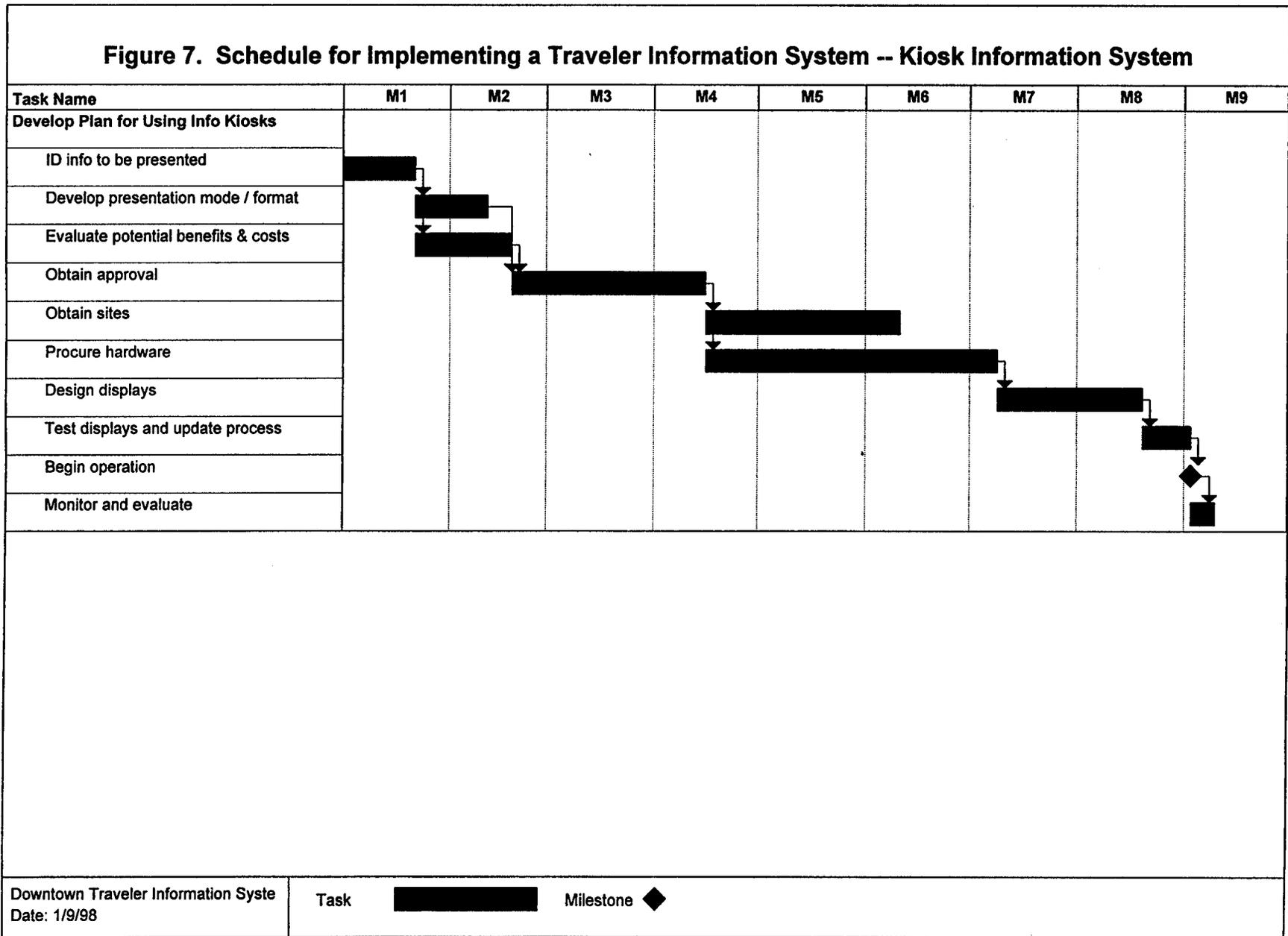


Figure 7. Schedule for Implementing a Traveler Information System -- Kiosk Information System



Resource Requirements for Short-Range Implementation Plan

Table 2 on the following page provides the estimated capital costs, staffing requirements, ongoing O&M costs, and projected schedule for short-range implementation. The table is broken into two components, both equally important to the effectiveness of the project. Depending on which information dissemination media are pursued, estimated resources for short-term implementation range from \$30,000 to \$150,000 for capital costs, \$100,000 to \$180,000 for annual operating costs, and 1 to 3 additional full-time staff positions.

Data collection and fusion refers to proposed enhancements to the current method of collecting and compiling downtown construction data. The intent is to provide more reliable and timely street and lane closure information. This particular component is the biggest vulnerability in the current traveler information system and is critical to the effectiveness of additional dissemination approaches. The system currently in place will not provide a sufficient level of accuracy to maintain credibility with travelers. The most reliable method for monitoring downtown work zone activity and reporting accurate, timely information is the designation of a staff person, a "construction coordinator," to serve as the clearinghouse for the HOT TOPIC committee. Given that the downtown streets are the responsibility of the City of Houston and that all activity within the street rights-of-way are permitted by the City, the City should be the lead agency responsible for monitoring, enforcing, and reporting information on construction work zones in the downtown area.

In addition to the suggestions offered below, Appendix C includes specific contract language related to construction work zone traffic control that may be applicable.

- Modify contract language and city ordinances as necessary to place a greater responsibility for street and lane closure notification on the contractor. This would include notification of not only the City, but METRO transit dispatchers and any other private or public entity directly impacted by lane closures and detours.
- Designate a staff person as construction coordinator to monitor and enforce downtown work zones, with legal and organizational authority (and police assistance when warranted) to direct the contractor to vacate the street and re-open lanes to traffic in the event of non-compliance with the project's permit or traffic control plan. Many of the suggestions presented here may already be required of the contractor; if so, then the enforcement aspect of the construction coordinator's job will become the emphasis.
- Require all projects, including City-contracted projects, to be permitted, so that all approved downtown construction projects are documented in one system. Use the permitting system to generate a daily list of approved street and lane closures downtown to be checked.

Information dissemination refers to each of the proposed media highlighted in the previous section. Estimated costs, staffing and schedule requirements are presented for each medium.

Table 2. Short-Range Implementation of Traveler Information Strategies

DATA COLLECTION AND FUSION

Mechanism	Estimated Capital Cost	Annual Staff Resources Required ¹	Estimated Annual Costs to Operate and Maintain	Time Frame for Implementation
Designate a downtown construction coordinator to collect daily lane closure information, develop and distribute map ²	\$25,000 ³	1.0	\$50,000 ⁴	60 days

INFORMATION DISSEMINATION

Traveler Information Medium	Estimated Capital Costs (including development)	Annual Staff Resources Required ¹	Estimated Annual Costs to Operate and Maintain	Time Frame for Implementation
Newspaper	\$0	0.05	\$2,250	Immediate
AM/FM Radio	\$0	0.05	\$2,250	Immediate
CMS (exist)	\$0	0.25	\$16,000	Immediate
Television	\$5,000 ⁵	0.05	\$2,250	30 days
Web Site	\$10,000 ⁶	0.5	\$23,000	60 days
Traffic Hotline	\$15,000	0.5	\$23,000	90 days
Email Listserv	\$10,000	0.5	\$23,000	120 days
CMS (new)	\$20,000/sign ⁷	0 ⁸	\$5,000/sign	9 months
Kiosks	\$5,000/kiosk	0.25	\$5,000/kiosk	12 months

Notes:

1. Value indicates the number of full-time equivalents if work performed in-house. Staff costs are included in annual O&M costs and are estimated at \$45,000 per staff person, including salary and fringe.
2. The City of Houston should be the lead agency in designating a construction coordinator who could also be responsible for monitoring and enforcing downtown work zones.
3. Includes vehicle, computer, and communication equipment (radio, cellular phone).
4. Includes salary and fringe, vehicle operating costs, communication costs, work space and computer.
5. Development of television-suitable graphics.
6. Assumes development with existing web server. Separate web server, including software, estimated at an additional \$15,000.
7. Assumes portable, solar-powered CMS with capability for communication by radio and/or cellular phone
8. Staff requirements included with *CMS (exist.)* and includes message development and operations

Public Relations Issues

In reviewing experiences on other public projects throughout the country, a common theme identified is the importance of marketing as a means of increasing utilization of traveler information services, reducing complaints, and maintaining a positive public image. Implementation of any of the above technologies should be complimented by a public relations and public information strategy. Many of the strategies identified in this study for implementation include a marketing element in the implementation time frame.

As the list of downtown building and infrastructure projects grows, strong consideration should also be given to creating a relevant and recognizable name that positively identifies all the various projects with downtown improvement or redevelopment. Examples of descriptors used for other projects include the "Paving the Way" road construction program in Columbus, Ohio, and "the Big Dig" moniker for the massive Central Artery and Tunnel Project in downtown Boston. Although the name "HOT TOPIC" may have relevance to those directly involved in the project, it does not immediately create a mental connection to downtown mobility or revitalization. By using and publicizing a recognizable name that connects street construction with progress and renewal, multiple benefits can potentially be accrued: reduced driver frustration and a better public image because travelers know why the construction is taking place; a triggered behavioral response to actively seek traffic information; and, as described in the next chapter, better detection of unexpected traffic snarls downtown due to a greater number of phoned-in calls by citizens.

