AUSTIN AREA-WIDE IVHS PLAN and IH-35 CORRIDOR DEPLOYMENT PLAN

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Submitted to the

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Region 6 Texas Division

Prepared by the

Texas Department of Transportation
Austin District
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In cooperation with the

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Department of Public Works and Transportation

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and
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DISCLAIMER

This report has been prepared in cooperation with the U.S. Department of Transportation (USDOT), Texas Department of Transportation (TxDOT), City of Austin, University of Texas at Austin (UT), and Wilbur Smith Associates. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the USDOT, TxDOT, City of Austin, UT or Wilbur Smith Associates.

EXECUTIVE SUMMARY

This report documents a significant and largely in-house effort by the Texas Department of Transportation and the City of Austin to study and develop an intelligent transportation system (ITS) deployment plan for the Austin area. ITS issues, strategies, and technologies pertinent to the Austin area are discussed in relation to distinct tasks.

The objectives of this study are designed to support the future operational tests and implementation of ITS user services by various agencies on corridors in the Austin metropolitan area. Specific objectives for this study are:

- Develop organizational structure,
- Develop area wide ITS plan, and
- Deployment on II-I 35 corridor.

Important milestones have been reached during this study that will enable a successfully integrated intelligent transportation system for the Austin area. These milestones form a strong and stable foundation for future integrated ITS initiatives.

An organizational structure was formed during the completion of Task I and Task II that created and cemented partnerships between transportation and emergency service agencies across treacherous jurisdictional boundaries. These partnerships have been strengthened throughout the rest of the study and support a strong foundation for future integrated ITS initiatives.

Private commodity freight transportation was also identified in Task I as a significant partner in future ITS deployment in the Austin area. The concerns of this important local ITS stakeholder have been included in the recommended local ITS deployment process developed in this study.

Results of Tasks III, IV, and VI reveal a clear direction in deployment of ITS techniques and technologies for the Austin area. Surveillance identified a cost effective technique with reliable and proven technology vital to support the operation and evaluation of future ITS deployment initiatives in the Austin area. Information available from surveillance techniques and technologies supports virtually every ITS user service making it the idea priority for deployment in the Austin area.

Issues needing resolution to successfully implement a strategic plan are discussed in Task V. A strategic plan identifying four areas for deploying ITS in the Austin area are presented. These four strategic areas are:

- Surveillance,
- Incident Management,
- Centralized and Multi-Agency Service Center, and
- Traveler Information.

Finally, Task VII identifies plans, specifications, and estimate (PS&E) for three specific projects designed to support study objectives and the strategic plan. These projects signify the genesis of integrated ITS deployment recommended in this study.

ORGANIZATION OF REPORT

INTRODUCTION

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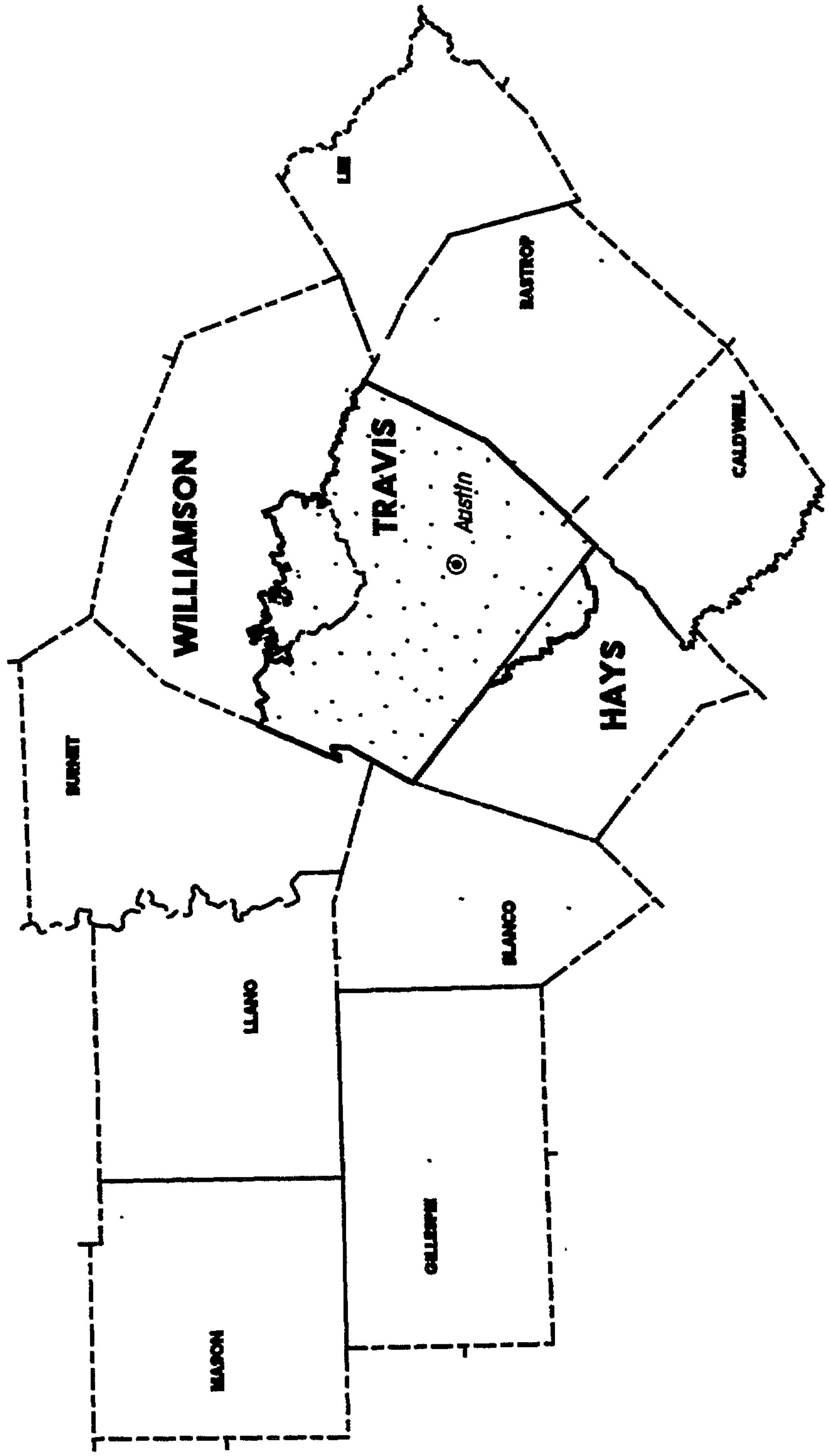
BACKGROUND

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, signed by President Bush in December of 1991, provides funding authorizations for highways, highway safety, and mass transportation for fiscal years 1992-1997. Title VI-Research, Part B-Intelligent Vehicle-Highway Systems Act of ISTEA provides for planning grants to state and local governments to study the feasibility of intelligent vehicle-highway systems (IVHS) development and implementation[1]. Since this time, IVHS has evolved to what is now called Intelligent Transportation Systems (ITS).