LONG-RANGE IMPLEMENTATION ISSUES: BEYOND THE TWO-YEAR PLAN

Enhancement of Data Collection Through Real-Time Methods

Given the critical importance of data accuracy, a long-term improvement under consideration is the use of a traffic-responsive detection/surveillance system to improve data quality. The use of video surveillance has been successful on the construction projects documented earlier in the report, although each of those long-term projects were fixed within one corridor with continuous video transmission monitoring. The Central Artery and Tunnel Project now underway in Boston uses CCTV (closed circuit television) cameras mounted at strategic locations as a verification and assessment of telephoned complaints. No documented cases of the use of CCTV to monitor construction activity in a central business district setting were found.

In defining such a system, researchers should answer the question, "What is the purpose of installing a video surveillance system downtown?" In order to develop practical technology options, reliable cost estimates, and expected benefits, goals need to be clearly defined. Listed below are some of the questions that should be addressed in defining goals:

Should the scope of a downtown CCTV system be limited to the temporary nature of the Downtown Transit Street Projects, or should a system be designed with long-term uses in mind?

What are the expected uses of downtown CCTV?

For incident verification, during construction only or beyond?

To monitor construction activities on a specific project?

To determine at any given moment the construction activity in progress throughout downtown?

For traffic management?

For bus operations management?

For parking management?

For direct video feed to media outlets?

For video feed or "snapshot" displays on a web site?

What are the City of Houston's long-range plans for real-time traffic signal operation on the downtown street network?

In an effort to provide preliminary concepts and resource needs for deployment of real-time detection/surveillance downtown, the following information is provided for consideration.

Detection

The possibilities for real-time detection are:

1. Loop detectors;
2. AVI readers strategically positioned to read transponders already present in the vehicle stream; and
3. Telephoned complaints from the general public.

Loop detectors are not currently present. Some will be installed as a part of street construction work, although overall downtown coverage will be low, and severely limited in the early stages. To achieve sufficient coverage, loops could be installed; however, the cost for installation, communications, and software/hardware required to utilize the loops for incident detection is estimated at \$450,000 to \$500,000.

AVI readers are not a feasible alternative; each reader costs between \$20,000 and \$40,000 and requires high O&M expenses for wireless transmission or similar communications costs. The number of readers and associated communication requirements needed to provide adequate coverage would be cost-prohibitive.

Phoned-in complaints can be used as a cost effective and timely means of detection, provided that (1) a free cellular number is available, (2) a simple easy-to-remember land line number is established, and (3) both are well publicized. There are two options for cellular phone reporting. The first is to get existing 911 calls, which are free for cellular phones, routed to TranStar after action at the 911 dispatch if a freeway or downtown street is involved. The second is to set up an N11 system and work with cellular phone providers to offer these calls free as a promotional effort.

Surveillance

The major CCTV system for TranStar that is in place in the vicinity of downtown is along I-45. I-10 from I-45 to east of US 59 is under construction. "Build out" completion is unknown at this time. Communication hubs where fiber connections are possible are located along the I-45 corridor, so in combination with the fiber suppliers in the CBD, the infrastructure is available to make CCTV monitoring possible.

Given restricted views created by buildings, as well as camera range, it is possible that 13 to 15 cameras would be needed to monitor street conditions. Figure 8 illustrates one possible camera configuration and its relation to the existing TranStar communications infrastructure. The locations shown on the figure were identified solely on the basis of the Downtown Transit Streets rehabilitation projects, with the core area of the CBD as the focal point. Cameras can be phased in accordance with the phasing of the street rehabilitation work. Alternate camera locations may be warranted depending upon how the long-term goals of the video surveillance system are defined.

Figure 8. Possible CCTV Camera Locations for Downtown Houston



The following section includes several possible CCTV options. All options, except Option 5, will require a one-time cost of approximately \$ 20,000 for two broadband digital multiplexors that will accommodate up to 16 cameras. The cost of video multiplexing at TranStar and automated data fusion capabilities have not been included. Because all options involve the use of existing TranStar infrastructure, TxDOT will have to be a key player in the decision-making process due to their primary role in developing, operating, and maintaining the infrastructure.

Annual ongoing operational support for detection and surveillance is estimated at \$60,000 per year. This cost assumes that operational duties cannot be absorbed with existing staff and includes one full-time employee.

OPTION 1: Twisted Wire Pair (without pan-tilt-zoom capability (PTZ))	
<i>Description:</i> Video transmission using twisted pair technology supplied by Southwestern Bell. Will run full motion video up to one mile, linking with existing TranStar communication hubs.	
<i>Advantages:</i> Quick installation	
<i>Disadvantages:</i> Long-term maintenance concerns	
Estimated per camera cost:	
Camera and housing	\$ 5,000
Camera mounting	\$ 3,000
Installation (site to existing communications hub)	\$ 1,600
Transmitter, receiver, and multiplexor cards (hub to TranStar)	\$ 7,200
Design/specification development (15%)	\$ 2,500
Estimated capital and installation cost	\$ 19,300 per camera
Annual O&M cost, not including operations personnel (O&M costs cover monthly telephone service charges, power, and routine maintenance for camera and housing)	\$ 1,100 per camera
Estimated capital costs for 15 cameras	\$310,000
Estimated annual O&M costs for 15 cameras	\$ 77,000 per year

OPTION 2: Twisted Wire Pairs with PTZ

Description: Same as Option 1 with pan-tilt-zoom capability in four wire circuit

Advantages: Same as Option 1, PTZ capability

Disadvantages: Same as Option 1

Estimated per camera cost:

Camera and housing	\$ 5,000
Camera mounting	\$ 3,000
Installation (site to existing communications hub)	\$ 2,100
Transmitter, receiver, and multiplexor cards (hub to TranStar)	\$ 7,200
Design/specification development (15%)	<u>\$ 2,600</u>
Estimated capital and installation cost	\$ 19,900 per camera
Annual O&M cost, not including operation personnel (O&M Costs cover monthly telephone service charges, power, and routine maintenance for camera, camera controls, and housing)	\$ 1,600 per camera

Estimated capital costs for 15 cameras \$319,000

Estimated annual O&M costs for 15 cameras \$ 84,000 per year

OPTION 3A: Fiber Optic

Description: High quality, full motion video transmission using leased fiber from camera site to existing communications hub. Assumes fusing of each fiber at the existing hub.

Advantages: Professional quality images

Disadvantages: Some new fiber installation is likely; costs unknown until additional design completed; high O&M costs due to leasing charges.

Estimated per camera cost:

Camera and housing	\$ 5,000
Camera mounting	\$ 3,000
Installation (site to existing communications hub)	\$ 1,500
Transmitter, receiver, and multiplexor cards (hub to TranStar)	\$ 5,700
Design/specification development (15%)	<u>\$ 2,300</u>
Estimated capital and installation cost	\$ 17,500 per camera
Annual O&M cost, not including operations personnel (O&M costs cover fiber lease costs, and routine maintenance for camera, camera controls, and housing)	\$ 12,000 per camera

Estimated capital costs for 15 cameras \$283,000

Estimated annual O &M costs for 15 cameras \$240,000 per year

OPTION 3B: Fiber Optic directly to TranStar, with Leased Cameras

Description: High quality, full motion video transmission using leased cameras and leased fiber from camera site to TranStar.

Advantages: Professional quality images. Fusion or multiplexing with TranStar fiber at communications hub is not required.

Disadvantages: Some new fiber installation is likely; costs unknown until additional design completed; high O&M costs due to full leasing charges.

Estimated per camera cost

Installation included in \$1500 monthly per camera charge	\$ 0
Design/specification development	<u>\$ 2,500</u>
Estimated initial costs	\$ 2,500 per camera
 Annual O&M cost, not including operations personnel (O&M costs cover camera and fiber lease costs; assumes a minimum 5-year lease; routine maintenance of camera and housing provided by vendor)	 \$ 18,000 per camera

Estimated capital costs for 15 cameras (design only)	\$ 37,500
Estimated annual O&M costs for 15 cameras	\$270,000 per year

OPTION 4: Microwave

Description: Full motion video transmitted through wireless technology. Because a clear line of sight is needed between the camera transmitter and receiver, the signal receiver may have to be mounted nearby with signal fed through another communication medium, such as telephone line or fiber, or multiple transmitters and receivers could be needed to relay signal to communications hub.

Advantages: May reduce some problems related to wireline connections and determining camera mounting location since direct wireline connection not an issue.

Disadvantages: A clear line of sight is required, which may be difficult due to building obstructions. Thus, the advantages related to reducing wireline connections may be negated. Costs are difficult to project because design is site specific. Ongoing O&M costs also hard to project because of the need for specialized personnel.

Estimated per camera cost:

Camera and housing	\$ 5,000
Camera mounting	\$ 4,000
Installation (site to existing communications hub)	\$ 5,000
Transmitter, receiver, and multiplexor cards (hub to TranStar)	\$ 7,200
Design/specification development (15%)	<u>\$ 3,200</u>
Estimated capital and installation cost	\$ 24,000 per camera
Annual O&M cost, not including operations personnel (O&M costs cover power, and routine maintenance of equipment, camera, camera controls, and housing)	\$ 1,800 per camera

Estimated capital costs for 15 cameras	\$386,000
Estimated annual O&M costs for 15 cameras	\$ 87,000 per year

OPTION 5: Twisted Wire Pair — Partial Motion Images	
<i>Description:</i> Using Southwestern Bell four-wire circuit, video image is transmitted at a lower frame-per-second rate. PC at the field site is used to digitize image for transmittal by modem.	
<i>Advantages:</i> Ability to use any standard telephone circuit; suitable for incident detection only	
<i>Disadvantages:</i> Lower quality image; questionable use for other purposes, such as vehicular travel time.	
Estimated per camera cost:	
Camera and housing	\$ 5,000
Camera mounting	\$ 2,000
Installation (site to TranStar)	\$ 10,000
Design/specification development (15%)	\$ 2,600
Estimated capital and installation cost	\$ 19,600 per camera
Annual O&M cost, not including operations personnel (O&M costs cover monthly telephone service charges, power, and routine maintenance for camera, camera controls, and housing)	\$ 1,600 per camera
Estimated capital costs for 15 cameras	\$294,000
Estimated annual O&M costs for 15 cameras	\$ 84,000 per year

All options, except Option 3B, assume permanent camera installations. In terms of more temporary arrangements, TxDOT is using a prototype trailer-mounted video camera developed by TTI in the Dallas area. It employs wireless technology with a three-mile range, although clear line of sight is required. The equipment is solar-powered, has a pneumatic mast for height extension, has long-distance camera range, and provides full-motion video. It has been used to record activity at construction sites but has not been used for real-time response to incidents. The cost to develop the prototype was approximately \$50,000.

Incorporation of Downtown TIS into Regional ATIS Plans

As mentioned previously, Houston is a U.S. DOT-funded Priority Corridor site. The objectives of the downtown traveler information system are closely related to the objectives of several elements of the Priority Corridor. The types of projects that potentially link with this effort are as follows:

- Development of public information support,
- Traveler information kiosks, and
- Dissemination of traveler information.

Automated fusion of downtown lane closure data into a standard format for distribution will depend on the long-term prospects for ATIS on a larger scale. The implementation of the findings included in this study provide opportunities to not only test technologies that can be eventually incorporated into a real-time framework, but the effort lends itself to piloting a true cooperative, interagency ATIS on a small scale.

A PUBLIC/PRIVATE PARTNERING APPROACH

The plan described in the previous section assumes that the public agencies involved in downtown construction activities will design, build, operate and maintain the traveler information system. This approach is inherent for basic traffic information tied directly to the traffic operations functions, such as information displayed on changeable message signs. For more consumer-oriented information, however, the private sector may be in a better position to provide and market traveler information services at a lower cost. The challenge for public agencies is to define which information dissemination techniques should be implemented and supported directly by public agencies to serve mobility needs and which would be better suited and more cost-effectively implemented by private sector companies who are given direct access to data on traffic conditions. As of this date, however, there are no examples at the national level of pure private ventures that provide real time traffic information without the support of some level of public funding.

An interesting possibility for private partnering arises when considering the downtown project. Although it does not serve an extremely large market in comparison to the region, it does have unique characteristics, lending itself as a test bed for a public/private partnering approach. It is generally accepted that, at this point in the development of traveler information systems nationally, there is an absence of value by the consumer for traffic information by itself. With the exception of radio traffic reports, the attractiveness of traffic information increases when it is "bundled," or offered in combination with other types of information. This is where the uniqueness of the downtown area comes into play: information on special events, entertainment, restaurants, cultural activities, locations of historical points of interest, parking availability, and special noteworthy items related to downtown could be offered to the public in combination with street and lane closures. By providing information that publicizes activity downtown, a larger economic development interest can be served in conjunction with the goal of improving mobility.

As an example, Microsoft Sidewalk™ currently offers a web site for Houston that provides entertainment and restaurant information (<http://houston.sidewalk.com>). The same service in Seattle also includes real-time traffic information (<http://seattle.sidewalk.com>) called "Trafficview," which was developed in part with funding from the Washington Department of Transportation. A private sector company offering bundled information could conceivably generate revenue through advertising and possibly through some form of subscription service. Because a consumer market for traffic information has not yet been developed, a public agency would need to financially support this type of endeavor, at least initially, with clear goals for how it can serve the public good.

With the exception of CMSs, all of the dissemination technologies described in the previous section lend themselves to private provision. Although a web site may be a fairly low cost technique for the public agencies to pursue, consideration should be given to allowing this to be an attractive component of a larger package for a private sector endeavor. There may be other technologies not presented in this study that a private sector company would want to independently pursue given the market demand.

The key to this type of approach on the part of the public agencies is the data collection component. Data quality, such as accuracy and reliability, will be just as critical in a public/private effort as it is with a pure public provision approach. There are two methods for data collection improvement presented in this study: (1) designation of a "construction coordinator" and (2) real-time traffic condition detection/surveillance. As described previously, the construction coordinator could serve as both a clearinghouse for lane closure information and, in working with the various agencies and contractors, as a conflict mitigator to promote traffic operations. Manual input of traffic condition data could be made by the construction coordinator to a database from which the private sector player(s) would have access. Logically, this database would be located at TranStar, since one of the goals of this approach would be as a pilot to assess the feasibility of public/private partnering for a larger regional ATIS based at TranStar.

Implementation of a public/private partnering approach would begin with a discussion of market possibilities with potential private players, a review of possible contract arrangements using the experiences of other public agencies as a reference point, and development of an RFP or other appropriate contracting mechanism. In the meantime, with imminent commencement of the Downtown Transit Street Project in early 1998, the public agencies should focus their immediate attention on improving the data collection process, making the current map more reliable, and utilizing traditional media approaches (radio, newspaper) more intentionally with the assistance of existing public information staff.



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APPENDIX A — DOWNTOWN CONSTRUCTION MAP