In April of 1993 an initiative titled, *Proposal for a Planning Study of an Area-Wide Intelligent Vehicle Highway System for the Austin Metropolitan Area and an Early Deployment Plan for the IH-35 Corridor*, was accepted for funding by the Federal Highway Administration (FHWA) under the United States Department of Transportation (USDOT). This proposal was submitted jointly by the Texas Department of Transportation (TxDOT) Austin District and the City of Austin Department of Public Works and Transportation (DPWT).

Metropolitan Area

The Austin District is one of the twenty-five regional TxDOT offices encompassing a ten county area in central Texas. The Austin Transportation Study (ATS) is the local metropolitan planning organization (MPO). The ATS metropolitan area includes parts of three counties and nineteen local jurisdictions with a total population of 687,000 (1990 census). For the purpose of this study, the ATS boundary was selected as the limits of the study area to be considered. Austin, the largest city in the ATS boundary, is near the center of this metropolitan boundary, as shown in **Figure i-1.**



Austin Metropolitan Boundary_Figure i-1

Austin Area

Austin, the capital of Texas, is divided along its north-south axis by Interstate Highway 35 (IH 35). As illustrated in **Figure i-2,** the southern tip IH 35 is at the U.S.-Mexico border, in Laredo, Texas, and the northern tip terminates in Duluth, Minnesota. The Colorado River also dissects Austin along an east-west axis.

Austin is home to numerous state office complexes and high-tech industries, as well as, the University of Texas (UT). Additional traffic generators in the Austin area are illustrated in **Figure i-3** and include the UT Memorial Football Stadium, UT Frank Erwin Special Events Center, and the City of Austin Convention Center.

Austin, as well as most urban areas of Texas, has witnessed increased auto use and ownership that have exceeded the capacity of the transportation network. This increase has resulted in more urban traffic congestion, excessive air pollution and fuel consumption, higher accident rates, and unacceptable levels of frustration and delay[2]. A population explosion to over one million persons by 2020 is expected to aggravate Austin's transportation network, further reducing transportation safety, mobility, air, and water quality[3].

STUDY OBJECTIVES

The objectives of this study are designed to support the future operational tests and implementation of ITS user services by various agencies on corridors in the Austin metropolitan area. Specific objectives for this study are:

- Develop organizational structure,
- Develop area wide ITS plan, and
- Deployment on IH 35 corridor.

IH 35 Corridor_Figure I-2

Austin Area_Figure I-3

ITS PLANNING PROCESS

IVHS, or more recently Intelligent Transportation Systems (ITS), uses modem communication, computer, and electronic technologies to improve the safety and efficiency of the transportation system. These technologies can be combined to provide several capabilities or "user services". To date, 29 user services have been bundled together into six broad service areas[4]. Some user services are still evolving to overcome technological, as well as, institutional barriers. To aid metropolitan areas in prioritizing ITS deployment, the USDOT has identified specific user services comprising a core infrastructure for ITS deployment. The user services in this core infrastructure are indicated in **Table i-1.** Integration of this core infrastructure, which will involve multi-agency cooperation, is needed for successful deployment of ITS into the existing transportation system.

The FHWA developed a guide titled, *IVHS Planning and Project Deployment Process,* for distribution in April of 1993. This process, illustrated in **Figure i-4,** was created to serve as a tool for organizations to systematically plan for, and implement, ITS technologies as a part of an integrated transportation system[5]. The process presented in this guide was used for this study.

Local ITS Planning Methodology

The study proposal submitted by TxDOT and the City of Austin relates to the planning process developed by the FHWA through the completion of seven tasks. An outline of the seven tasks detailed in this study are listed below.

Task I-Austin ITS Organization and Procedures

The Study will contact agencies that may benefit from the implementation of IVHS technologies or are users of the transportation system in the Austin area in order to develop Austin IVHS organization and procedures. Steps involved in this task include:

- Assessing the local agencies to define existing transportation problems and develop user service objectives.

- Review/assessing existing policies/procedures in order to develop a user service plan meeting short, medium, and long term objectives.
- Developing the organizational structure to provide the institutional framework for cooperation among agencies.
- Establishing an organizational diagram showing the relationship of various agencies and a report describing this organization.

Task II-Identify/Assess Existing Resources From All Participating Agencies

The Study will identify and assess existing various resources utilized by participating agencies. The Study will concentrate on the City of Austin signal system and the TxDOT freeway traffic management systems deployed in Austin. This task will develop:

- Facilities summary,
- Equipment summary,
- Maintenance summary,
- Personnel and funding summary, and
- Report recommending functional requirements to support user services.

Task III-Evaluate State of the Art Traffic Management Techniques and ITS Technologies

The Study will evaluate techniques and technologies which offer the most promising chance of performing system functions. Functional areas identified in this task will be used to:

- Screen and evaluate techniques and technologies,
- Recommend training for computer modeling needed to measure the performance and reliability of the techniques used, and
- Prepare a report identifying standards, system components, and impacts.

Task IV-Identify/Assess Corridors

The Study will identify and assess corridors to further identify problems. This task will:

- Identify and evaluate roadways by corridor, and
- Develop maps and a report identifying priority corridors.

Task V-Develop Austin ITS Plan Document

The Study will develop a document which outlines the steps necessary to deploy ITS in the Austin area. The deliverables of this task include:

- Strategic deployment plan incorporating the user service plan and
- Plan document suitable for distribution to users.

Task VI-Austin ITS Plan Assessment/Evaluation Criteria

The Study will establish evaluation criteria needed to adequately assess the success of ITS deployment in the Austin area. This task will result in:

- An implementation assessment methodology including performance criteria involving both quantitative and qualitative measurements and
- A report identifying performance criteria and data gathering procedures.

Task VII-Prepare IH 35 Action Plan, Plans, Specifications, and Estimates (PS&E) for the Initial Deployment Project