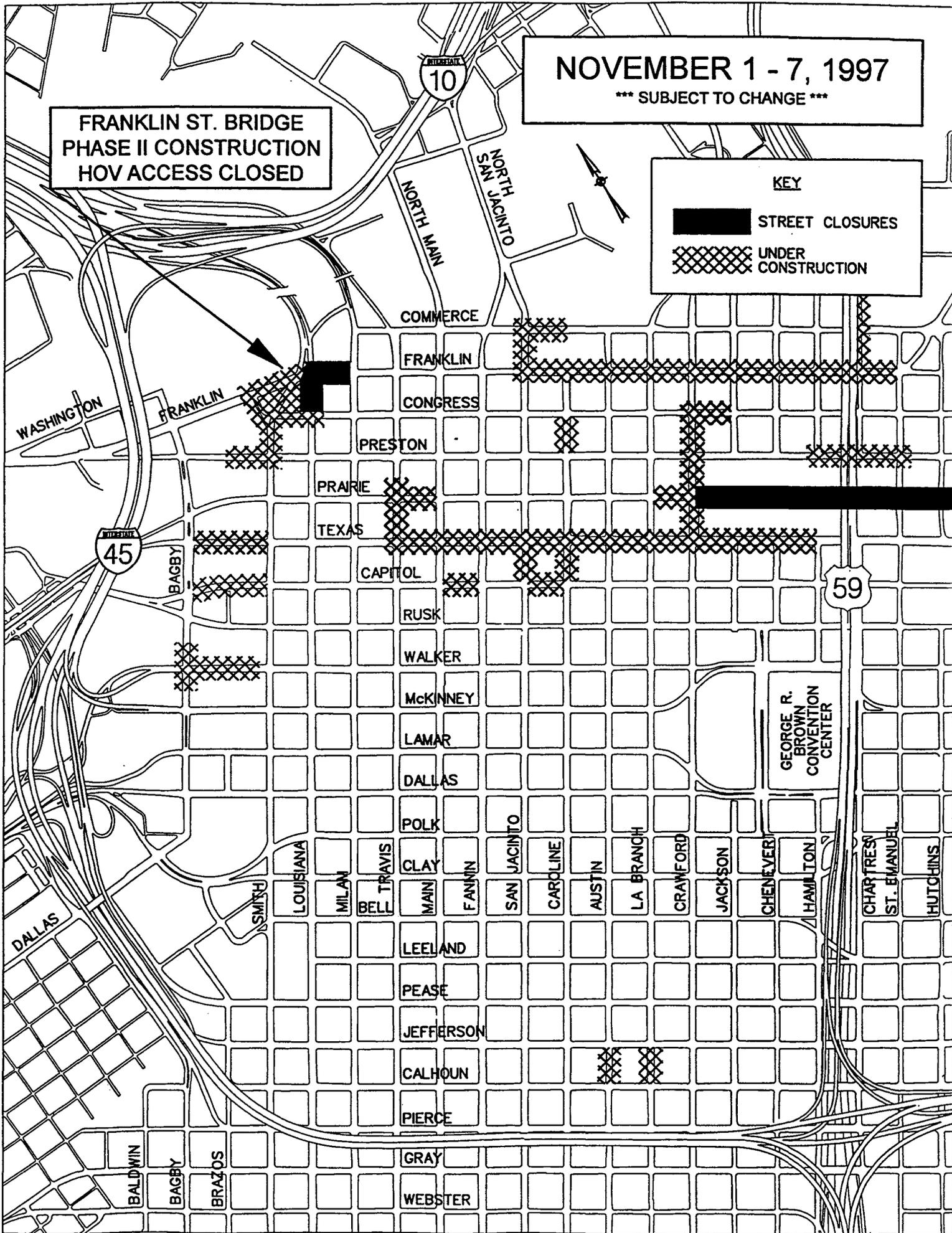
NOVEMBER 1 - 7, 1997

*** SUBJECT TO CHANGE ***

FRANKLIN ST. BRIDGE
PHASE II CONSTRUCTION
HOV ACCESS CLOSED

KEY

- STREET CLOSURES
- UNDER CONSTRUCTION



Downtown Houston - Major Construction Areas

November 1-7, 1997

<i>Construction Limits</i>	<i>Closures</i>	<i>Work Performed</i>	<i>Comments</i>
Franklin Street Louisiana to Milam	Complete Closure	Bridge Reconstruction	Major Detour - Use Alternate City of Houston
Louisiana Street NBD from Congress to Franklin	Complete Closure	Bridge Reconstruction	Major Detour - Use Alternate City of Houston
IH 45 HOV Lane Louisiana Street Entrance	Complete Closure	Bridge Reconstruction	Use Travis Street Entrance City of Houston
Walker Street WBD from Smith to Bagby	Multiple Lanes	Tunnel Construction	City of Houston
Bagby Street Rusk to McKinney	Multiple Lanes	Tunnel Construction	City of Houston
Franklin Street San Jacinto to St. Emanuel	Multiple Lanes	Utility Construction	City of Houston
San Jacinto Street NBD from Franklin to Commerce	Multiple Right Lanes	Building Construction	Harris County Courthouse
Commerce Street San Jacinto to Caroline	Southside Lanes	Building Construction	Harris County Courthouse
Caroline Street SBD from Congress to Preston	Multiple Right Lanes	Sanitary Sewer Construction	City of Houston
Congress Avenue WBD from Jackson to Crawford	Multiple Lanes	Utility Construction	
Preston Street EBD from Bagby to Smith	Multiple L/R Lanes	Sanitary Sewer Construction	City of Houston
Preston Street EBD from Hamilton to St. Emanuel		Construction	
City Block bounded by Prairie, Texas, Travis and Main	Lanes Around Block	Building Construction	Rice Hotel Renovation
City Block bounded by Texas, Capitol, San Jacinto & Caroline	Lanes Around Block	Building Construction	Federal Detention Center
Prairie Street WBD from Bastrop to Crawford	Complete Closure	Stadium and Parking Lot Construction	Detour to Capitol Street Downtown Stadium
Prairie Street WBD from Crawford to La Branch	One Lane Open	Utility Construction	Downtown Stadium
Texas Avenue EBD from Bagby to Smith	Multiple Right Lanes	Sidewalk Improvements	City of Houston
Texas Avenue EBD from Travis to Hamilton	Multiple Lanes	Utility Construction	Downtown Stadium
Crawford Street NBD from Texas to Congress	Multiple Left Lanes	Utility Construction	Downtown Stadium
Capitol Street WBD from Fannin to Main	Various Lanes	Sanitary Sewer Construction	City of Houston
Capitol Street WBD from Smith to Bagby	Multiple Right Lanes	Building Construction	Bayou Place
La Branch Street SBD from Jefferson to Calhoun	Multiple Right Lanes	Building Construction	St. Joseph's Hospital
Austin Street NBD from Calhoun to Jefferson	Multiple Right Lanes	Building Construction	St. Joseph's Hospital

Prairie Street from Bastrop Street to Crawford Street will be permanently closed for construction of the Downtown Stadium and neighboring parking areas. Prairie Street traffic will be detoured to Capitol Street.

*** Subject to Change ***

APPENDIX B – ATIS CASE STUDIES

ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS) CASE STUDIES

This section of the report provides a detailed review of seven FOTs using ATIS technologies to enhance commuters knowledge of traffic and transit conditions. The case studies review the major goals of the projects as well as the technologies that are being utilized to provide advanced or en-route travel information. System and information architecture diagrams are included where possible.

Boston, Massachusetts (SmarTraveler)

SmarTraveler offers real-time, route-specific highway and transit information by telephone in Boston, Massachusetts. The service area of SmarTraveler is east of Route 495, which is the outer loop of Boston and encompasses the greater urban area of the city and several bedroom communities. The operational test was initiated in January 1993 and is operated by SmartRoute Systems of Cambridge, Massachusetts. The FOT is jointly funded by the Massachusetts Department of Transportation and the Federal Highway Administration with equal contributions from the private sector.

The service can be accessed by both conventional and cellular phone users. There are two different cellular phone operators in the region — Cellular One and NYNEX. Conventional phone users and Cellular One subscribers access SmarTraveler by dialing a common 7-digit phone number. NYNEX subscribers need only dial *1 and are not required to pay any access charges because of a previous arrangement with SmartRoute Systems (3). The free service charges for NYNEX cellular phone users remained throughout the operational test. Cellular One and conventional callers are only required to pay customary phone or cellular service charges.

Callers can receive route specific information by entering a unique code associated with the 21 monitored highway segments and/or four public transportation services in the region. A recorded message will provide the caller with information on accidents, road conditions, and travel times. At this time, information on alternative routes are not a part of the service but is planned to be a part of the system.

Travel conditions are monitored by utilizing several different data sources. Information is gathered from state police reports, traffic probes using cellular phones and two-way radio communications, 44 slow scan cameras, two traffic monitoring airplanes, and reports from various transportation agencies in the region. The information is updated regularly between 5:30 a.m. and 7:00 p.m., Monday through Thursday, until 9:00 p.m. on Fridays, and on Sunday afternoons. Information is updated continuously during these times. The maximum allowable time in between updates is 15 minutes (4). Road construction schedule information is provided at all other times, except when the hours of operation are extended for poor weather or holidays (5).

Several evaluations of SmarTraveler occurred during the three year test period. One of the primary evaluations was user acceptance of the information and comparing the relative attractiveness

of SmarTraveler information to traditional traffic information reporting sources, such as radio and television road reports. The impact of a marketing effort aimed at increasing SmarTraveler usage among callers that have not used the service previously was also examined.

During the three year test period, the amount of calls accessing SmarTraveler information has increased to nearly 60,000 calls per week from a core group of 20,000 callers. Daily usage of SmarTraveler experienced steady but modest growth during the test period. Holidays and severe weather events were periods when usage was greatest.

One significant finding was that cellular callers had a greater propensity to call for traffic and transit information than conventional callers despite the base population of conventional callers exceeding the base population of cellular callers within the study (3). More specifically, NYNEX callers were increasingly utilizing the system during the test period. In comparison to the other two user groups, NYNEX caller growth could be projected to grow by more than 1,400 callers per year, while landline callers could be anticipated to grow by 800 callers per year and Cellular One callers would grow by only 120 callers per year.

It is unclear what may have influenced the differences in utilization between the three different user groups (3). However, ease of access and cost appear to be the two primary factors that influence user utilization. NYNEX users dial a simple 2-digit code (*1) to access SmarTraveler and were not charged any fees. NYNEX users could also access the system before a trip and *during* a trip. Landline users, though, needed to call SmarTraveler *before* the trip and had to make subsequent travel decisions at that time. En-route information was simply unavailable for landline users. Another factor that may be influencing landline callers was cost and ease of access. Almost half of the calls made by landline callers were made from the office where phone charges are paid for but personal calls may be discouraged. It is unclear, though, how much of a factor these may have been. Cellular One callers have the same pre- and en-route access privileges as NYNEX cellular phone callers; however, this user group was not exempt from typical user fees associated with cellular phone usage. Cost may be the primary influencing factor among all cellular phone groups.

Another finding was the marketing campaign aimed at attracting additional users has had little impact on convincing people about the merits of the information available from SmarTraveler versus radio or television road reports (3, 5, 6). It appears that there is a core group of people that actively utilize the service and little activity from other people in Boston. One study did indicate that more the 160,000 people in the Boston area have accessed the information at one time or another, but there remains a core group of active callers (5).

In comparison to other media, SmarTraveler users have a greater satisfaction level with the information they receive from this service versus other broadcast media. Users also indicated general satisfaction with the information being provided and also indicated a desire to keep utilizing the service in the future. However, when queried about the potential for paying for this service, there is generally a poor response to this proposition (5). Evidence does exist showing the sensitivity of callers towards fees. Cellular One charges were free for a month during the test as part of a

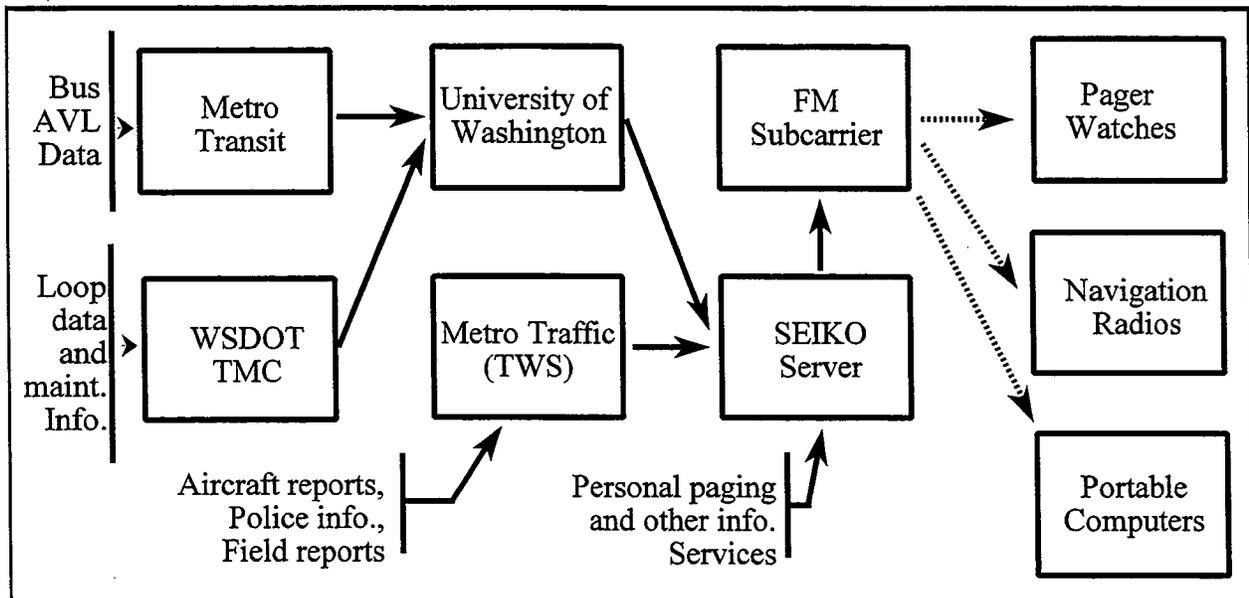
SmarTravler promotional project. Cellular One calls increased during the free month but returned to pre-promotional levels after the service charges were reinstated (3).

Seattle, Washington (SWIFT)

The Seattle Wide-area Information for Travelers (SWIFT) is a two year, \$7 million, field operational test that will use existing technologies to deliver traffic information to motorists. The SWIFT system is intended to accomplish the following services: pre-trip travel information, en-route driver information, route guidance, traveler services information, such as police and hospital services, ride matching and reservation, en-route transit information, and personal paging (7). SWIFT is the result of several public and private agencies cooperatively aligned to deliver real-time traffic information. The Federal Highway Administration (FHWA) provides funding and program assistance along with the Washington State DOT, which also provides project management, traffic data, contracting services. Other agencies and corporations involved include Metro Traffic, University of Washington, SEIKO Communications Systems, Delco Electronics, IBM, Metro Traffic Control, Etak, and SAIC. The University of Washington was responsible for developing the system architecture and with the selection of data systems. Figure 9 shows the SWIFT system architecture.

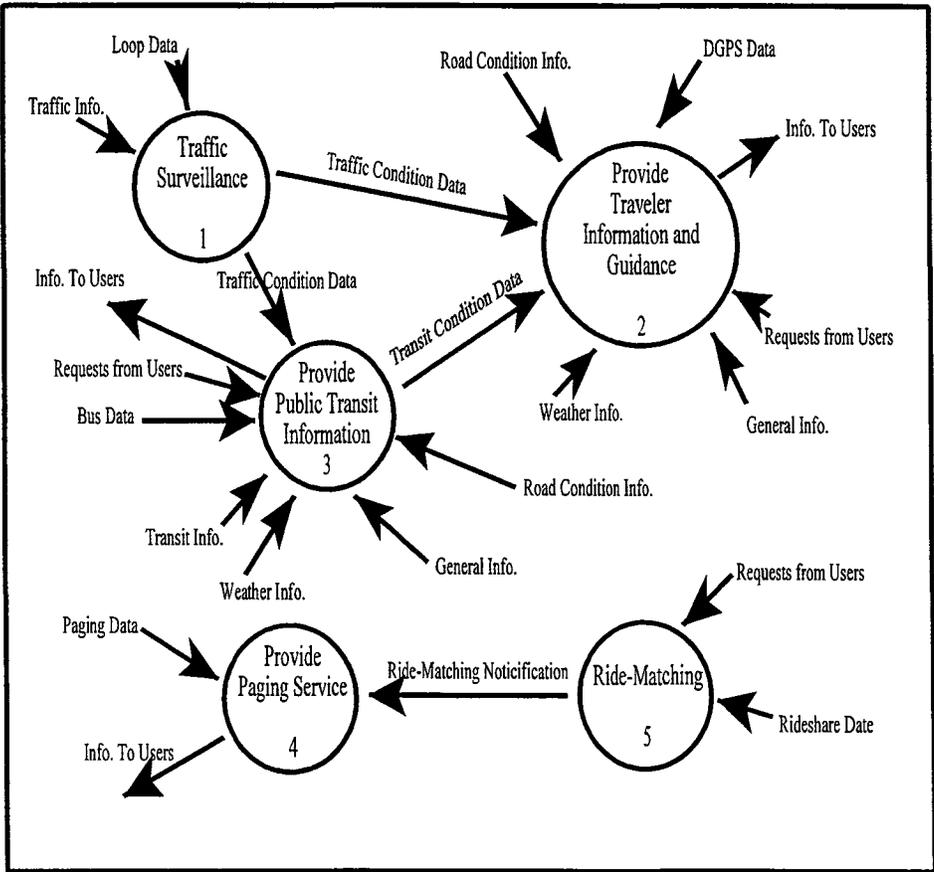
SWIFT is the first FOT to use existing technologies rather than create new ITS specific technologies to deliver information. High-speed FM subcarrier broadcasts will serve as the primary means of communicating information to motorists. FM subcarriers are currently being used to broadcast such things as paging services and background or "elevator" music. Based on a report detailing SWIFT, FM subcarrier broadcasts are good candidates to deliver construction updates and detour information (8). The report, though, did not provide greater detail regarding construction information and FM subcarrier technology.

Figure 9. SWIFT System Architecture



The SWIFT operational test will broadcast (via the High-speed FM subcarrier) traffic information to 500 SEIKO Message Watches, 100 Delco navigation radios, and 100 portable pen computers (PDAs). The pager watches will display real-time information that is relevant to the user based on a profile of the user. In-vehicle route guidance will be tested with the navigation radios, which displays traffic information between the current location of the automobile and the final destination. The navigation radios will use text displays and synthesized voiced messages to convey direction and traffic information. The portable PDAs will display all traffic and transit information that is being made available by SWIFT (9). A Traffic WorkStation (TWS) serves as the central collection and distribution point for traffic information that will be broadcast to the three technologies described above. Figures 10 illustrates the information flow diagram for SWIFT.

Figure 10. SWIFT System Information Flow Diagram (7)



Santa Monica/Los Angeles, California (Smart Corridor)

The Smart Corridor Project in Santa Monica, California will integrate existing monitoring and information systems to enhance mobility in the region. The boundaries of the operational test include a fourteen mile stretch of Interstate 10 (Santa Monica Freeway) that is bounded by Interstate 5 (Santa Ana Freeway) and Interstate 405 (San Diego Freeway). The corridor is approximately 8 kilometers (five miles) wide and includes five major arterials that intersect with Interstate 10. It is the inclusion of these arterials that makes the Smart Corridor project unique and is relying upon the cooperation of several agencies to coordinate existing data gathering and dissemination systems to achieve a more balanced system within the corridor.

Public agencies that are teaming include the California Department of Transportation (Caltrans), California Highway Patrol (CHP), Los Angeles Department of Transportation (LADOT), Los Angeles County Transportation Commission (LACTC), the Los Angeles Police Department (LAPD), and the Federal Highway Administration. Currently, ramp metering and freeway monitoring is conducted by Caltrans using a semi-automated management system. Arterial traffic monitoring and control is under the stewardship of the LADOT (10).