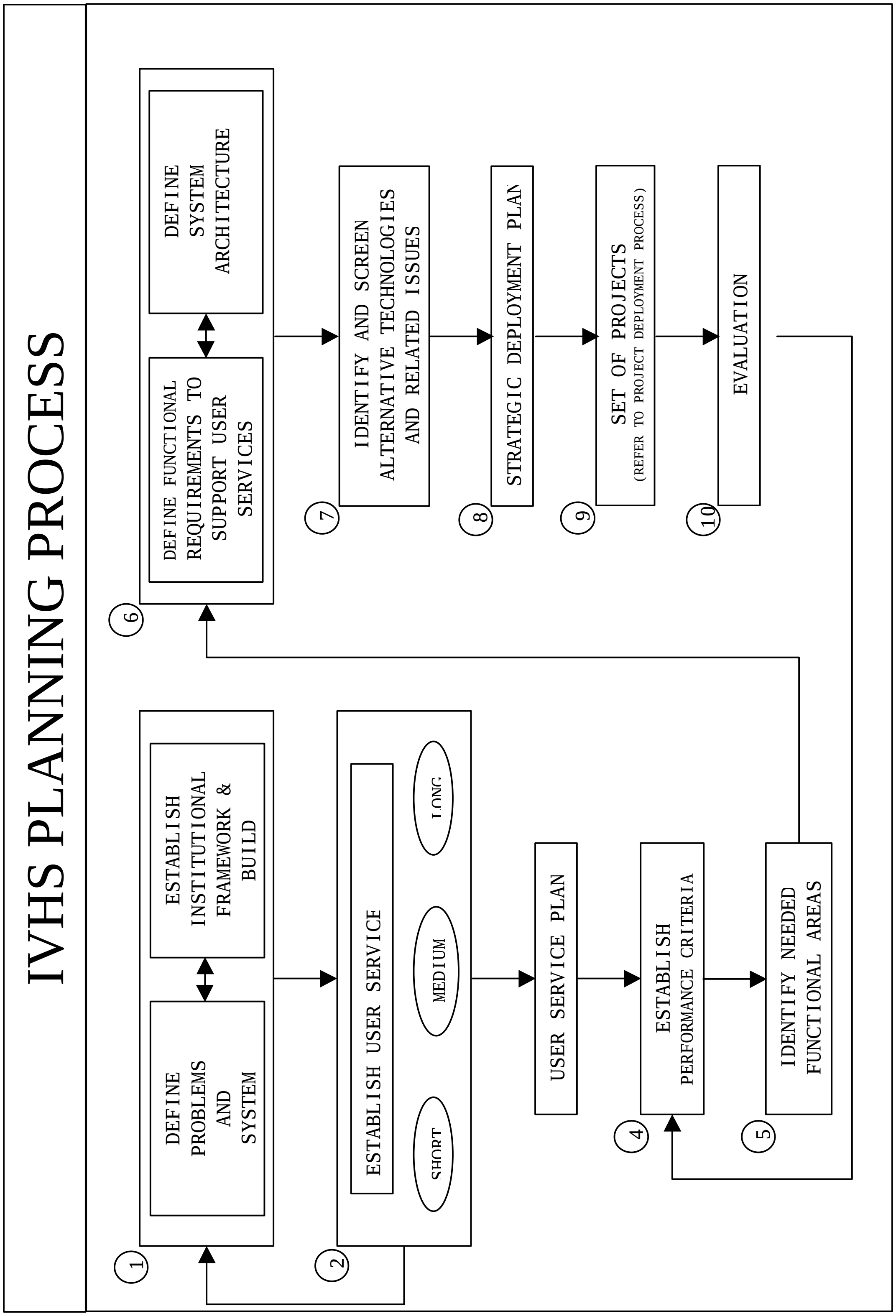
The completion of this task will provide an IH 35 action plan to include:

- Operations and maintenance,
- Initial project plans, specifications, and estimate (P&&E),
- An on-going process continuing for the life of the system, and
- A contracting date for the initial project included an the State Transportation Improvement Plan (STIP).

In June of 1993, an agreement was executed between the PHWA and TxDOT to complete this study. The Austin District Transportation Operations was responsible for completing the work for TxDOT. The Austin District, in cooperation with the City of Austin, decided to complete the bulk of the work with existing staff. An agreement was executed in March of 1994 between TxDOT and the City of Austin initializing this cooperative effort. The City of Austin Department of Public Works and Transportation, Transportation Division, provided the staff for this project.

ITS User Services	
➢ En-Route Driver Information♥	➢ Commercial Vehicle Electronic Clearance
➢ Route Guidance	➢ Automated Roadside Safety Inspection
➢ Traveler Services Information♥	➢ On-Board Safety Monitoring
➢ Traffic Control♥	➢ Commercial Vehicle Administrative Processes
➢ Incident Management♥	➢ Hazardous Materials Incident Response
➢ Emissions Testing and Mitigation	➢ Commercial Fleet Management
➢ Pre-Trip Travel Information	➢ Emergency Notification and Personal Security
➢ Ride Matching and Reservation	➢ Emergency Vehicle Management
➢ Demand Management and Operations	
	➢ Longitudinal Collision Avoidance
➢ Public Transportation Management♥	➢ Lateral Collision Avoidance
➢ En-Route Transit Information♥	➢ Intersection Collision Avoidance
➢ Personalized Public Transit♥	➢ Vision Enhancement for Crash Avoidance
➢ Public Travel Security♥	➢ Safety Readiness
	➢ Pre-Crash Restraint Deployment
	➢ Automated Highway Systems
➢ Electronic Payment Services♥	
	♥ Core Infrastructure

ITS User Services_Table i-1



FHWA ITS Planning Guide_Figure i-4

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1. *Intermodal Surface Transportation Efficiency Act of 1991, A Summary*, U.S. Department of Transportation.

2. *Options, An Update on Long-Range Transportation Options for the Austin Area,* Capital Metropolitan Transportation Authority, June 1994.

3. *Transportation Trends, Austin Metropolitan Area, 1960 to Present,* Austin Transportation Study, Draft September 1993.

4. *IVHS Architecture Development Program, Interim Status Report,* IVHS America, April 1994.

5. *IVHS Planning and Project Deployment Process,* Federal Highway Administration, Version 1.0 April 1993.

TASK I

AUSTIN ITS ORGANIZATION AND PROCEDURES

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DEFINING PROBLEMS

This task will define transportation system problems and develop a user service plan to address them. Obtaining a wide variety of viewpoints may yield a large coalition to address common problems. Building a coalition based on the most common problems will be the basis of the initial organizational structure.

Experience of Others

The U.S. Department of Transportation (USDOT) complied a report describing USDOT sponsored activities supporting the development and deployment of IVHS. The Austin study contacted nine other cities granted early deployment studies which were named in the report. These contacts revealed the opportunities and problems they encountered. A series of questions were posed to representatives of each study. A summary of the most useful information is included as Appendix IA. A frequently used tactic to get interest in the these studies was to identify a common problem and offer a quick ITS solution. However, it was disappointing to note that many coalitions seemed to disband after the problem was solved and the study completed. It appeared that many of the studies did not address very broad issues or transportation systems. Several dealt with only one roadway or corridor. Freeway corridors were typically targeted. This appeared to limit the involvement of agencies. On the other hand, some studies developed broad plans but the agency involvement was so large, diligent churning was necessary to keep interest peaked. The consensus was that building the coalition was the most important, time consuming and challenging task in the study. Often, it was felt that this task determined the degree of success achieved by the study.

Local ITS Stakeholders

Seventy-seven agencies in the Austin area were initially identified as potential stakeholders in NHS user services. These agencies included transportation infrastructure providers, public safety and emergency service agencies, information services, freight carriers, traffic generators, municipalities, special interest, and political representatives. A matrix was developed listing each agency and user service. Agencies were matched with user services estimated to be of interest. This matrix has been included as Appendix IB. Twenty-four agencies were initially identified for further contact. A survey was developed to identify general transportation problems and interest. Conversations among these agencies resulted in some additional agencies being contacted. Eventually, thirty-one surveys were sent out and twenty-two agencies responded. The results of the survey responses are included in Appendix IC. As a result of the responses, interviews were arranged with fourteen of the agencies. A synopsis of the interviews is included in Appendix ID.

Local Survey

The local survey identified what transportation related information agencies usedan how they currently received it. The survey also asked how they would like to receive information. The survey also identified corridors and the problems on them.

Information Needs

Currently, nearly all agencies responding to the survey indicated they usetransportation related information to improve performance. Accident location was indicated as the most widely used piece of information followed by congestion, construction, weather, and travel time. Most agencies get the information from radio sources followed closely by the telephone. This information is considered reliable and timely only some of the time.