Another major element associated with the demonstration project is monitoring and response to incidents. The existing resources of the participating agencies will be utilized to respond to non-recurring incidents. Technologies that are currently being used to identify incidents include closed circuit television (CCTV), freeway call boxes, cellular phones and freeway service patrols (FSP) (10). Other technologies that will be implemented or expanded include, highway advisory telephone (HAT), highway advisory radio (HAR), Trailblazer/detour signs along arterial streets, and changeable message signs (CMS). The CMSs will inform drivers of incidents ahead and the "Trailblazer" signs will guide drivers through side streets to by-pass the incident and to return to the freeway (11).

As part of the project, an evaluation will be made about how users interact with these systems as well as respond to the information these systems provide. The evaluation of these technologies has not occurred yet because the systems are either being expanded or phased in during the course of the project. However, a report noted by a Smart Corridor overview paper indicated that a significant amount of motorists, 40 percent, in the Los Angeles area have altered or changed their travel routes in response to information about traffic conditions. Another 30 percent indicated that traffic information was a factor in their route planning (10, 12). Hence, the potential is there for the technologies that are being implemented as a part of Smart Corridor to have an effect on congestion levels for recurring and non-recurring traffic incidents.

San Francisco, California (TravInfo)

TravInfo is a public/private partnership funded by the FHWA to provide comprehensive real-time traffic and transit information to the San Francisco Bay Area. Similar to other FOTs, the basic

premise is to enhance the public's knowledge about transportation events, such as congestion and accidents, and alternative mobility options. TravInfo has been established to encourage private sector involvement with the creation of new and innovative methodologies for presenting traffic and transit information to the public.

The public sector will continue to serve as the lead for collecting traffic and transit information using existing collection technologies. A transportation information center (TIC) will gather and send the information across phone lines and by other means to private sector participants. It is intended that the private sector will develop ATIS technologies for disseminating the information to the public users and to other private sector groups (13). The private sector, in turn, would provide services through value added resellers (VARs). VARs, also known as value added service providers (VASPs) and independent service providers (ISPs), essentially recycle the information in a more user friendly format/product that may not otherwise be offered by a public agency (13). Examples of VARs include smart kiosks, pagers, and in-vehicle displays. A majority of the efforts thus far have been in fostering these private/public partnerships and products. The system is specifically designed to encourage private sector innovation with ATIS technologies.

Data collection efforts will rely upon existing and expanded data gathering techniques in the region. Traffic data will primarily come from a traffic operations center (TOC) that is under development by Caltrans. Loop detectors, CCTVs, HAR, and CMSs are current traffic data collection and distribution techniques. Incident detection will be provided by an existing service offered by the California Highway Patrol. A freeway service patrol (FSP) that is equipped with AVL technology will serve as traffic probes and mobile reporters. Construction activities on collector streets, arterials, and non-state owned expressways will be a part of a database that is currently being developed. Transit data, including routes, stop locations, fares, and schedules will be provided by the major transit operators in the region to one central, regional transit database (13).

The data, once collected, will be processed at the TOC and distributed/accessed using three different communications media: a menu-based voice mail system, computer modem, and wireless broadcast. The voice mail system or traveler advisory telephone system (TATS) is menu driven and will provide callers with general information on traffic and transit. For more detailed questions regarding transit and ridesharing, the public can talk to a human operator (14). Information on 37 different freeways and eight bridges is available by calling the TATS. The system can accommodate up to 1,300 calls per hour. However, usage data indicates that the system is not being well utilized by the public because of limited knowledge about the service. A marketing campaign designed to promote the service began earlier this year (15).

Other sources of transit and traffic information for the public will be created by private sector involvement through the creation of VARs, such as the one's described above. This is the major directive of the operational test in San Francisco. The private sector will receive information from the public traffic and transit databases via FM high-speed subcarriers and dial-up and leased-line access to the databases. The information will be updated every minute to ensure accurate and timely information is being accessed (14).

Institutional, technology, traveler response, and network performance evaluation plans are being developed at this time to review the effectiveness of the operational test (16, 17). An institutional evaluation has already occurred. The primary objective of the evaluation was to determine what the major accomplishments and hurdles occurred as a result of public/private relationships. Of most concern to the private sector was the timeliness of public agencies. Public agencies were viewed as slow and bureaucratic.

Traveler response, both pre-trip and en-route, has been measured using stated preference surveys (18, 19). The propensity or willingness of commuters to use projected ATIS technologies was also studied. Major findings from the pre-trip study conclude that a majority of commuters have acquired traffic information prior to departing for a trip, either through direct observation or television and radio reports (18). Approximately half of the respondents indicated that they did not change their travel plans at all despite learning about delays before the trip began. Of those that changed their travel plans, most people chose to change departure times. Approximately 20 percent of those surveyed changed routes upon learning of delays. Very few respondents, less than 2 percent indicated that the information warranted changing modes (i.e. public transportation). Study participants were also queried to determine what potential effect various ATIS information messages (i.e. leave early, leave later, choose alternative route) may have on travel patterns. There appears to be a willingness to use ATIS information but there is a slight resistance to follow ATIS advice. Two major findings include: commuters are more willing to choose alternative routes or change departure times as expected delay increases and detailed descriptive information regarding alternative routes, once recommended, should have a positive result in encouraging commuters to use those routes. As a general finding, most people prefer the alteration of departure times, more specifically leaving early, versus other alternatives. A similar study conducted in Dallas, Texas that was cited in the San Francisco document indicates that commuters are more willing to alter the work-to-home trip rather than the home-to-work trip (20).

Potential future responses to travel directions from ATIS technologies were also examined by using a stated preference survey of Bay Area commuters (19). The survey examined these issues by framing them as en-route information that commuters could potentially utilize to make informed travel decisions (i.e. change route in response to anticipated congestion or leave early to overcome long delays). Of the findings, emphasis was placed on accurate and timely information regarding main thoroughfares as well as alternate routes. According to the study, the willingness of commuters to take an alternative route is directly related to how much information is available about that route. The information should include real-time travel information and predictive conditions that compares the main route with the alternative route. Furthermore, it should be anticipated that commuters are more likely to want to have the information made available to them but would rather formulate their own routes rather than be given directive information to alternative routes. Another conclusion from the en-route preference survey is ATIS managers should be cognizant of the dynamic nature of traffic information and the potential results of making this information available to the motoring public. Managers should also recognize that commuters can be habitual in nature with regards to their main routes and there will be some reluctance to choosing alternative routes when presented with that type of direction.

Detroit, Michigan (DIRECT)

The DIRECT (driver information radio using experimental communication technologies) field operational test is being administered by the new Metropolitan Transportation Center in Detroit, Michigan. The FOT is occurring along a 34 kilometer (21 mile) corridor of I-94 between downtown Detroit and I-275. The total cost for the project is estimated to be \$8 million. Eventually, the system will be integrated with the FAST-TRAC program being implemented in suburban Detroit.

The initiative for DIRECT is to evaluate alternative methods of communicating information to motorists. As part of this objective, the project will evaluate technologies that transfer information from a transportation center (MTC) to the roadway and technologies that transfer information from the roadway to motorists. Another objective of the test is to evaluate how this information is being utilized/accepted by motorists and what impacts to roadway congestion may have occurred because of changes in driver behavior. A vehicle tracking system, known as Teletrac, will be able to monitor and track changes in route selection based on information given to the motorist (21).

The MTC to roadside communication methods being evaluated involve two technologies: spread spectrum radio systems and digital trunking radio. The two technologies essentially allow data to be transmitted from the roadside to the MTC and from the MTC back to the roadside in information that is usable to motorists.

Once the information reaches roadway locations, the operational test is evaluating several roadside to motorist communication technologies. These technologies include: low-powered highway advisory radio (HAR) with flashing signs, automatic highway advisory radio (AHAR), radio data systems, and cellular call-in.

The low-powered HAR with flashing signs system allows motorists to receive localized traffic information via their car radio. When a motorist observes a flashing sign advising them to tune to a certain radio station, they will receive specific traffic information for that area (21). The AHAR system automatically preempts the regular car radio program by using localized transmissions to communicate site specific traffic information. The automobile must be equipped with certain technologies in order to receive this information.

The cellular call-in technology will allow cellular phone users to call into a terminal and access specific route or locational traffic information by coding in a number associated with that route or location. The initial test will involve only 30 vehicles that are specially equipped to receive the information. The information will be limited to traffic congestion, weather and road conditions, and parking availability. Eventually, it is anticipated that this aspect of the program will include information on alternative routes and travel times (21).

Oakland County, Michigan (FAST-TRAC)

The FAST-TRAC (faster and safer travel through traffic routing and advanced controls) field operational test is located in Oakland County, Michigan, which is a fast growing suburban region of Detroit. The FOT is designed to integrate ATIS concepts with advanced traffic management system (ATMS) technologies within the arterial system of the county. The FOT will serve as a testbed for determining how ITS technologies might be used to enhance mobility in congested suburban locations throughout the United States. FAST-TRAC is the first attempt at fully integrating ATIS and ATMS and is considered the largest operational test of its kind at \$70 million dollars (21). The Road Commission for Oakland County (RCOC) and the Michigan Department of Transportation (MDOT) are working in cooperation with several public and private entities to bring this project to fruition.