Desirably, responding agencies would receive information concerningtraffic related conditions including accidents and congestion. The location of the accident was most important followed by alternate routes, type of accident, location of construction, and anticipated delay. Most agencies indicated they would like to have access to this information through a computer at work. Other highly desired forms of access included radio, computer in vehicle, and changeable message signs on the side of the roadway. They desire this information continuously, 24 hours a day, every day of the week, or at least Monday-Friday. Additionally, agencies operating a fleet of vehicles feel it is beneficial to automatically locate them on the roadway.

Corridor Problems

Three corridors were highly rated as influencing performance of the responding agencies. The highest rated was IH 35 followed by Loop l/Mopac and US 183. Other significantly rated corridors included US 290 & H 71/Ben White Boulevard, Larnar Boulevard, and Loop 360. The highest rated problems on these corridors include congestion followed closely by accidents. Construction delay, signal delay, and speeding were also indicated as regular problems. Widening the roadway, re-timing the signals, and restricting certain vehicles were selected as methods for solving these problems. Finally, the survey indicated that the state, city, and federal governments should be responsible for making the improvements.

Local Interviews

Interviews reinforced responses indicated on the survey, emphasizing the IH 35 corridor and the accidents and congestion that occur on it. Transportation infrastructure providers interviewed were concerned with upgrading the existing transportation network and the relation of ITS to the local planning and selection process. Agencies not involved in roadway transportation seemed unsure of how ITS related to their agency.

Texas Department of Transportation

TxDOT is currently upgrading US 183 and US 290 from signalized arterials to freeways. These construction improvements are expected to last for several more years. A proposed project on a section of IH 35 through downtown would upgrade lanes to current standards and construct high occupancy vehicle (HOV) lanes and a collector-distributor street system. One proposal for improving IH 35 would drastically change the terrain within the existing right of way. Additionally, TxDOT has installed two variable message signs (VMS) on the IH 35 corridor. However, insufficient staff and lack of an operations plan results in the signs being utilized. TxDOT also has a radio license, issued by the Federal Communications Commission, to operate county wide transmitter at 0.530 MHz on the AM band. Unfortunately, this frequency has remained idle since its acquisition in January of 1991 due to concerns over its operation. Currently, TxDOT depends on other enforcement agencies to notify them of an incident on the freeway. Enforcement agencies will usually notify TxDOT only if damage has occurred to the highway facility. This usually limits notification to major incidents.

City of Austin

The City of Austin is struggling to maintain anever expanding roadway network. Recent Traffic Light Synchronization (TLS) grants, sponsored by the governor have resulted in many signalized corridors being retimed. Not enough grant money is available to retime a large number of corridors. One TLS grant developed incident signal timings for the frontage roads along the downtown IH 35 corridor. These plans have never been implemented primarily because no procedures were developed for implementing the timings. A more modem and responsive system for controlling the signals is also needed.

Capital Metropolitan Transportation Authority (Capital Metro)

Capital Metro is aggressively pursuing technologies to improve the transit system. Automatic vehicle location (AIL) and signal priority are top concerns. Capital Metro is partnering with public safety agencies to improve radio communications.

Public Safety and Emergency Response

Public safety and emergency response agencies are concerned with communicating with their fleet. They are also concerned with communication at the incident scene. Each responding agency operates on their own radio frequency. Communication between agencies is not usually possible unless they get out of their cars and talk to one another. Coordination cannot take place until all agencies have arrived on the scene. Police dispatchers are usually responsible for notifying other agencies. Maintenance and operations agencies do not always get notified. Many times notification occurs only after initial responders are about to leave the scene. Recently, a coalition was formed among public safety agencies and Capital Metro in order to finance a radio network backbone. A new radio network will permit units from different agencies to communicate directly with one another. Each user communicates with its own units and does not hear other users unless there is a need to link them electronically. This system will require significant capital investment.

Public safety and emergency response agencies are also concerned with locating fleet vehicles on the roadway. No agency contacted utilized a true automatic vehicle location (AVL) system. Public safety agencies are concerned over security issues of AVL. They are concerned with who will have access to the AVL information.

Additionally, emergency response providers are concerned with accidents and training personnel on proper procedures at incidents. Policing agencies are particularly concerned with response to accidents involving trucks along the downtown IH 35 corridor. Many times cargo is spilled and additional equipment is needed to clear the roadway. The four freeway lanes in each direction in this area are physically divided into two pairs. A truck accident in either pair of freeway lanes will close that section of freeway. Since one pair is an express section, with no exits or entrances, traffic can be trapped. The local police agency has recently deployed a weights and measures enforcement unit in order to reduce the number of accidents caused by trucks that are overweight or have loads that are not safely secured.

Commercial Vehicles

Freight carriers in the Austin area would benefit from improved traveler information on the transportation system in the Austin area. Freight circulates both in and through Austin. Although rail lines pass through Austin, there is no facility for unloading trailers or increasingly popular double stacked containers. Commodities may be flown into the airport, but once in Austin it must be trucked. Local businesses depend on an efficient trucking system to remain economically competitive. Local freight and commodity carriers must have real time, accurate information on the transportation system in order to deliver goods efficiently.

Truck traffic passing through the Austin area, especially originating from Laredo, is expected increase on IH 35 through Austin due to the North American Free Trade Agreement (NAFTA). NAFTA will relax trade restrictions between Canada, Mexico, and the United States. This is expected to have significant effects on congestion, pavement, and air quality in Austin. These impacts could be mitigated through improved communications with the freight industry. Information on congestion and incidents could be communicated to freight carriers allowing them reroute and avoid delays in the Austin area.

Local Workshops

Two workshops were held in the Austin area during the study period to stimulate interest and provide input for the Austin ITS deployment plan. The first workshop was held on October 13, 1995 at the Joe C. Thompson Conference Center on the campus of the University of Texas at Austin. This all day workshop provided attendees with an overview of some ITS initiatives around the country, while the afternoon focused on ITS activities closer to the Austin area. While general support for ITS activities was expressed in the afternoon open forum, there was a fear that the institutional environment in Austin was so diverse that no decision or implementation would ever take place. Austin has witnessed the development of several good plans, few of which have ever been implemented.

The second workshop was held on January 31, 1996 and was more focused on incident management. A few agencies, including TxDOT, are trying to implement a freeway courtesy patrol. The workshop was designed to garner support from additional agencies. Although this workshop was not specifically designed to support this study, the opinions and concerns expressed at this workshop has been considered by the investigators.

Common Concerns

Roadway incidents appear to be a concern held by nearly all agencies. Improving the response to the incident, both enroute and on the scene, could calm this concern. Training is seen by some agencies as a way of improving incident response. Many agencies have experienced turnover. Personnel are not always trained to determine which agencies require notice during an incident. Thick books with long lists of names and complicated maps of who to call have not been entirely successful in the past. Inexperienced personnel have also been blamed for closing lanes, or in some cases, entire roadways when it was not desirable. A comprehensive, up to date training program, applicable to all agencies, could improve response.

Transportation information providers have long been challenged with accurately identifying the location, severity, and duration of incidents and congestion. These characteristics are desired by nearly every agency contacted. Reports from drivers are often inaccurate and must be verified by a reliable source before the information is disseminated to others. Monitoring police frequencies is not always considered reliable. In the past, an officer on the scene has stated that all lanes are closed. However, other sources verify that traffic continues to pass around the scene on the shoulder. The officer's statement is often misunderstood that traffic is at a standstill. Telephoning the enforcement communications dispatcher during an incident is not always well received. A stressful situation is not improved when another agency is pestering you for information. Closed circuit television (CCTV) capabilities, accessible by all agencies, could improve information dissemination. Radio stations broadcast traffic reports at regular intervals during peak periods. Most stations, however, appear reluctant to break normal programming for all but the most severe incidents. More numerous, day to day, and off peak incidents are never disseminated to the public.

USER SERVICE PLAN

Based on the information provided in the survey and follow up interviews, a user service plan has been developed. Services have been selected that will address the problems identified by the various agencies contacted. A user service plan utilizes the ITS user services identified in **Table i-1** for deployment in the Austin area. This plan indicates which ITS services are most important to the Austin area based on the information gathered in this task. The user service plan is designed to indicate services that will provide a level of satisfaction from a broad range of viewpoints. The user service plan does not necessarily list, or even recommend, specific projects. The plan provides general guidance for the types of projects to deploy. Agencies are encouraged to develop their own specific projects to meet stated objectives. The plan has broad objectives which will meet the expectations of many agencies, as well as, the traveling public. In addition, the plan prioritizes the user services into short, medium, and long term deployment.

User Service Objectives

Information provided from the survey responses and interviews identified several common problems in the transportation system. These problems can be addressed by the objectives listed below:

- improve incident traffic control,
- improve incident communication between agencies,
- improve training for incident responders,
- improve automatic vehicle location,
- improve driver information, and
- improve communications with other modes of travel.

These broad objectives can be addressed with a variety of specific projects. No single project or lump sum will fully satisfy these objectives. However, these objectives can be used by agencies as criteria for implementing projects. These objectives can be met by deploying projects providing specific user services in the short, medium, and long term.

Short Term Plan

The short term plan recommends user services that should be included in projects deployed in l-2 years. These services are critical for future success of ITS and provide the most cost effective benefits. Short term deployment should include:

- pre-trip and en-route driver information system,
- a roadway incident management plan for the IH 35 corridor, and
- develop a roadway incident management training curriculum.

Medium Term Plan

The medium term plan recommends user services which will require significant investment. However, these services will benefit broad array of users. The following user services should be included in integrated deployment in 2-5 years:

- advanced traffic control system,
- advanced public transportation management system,
- advanced commercial fleet management system,
- advanced emergency management system

Long Term Plan

The long term plan recommends a reevaluation of the user service plan in 5-10 years. This implies that the plan will change from time to time as user needs and the technology to satisfy them changes. Long term recommendations include:

- evaluate user service objectives and plan and
- deploy additional services as technology becomes available.

INSTITUTIONAL FRAMEWORK

ITS service objectives can not be met unless ITS services can be integrated into projects through the local project planning process. Some type of institutional framework or comprehensive, multi-agency process for integrating ITS services into the local planning process is necessary. Somehow ITS must fit into the existing project planning and selection process.

Project Planning and Selection Process

The existing project planning and selection process is a complicated task involving technical and non-technical concerns of coalitions. Coalitions consist of both public and private entities. Local transportation infrastructure providers, such as TxDOT, Travis County, City of Austin Department of Public Works and Transportation, and Capital Metropolitan Transportation

Authority (Capital Metro), currently provide funding for projects through a network of planning and selection processes. Federal assistance is usually filtered through TxDOT to the local agencies, including the MPO, Austin Transportation Study (ATS). A variety of federal, state, and local taxes provide the capital necessary for most transportation projects. Projects seeking Federal assistance are generally ranked according to established technical criteria. Projects funded solely by a single entity are not always selected according to technical criteria. Coalitions lobby these agencies to address their transportation concerns. Many times a project making good technical sense is thwarted due to a successful lobby by a coalition. On the other hand, coalitions are successful influencing projects for selection apparently having little technical merit.

Existing Coalitions

There are several existing planning coalitions in the Austin area which could provide an institutional framework through which ITS user services could be integrated into the existing project planning and selection process. In addition to coalitions among public transportation infrastructure providers, such as the local traffic management team (TMT), many more coalitions exist in the private sector.

Downtown Coalitions

Coalitions among downtown Austin businesses have existed for quite some time. Most businesses realize the importance of an efficient, reliable transportation system to deliver goods and services. The downtown central business district (CBD) is one of the most heavily congested areas in Austin. These coalitions are usually concerned with mobility, the ability to get from point A to point B. CBD coalitions are often influential in the project planning and selection process since so much of the area's economy is located in the CBD.

Neighborhood Coalitions

Neighborhood and community coalitions are also popular in the Austin area. These coalitions are most influential in the project planning and selection process when there is a question of safety. Safety of children and the effects of transportation improvements on schools always get the attention of planning and selection officials.

Environmental Coalitions

Environmental coalitions are also active in the local project planning and selection process. These coalitions have been successful influencing projects even after they are already under construction. Roadway projects have been stalled in the planning process or in some cases halted in the middle of construction until their concerns have been addressed. These coalitions are concerned with the effects of transportation projects on air and water quality, as well as, wildlife habitat.

These are certainly not representative of all the coalitions in the Austin area. There are many more. A few have been discussed to illustrate a point. An ITS coalition will have plenty of stiff and organized competition. ITS services can not be successfully integrated into the planning and selection process on a large scale by merely forming another coalition lobbying its agenda. ITS services can be integrated easily into the existing planning and selection process by using these services to support the efforts of existing coalitions. An example of this can be illustrated using an existing framework for project planning and selection used by the transportation infrastructure providers mentioned before.

Planning and Selection Framework

ISTEA, in addition to providing grants forITS, mandated that states shall develop, establish, and implement six management systems. These systems included pavement, bridge, safety, congestion, public transportation, and inter-modal management. The Metropolitan Planning Organization (MPO) in Traffic Management Areas (TMA), areas with population in excess of 200,000, were required to develop the congestion management system (CMS). Additionally, States were required to develop traffic monitoring systems. Congress has since suspended these mandates, however, the planning organizations in the Austin area have found these systems can provide a framework for planning and selecting projects. These management systems provide a process for collecting and organizing transportation related data. This data is used in the local planning process to evaluate projects.