The ATIS segment of FAST-TRAC utilizes the ALI-SCOUT dynamic route guidance system. ALI-SCOUT can provide real-time route guidance to drivers using either transmitted voice commands or simple in-vehicle navigational displays. The dynamic route guidance is accomplished when an equipped vehicle passes by intersections that have been installed with infrared communication beacons. Information is passed to the vehicles from the beacons via a central computer. Another feature of the ALI-SCOUT system is equipped vehicles essentially act as vehicle probes (21, 22). The FOT will eventually equip 3,000 to 5,000 vehicles with in-vehicle units (IVUs) that can be read by the infrared beacons.

Arterial traffic management and traffic detection are the two major components of the ATMS portion of the project, which is also known as TEKLITE. Traffic management of arterials and freeway ramps is accomplished by using Sydney Co-ordinated Traffic Adaptive System (SCATS). SCATS is a computer based signal control system that can adaptively control signals in real-time over a large geographic region. SCATS is integrated with the traffic detection system which utilizes the Autoscope video image processing system to provide real-time traffic information. To enhance integration, a transportation information management system (TIMS) is being developed to achieve information exchange between multiple sub-systems and agencies. Figure 11 is an example of the TIMS information exchange paradigm (23). Figure 12 represents a simplified version of the process.

One of the primary system objectives of the Autoscope system is to maintain mobility during road construction or major special events (23). A formal evaluation of the effectiveness of FAST-TRAC achieving this goal has not been conducted because of the infancy of this project. Currently, the project is in phase two of a three phase project. During phase two, integration of the ATMS and ATIS systems will be completed as well as an evaluation of this effort.

Figure 11. TIMS Server Software Process (23)

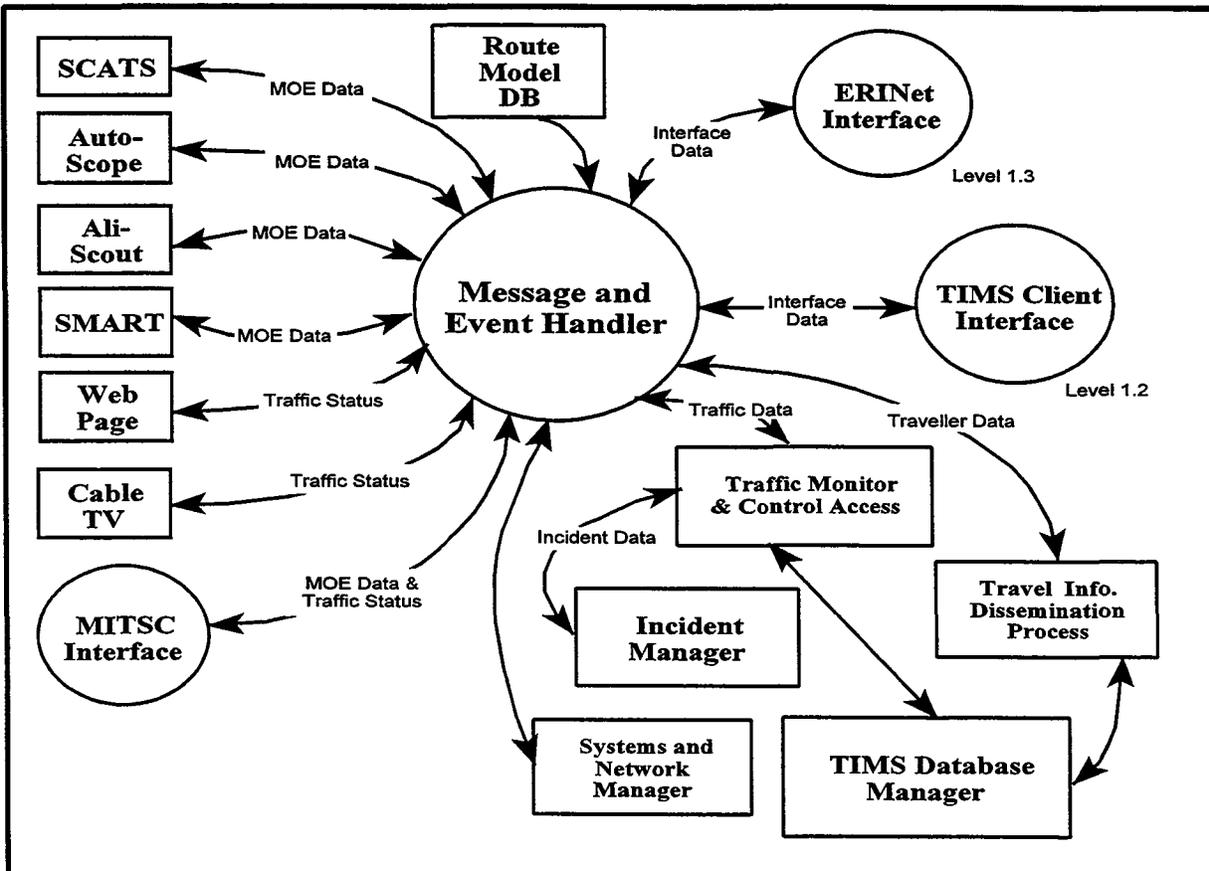
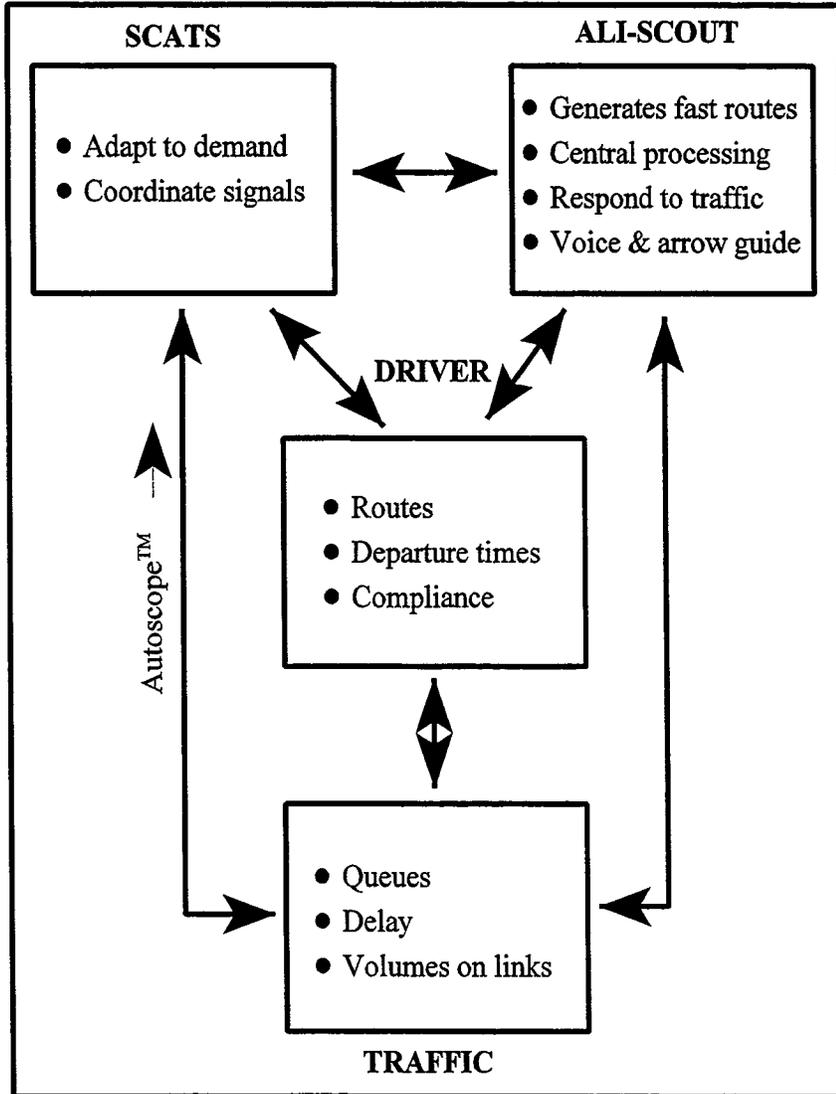


Figure 12. FAST-TRAC System Flow Diagram (24)



Minneapolis-St. Paul, Minnesota (TRAVLINK)