Four of these systems can be easily supported by ITS user services, Travel and Traffic Management services can be used to support the objectives of the Congestion Management System (CMS). Public Transportation Management services obviously support the Public Transportation Management System (PTMS). Electronic Payment Services and Commercial

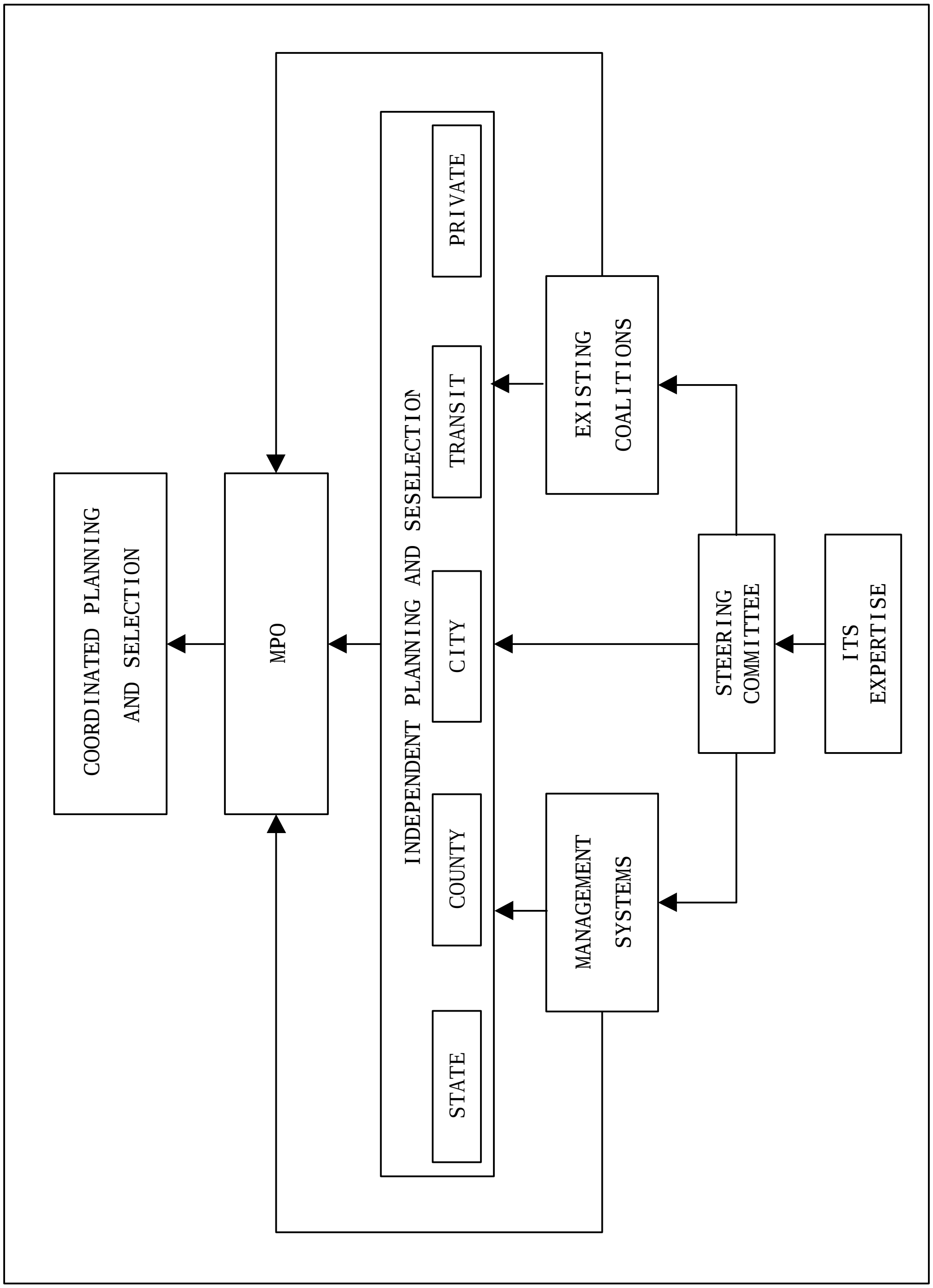
Vehicle Operations can support the objectives of the Intermodal Management System (IMS). Emergency Management and Advanced Vehicle Safety Systems can support the objectives of the Safety Management System (SMS).

ITS services should not be used to replace existing frameworks for project planning and selection. ITS can be best integrated into existing project planning and selection processes by supporting already established institutional frameworks. This process can be illustrated as shown in **Figure I-l**.

Although public and private coalitions, operating under existing frameworks, exist in the Austin area, II'S is not well understood by them. A broad based steering group will be needed to facilitate the existing institutional framework.

Local IVHS Steering Committee

The Texas legislature enacted Senate Bill 383 in 1993. This legislation requires a state agency that is advised by an advisory committee to adopt rules that state the purpose of the committee, describe its task, and the manner in which it reports to the agency. The Texas Transportation Commission identified advisory committees established in accordance with this legislation through Minute Order 103067. Local IVHS Steering Committees are identified in this minute order. Portions of this minute order relating to the 1ocaI IVHS Steering Committee are included in Appendix IE. The rules stated in the minute order are minimum requirements. Advisory committees are free to adopt additional governing rules that do not conflict with those established in Minute Order 103067.

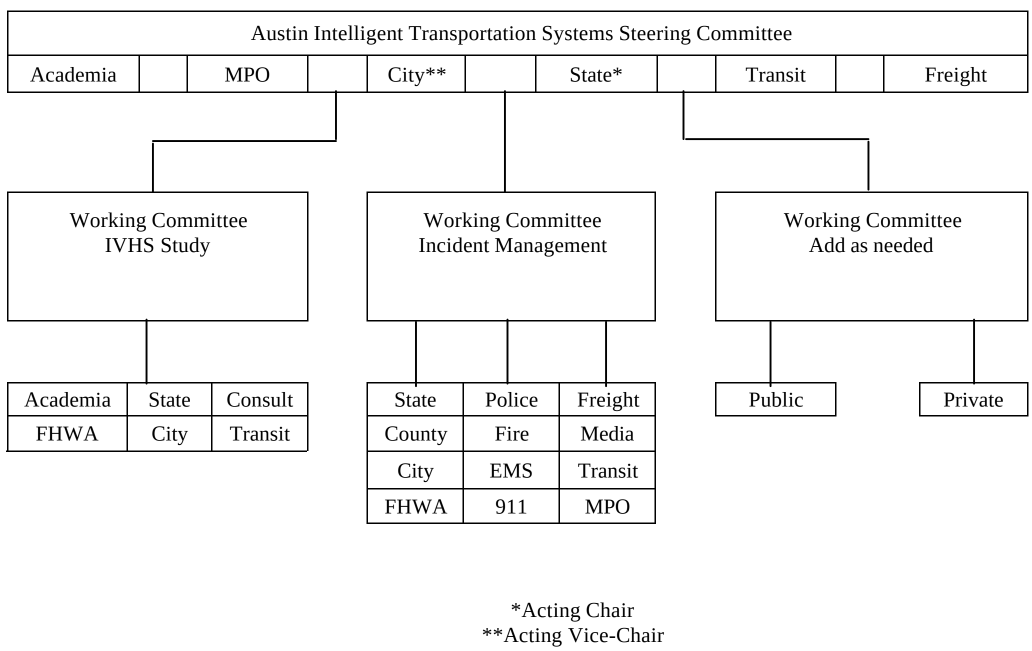


Local ITS Integration_Figure I-1

IVHS is an evolving tool for agencies to use. IVHS must remain flexible and able to change with the local environment in which it is used. ISTEA has placed more emphasis on multiple mode of travel. Intelligent Transportation Systems (ITS) is a title that has steadily replaced IVHS. ITS reflects the evolving multimodal nature of the local planning process. Therefore, it is recommended that the local IVHS steering committeebe titled Austin ITS Steering Committee.

The local ITS steering committee may be subject to the golden rule of government. The golden rule holds that "he who has the gold rules". Representation on the steering committee should include local infrastructure providers. These providers usually possess the required resources. The State, City, Transit, and MPO, agencies have indicated an enthusiastic response to planning and deployment of ITS user services. Additionally, ITS technologies have undergone considerable research by private and academic institutions. Local Austin academic institutions have participated in this research. Representation from academia could provide important information from this area of ITS. The effect of freight transportation in Austin has been discussed earlier. Representation from this transportation sector could facilitate improved freight operations. The steering committee can serve as an administrative funnel for ITS technologies in the Austin area. Only single representation from agencies is required. The problem solving should take place in working committees or groups that report to the steering committee.

Working committees are where the technical expertise for local ITS technologieslies. Working committees are where you wiI1 find multiple representation from a single agency. This is where deployment issue will be brought to the surface and discussed. At least two working committees can be envisioned for immediate deployment. This study should comprise one of the committees. The other committee should be formulated to address the short term goal to develop an incident management plan. A recommended organizational diagram is shown in **Figure I-2**.



Local ITS Steering Committee_Figure I-2

The ITS steering committee representatives should participate on other existing coalitions or committees. When a need arises that can be addressed though ITS, the vice-chair could call a meeting of the committee to discuss the issue. If needed, the chair could form a working committee to study the issue and make recommendations for the committee to consider.

Steering Committee Roles

Chair

- Create working committees
- Coordinate working committees

Vice Chair

- Call the meetings
- Provide minutes of meetings

Working Committee

- Provide technical expertise
- Recommend solutions to Steering Committee

Steering Committee Responsibilities

- Texas Senate Bill 383,73rd Legislature, 1993
- TxDOT Minute Order 103067 dated December 22, 1993
- No more than 24 members
- Private sector must be represented
- Must meet once a calendar year
- Must have a quorum to vote
- Must elect a chair and vice chair by a majority vote

References

Specific citations were not utilized in this section, however, the following documents contain general information used to formulate recommendations made in this task. The reader is encouraged to become familiar with these documents.

IVHS Planning and Project Deployment Process, Federal Highway Administration, Version 1.0 April 1993.

IVHS Architecture Development Program, Interim Status Report, IVHS America, April 1994.

National Program for Intelligent Vehicle-Highway Systems (IVHS), Volume 1 and 2, Federal Highway Administration, Draft May 1994.

TASK II

IDENTIFY/ASSESS EXISTING RESOURCES FROM ALL PARTICIPATING AGENCIES

Executive Summary

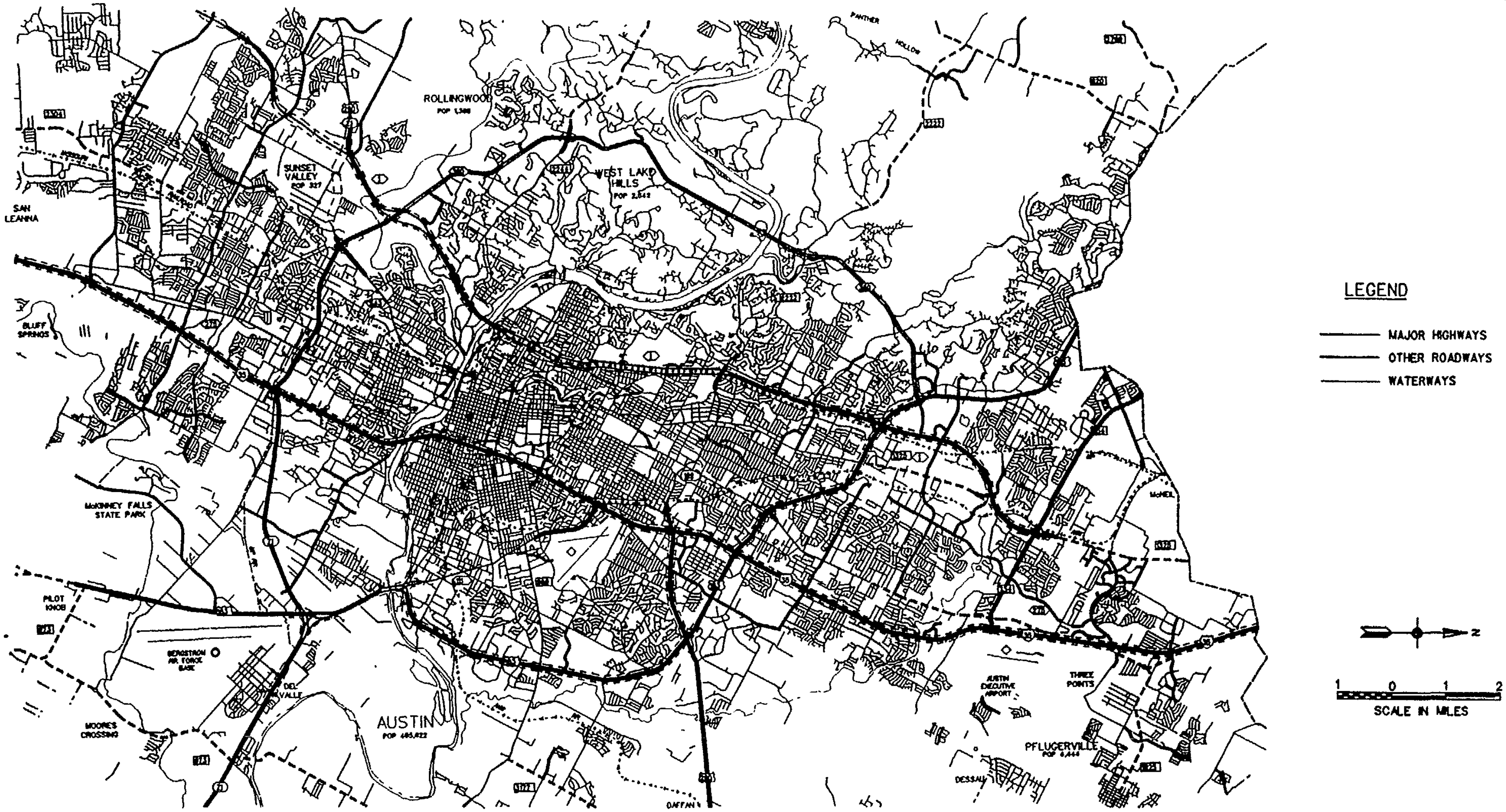
This study involves the identification and assessment of existing resources from all of the participating agencies of the Austin Area-Wide ITS Early Deployment Project. This report involves a portion of one task of a multi-task effort for the development of an Intelligent Transportation System (ITS). The study will assist in the development of the functional requirements to support the user services identified in the user service plan. The user service plan includes traffic control, incident management, public transportation management, en-route and pre-trip travel information, emergency vehicle management, and commercial fleet management. Each user service has some existing technology already applied in the Austin area to accomplish several functions.

Study Area

The study area for this project includes the City of Austin metropolitan area, as shown in **Figure II-i.** The City of Austin is the capital of Texas and has a metropolitan area population of approximately 600,000 persons.