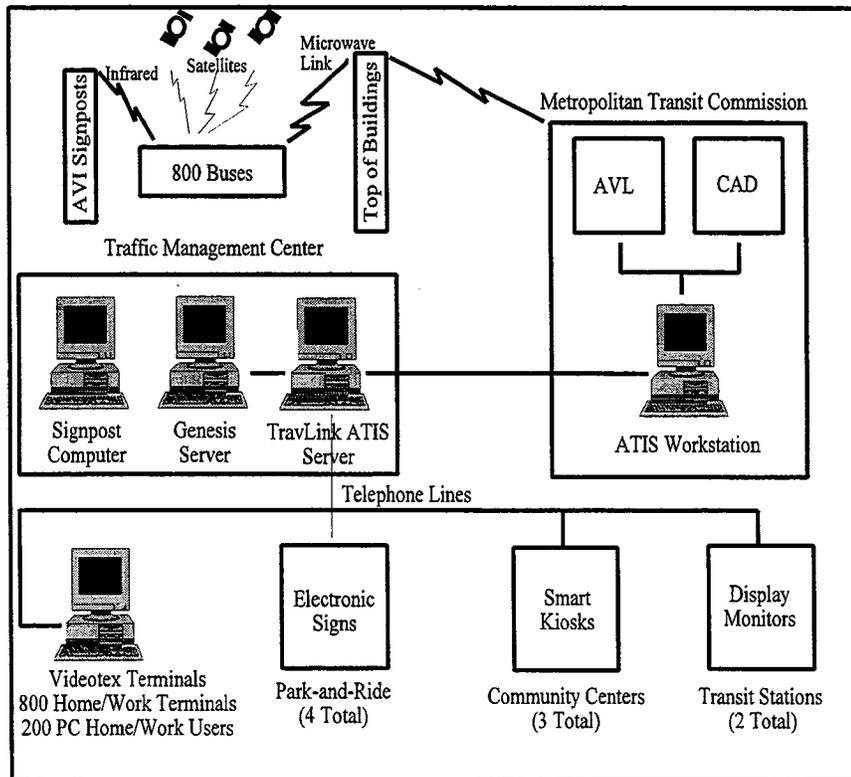
TRAVLINK is one of the sixteen federally sponsored ITS Operational Tests. TRAVLINK will evaluate the integration of automatic vehicle location (AVL) with ATIS on the I-394 corridor through Minneapolis-St. Paul. A major objective of the operational test is to determine how improved traveler information may influence mode choice. More specifically, the test will observe how improved information will encourage commuters to switch from automobiles to transit or other high occupancy modes. The project is designed to compliment existing systems, such as the HOV lane system and existing transit services to downtown. Minnesota's Guidestar is responsible for managing and implementing TRAVLINK. Guidestar is the official Minnesota Department of Transportation's (MNDOT) ITS program (25).

The ATIS system will provide both real-time and static information on road conditions to assist current and potential transit users plan their bus trip. The AVL system using global positioning (GPS) technology will provide real time information on bus schedules, delays, and travel times. Information about bus schedules is distributed to a number of display devices: videotext terminals, smart kiosks, electronic signs, and display monitors. Videotext is an "on-line" subscription service and the videotext terminals are located in nearly 1,000 homes and offices. Another customer oriented feature of TRAVLINK is information will be made available about the cost and travel time comparisons between automobiles and buses. Another major objective of the operational test is to determine the quality and timeliness of the information to the customers (25).

A document produced for MNDOT by Lockheed Martin Federal Systems analyzes customer wants and needs with ITS technologies (26). The study involved a statewide survey that identified 18 fundamental traveler wants and needs. Some of the findings concluded that there is moderate opportunity for the development/interest in technologies that could provide travel information regarding construction delays and alternative routes. Those people surveyed did indicate that pre-trip and/or en-route information about current or planned construction activities should be far enough in advance to choose an alternative route, start time, or mode. The significant finding from this was motorists wanted "advanced" warning. Survey respondents often indicated that construction signage was poorly placed and they could not respond in time to avoid the delay. Also noted was the perception that construction projects are poorly coordinated, which cause delays on primary and secondary routes. As part of these findings, a list of major transportation services and corresponding attributes was developed. In conclusion, travel condition information should include: traffic level, congestion, accidents, weather, road surface conditions, and construction or other planned events.

TRAVLINK is closely linked with another operational test managed by Guidestar. The project, called Genesis, provides detailed traffic and transit information via personal communication devices (PCDs). TRAVLINK is primarily responsible for providing transit information while Genesis collects real-time traffic information. Traffic information collection is centralized in MNDOT's Traffic Management Center (TMC). A system of pavement loops and CCTV cameras provide current traffic information. Figure 13 shows the shared information architecture between Genesis and TRAVLINK.

Figure 13. TravLink ATIS/AVL System (25)



Other ATIS Projects

Limited information is available regarding other ATIS operational tests. Most ATIS related projects are relatively new or for those projects that have been implemented, detailed evaluations have yet to surface within the literature. The information that could be garnered from the literature is presented below. Two ATIS FOTs, Pathfinder and Advance, have received some attention in the literature, while systems specific projects, such as ROGUE, Travepilot, and CARIN have received more attention (27).

The first domestic TIS project was Pathfinder in Santa Monica, California along a 21 Kilometer (13 mile) corridor of the Santa Monica Freeway. Pathfinder examined some of the basic feasibilities of in-vehicle navigation systems. Twenty-five vehicles were equipped ETAK-modified displays, which provided information on congestion, accidents, highway construction, and route deviation. Information was presented with a map display and/or digital voice. A majority of the evaluation focused on the human factors issues associated with the interaction between drivers and graphical and voice information.

The largest FOT is the Advanced Driver and Vehicle Advisory Navigation Concept (ADVANCE). The project is located in Chicago, Illinois and suburbs to the northwest and is similar in concept to TravTek (27). Unlike TravTek, though, ADVANCE will also look to relieve congestion on major arterials as well as highways. The project is a part of a multi-agency effort that involves the Illinois DOT, the University of Illinois, and the City of Chicago. Private agencies that are participating in the project include Ford, Toyota, Nissan, Saab, Volvo, Peugeot, ETAK, Navigation Technologies, DonTech, Motorola, and Sun Microsystems. The project is set to begin this year.

A small operational test called DriverGuide was conducted and tested in San Francisco airport. Using French air travelers to the United States, the travelers entered origin-destination pairs on a computer. Subsequently, a set of instructions was printed for them. Information beyond this level is not yet available.

Other projects, such as Travelpilot, ROGUE, and CARIN are primarily focused on vehicle tracking systems and how these might be better utilized to provide enhanced directional information. The projects use CD-ROMS, wheel sensors, and interactive CD maps to guide motorists and emergency vehicles.

**APPENDIX C – POSSIBLE CONTRACT REQUIREMENTS FOR
DOWNTOWN WORK ZONES**



POSSIBLE CONTRACT REQUIREMENTS FOR DOWNTOWN WORK ZONE TRAFFIC CONTROL

1. All traffic control devices, signs, barricades, warning signs and flagman operations shall be furnished, placed, constructed, executed, and maintained in the appropriate types and sizes in accordance with the latest edition of the Texas Manual on Uniform Traffic Control Devices (TMUTDC). The City of Houston Standard Specification series no. XXX and the City of Houston Transportation Criteria Manual or as directed by the engineer. If a conflict arises, then the City of Houston Transportation Criteria Manual shall control unless otherwise instructed by the engineer.
2. Installation of construction barricading and signing shall be coordinated through the Traffic Management Division of the Department of Public Works at XXX-XXXX.
3. The use of advance warning flashing arrow panels is required for closing of traffic lanes. The contractor shall be required to furnish one stand-by unit in good working condition at the jobsite, ready for immediate use.
4. The contractor shall provide one (1) full-time, off-duty, uniformed, certified peace officer and one (1) vehicle of the type approved by the engineer, for temporary lane closures and working in intersections as part of the traffic control operations. The peace officer shall be able to show proof of certification by the Texas Commission on Law Enforcement Officer Standards.
5. The contractor shall notify the Traffic Management Division, Traffic Safety Coordinator at XXX-XXXX no later than the Monday before the Monday of the week during which he/she intends to set up barricades and detour traffic prior to the start of construction. Also, provide two (2) working days advance notice to the Traffic Safety Coordinator prior to actually blocking traffic lanes.
6. The contractor shall notify all other governmental agencies whose right-of-ways are affected by his work zone traffic controls. The contractor shall provide any additional traffic control devices that they may require.
7. The contractor shall maintain driveway access at all time at the sole expense of the contractor. If access cannot be maintained, at least 24-hour written notice will be given to affected property owners and approval is required from the engineer.
8. Temporary lane closures in the central business district or on arterial streets shall not be permitted during the hours of 7:00 a.m. to 8:30 a.m. and 4:30 p.m. to 6:00 p.m. Monday through Friday.

9. The contractor shall make an inspection of all traffic control devices at least two times a day (once at the beginning of the day and once at the end of the work day) including non-work days. The contractor shall ensure that all devices are in proper working order.
10. All signs used at night shall be reflectorized and shall have a type A flashing light.
11. All channelizing devices used at night shall have a type C steady burn light.
12. All detour route signs (M4-9 series) shall have street name plaques.
13. In parking lane/parking spaces to be closed as part of lane closures, the contractor shall hood all existing meters for no parking and provide no parking signs. Meter hoods and locks shall become the property of the City of Houston at the completion of the project.
14. Contractor shall notify METRO dispatcher at YYY-YYYY, two (2) weeks prior to lane closures at bus stops.