As shown in Figure II-i, the study area includes the City of Austin and adjacent urban and suburban areas which are served by freeways and other major roadways. Austin is served by the IH 35, US 183 and MOPAC freeways in the north-south direction and by US 290/SH 71 in the east-west direction. These highways are supported by corridor streets which serve motorists in using the freeways to reach their destinations and in *making* short thru trips within the area. The freeway and major highway system is in various stages of construction/reconstruction which is expected to continue beyond the life of this study and for the next twenty years as identified in the Austin Transportation Plan.

The freeway service roads, highways and street networks within the area which are served by traffic signals are anticipated to be served by an expanded traffic signal system. In addition, public transportation is provided which will play an ever increasing importance in the movement of people



Study Area

Austin Area - Wide ITS

Austin, Texas

WILBUR SMITH ASSOCIATES
CONSULTING ENGINEERS AND PLANNERS
HOUSTON, TEXAS

North American Controls Corporation
Advanced Traffic Engineering
Kessmann & Associates

Figure II - i

within the area. The State, under the jurisdiction of the Texas Department of Transportation, has programmed/planned portions of the freeway management system for the Austin Area. The City of Austin has an existing traffic signal system and has planned an expanded traffic signal system. Capital Metro, the area transit agency, has planned or is planning a SMART Bus Program, High Occupancy Vehicle (HOV) lanes, and light rail system. Other Public Safety agencies, such as Fire and Police, have been involved in transportation development programs. These efforts toward enhancing transportation with some coordination between agencies have been largely independent. As these projects move from the independent internal planning stage toward implementation, a need is developing for these new "intelligent" transportation systems to interphase with the other transportation system providers.

Many existing streets cannot be widened because of right-of-way (ROW) limitations and neighborhood opposition to widening. In addition, the Colorado River divides the study area between north and south Austin. The present street widening limitations and the Colorado River provide constraints to a free flow of traffic. Funding constraints have also limited or delayed needed transportation projects. The City of Austin and TxDOT are planning on utilizing an ITS to supplement the existing and planned street and highway network

Systems Applications

Because of ongoing roadway construction, restricted capacity across the Colorado River and street widening restrictions, ITS and other advanced applications need to be implemented in order to assure optimum mobility and safety within the study area. ITS and other advanced systems can be utilized prior to, during and after roadway construction. In addition, the use of bus, vanpoo1 and carpool ridership and other transportation demand management activitiesare planned to be part of ITS applications.

Incident management is proposed to be implemented as part of the overall system development. Approximately 55 to 60 percent of congestion has been found to be caused by incidents. The overall effectiveness of an area wide traffic management system will be limited if incident management is not included. This includes coordination between Public Safety Agencies (PSA) and Traffic Management Personnel. Incident management also includes traveler in6ormation on traffic conditions within the area (e.g. home and office information via television and telephone, information kiosks, commercial radio broadcasts) and in-vehicle advisory information for motorists (e.g. cars, trucks) with the system (including alternate route advisories).

A Traffic Management Center (TMC) which provides offices and space in a traffic control center would provide the most effective manner for traffic and incident management for all vehicles within the system. Initial flexibility and modular design of the Traffic Control and EMS systems would need to be provided' for future ITS applications with adequate provisions provided initially within the TMC.

ITS applications, together with implementation of other systems and incident management would provide efficient and safe traffic operations within the Austin area today and in the future. The purpose of this report will be to provide input into the ITS development process for the Early Deployment Study for the Austin metropolitan area.

Study Findings

This report summarizes the work effort involved with three (3) work authorizations encompassing nine (9) combined work tasks. These tasks include the following:

- Austin Traffic Signal System;
- Freeway Traffic Management System;
- Public Transportation Management;
- Incident Management;
- Emergency Vehicle Management;
- Commercial Fleet Management;
- Traffic Management Center State-of-the Practice Review;
- Multi-Agency Traffic Management Center; and, Disseminating Traveler Information.

Each work task provided a conceptual overview of a particular area and was not intended to provide a design or detailed discussion of a topic. Several of the work tasks addressed specific questions. All of the areas provided a summary of the following areas:

- facilities;
- equipment;
- maintenance;
- personnel;
- funding; and,
- implementation phasing.

The findings are summarized on **Table II-i**

Implementation and Phasing Strategy

The implementation of an ITS for the City of Austin would be an ongoing process over many years. Since many agencies have similar needs as discussed in other sections, the concerned agencies should pool and coordinate their funding, planning, and design efforts. One building for a Traffic Management Center could house many agencies and have one communications hub center.

Recommendations for implementation consist of the following:

1) Form an Operations Management Committee comprised of a representative of each participating agency to oversee ITS development. Consideration should be given to establishing an operating entity with an Executive Director as done in Las Vegas, Nevada and Houston, Texas.

2) Develop a Deployment Plan for submittal to the MPO immediately showing expenditures vs. time. This step could be done simultaneously with Step #1 and could be completed prior to the completion of Step #l. Steps #3 and #4 below could proceed while Step #l is being completed. With the January, 1996 Initiative, "Operation Time Saver," announced by Secretary Pena, it is imperative that the Austin area develop and submit its

Table II-I
Summary of Findings
Austin Area-Wide ITS
Austin, Texas

SYSTEM COMPONENT		FACILITIES SUMMARY	EQUIPMENT SUMMARY	MAINTENANCE SUMMARY	PERSONNEL SUMMARY	FUNDING SUMMARY	IMPLEMENTATION/ PHASING SUMMARY
City of Austin Traffic Signal System (TSS)		+ $5M Traffic Management Center (TMC)	$42M total	$3M per year	Need additional staffing Management Engineering Operations Maintenance plus existing staff	Federal – ISTEA State – TxDOT Local – Bond and General funds	Establish Operating Entity Deployment Plan Funding Design Deployment Operations & Maintenance
TxDOT Freeway Traffic Management System (FTM)		+$4M Traffic Management Center (TMC)	$1M/mile or $63M	Maintenance Contract with a Manager	7-20 total staff Managers: 2 – 4persons Operations: 2 – 8 persons Maintenance: 3 – 8 persons	Federal – ISTEA State – TxDOT	65 miles of FTM 25 miles of HOV
Public Transportation Management (PTM)		Part of Capital Metro central dispatch and/or TMC	$10,000 per bus	Part of dispatch function	existing staff	Federal, State and Local	Integrated part of SMART Bus Program
Roadway Incident Management (RIM)		TMC &Emergency Safety Center (ESC)	Same as TSS and FTM	Part of TMC & ESC function	3 persons per system, TSS and FTM	Part of TMC	Combine operations of ESC and TMC
Emergency Vehicle Management (EVM		Part of ESC with Public Safety Agencies (PSA); 800 MHz system with all agencies	Detailed study being conducted by PSA	Part of 800 MHz system	Same as maintenance	Detailed study being conducted	Part of 800 MHz system
Commercial Vehicle Management (CVM)		TMC plus private companies	No additional equipment required by public sector other than software ($100)	No additional major funds needed	No additional finding needed other than software in TMC	No additional funding needed other than software in TMC	Needs to be incorporated into TMC implementation
Disseminating Traveler Information		TMC with integrated software and hardware for Traveler Information System (TIS)	Hardware and software $1.6M plus TIS $42K	10% equipment costs plus telephone costs	2 full time staff	Federal, State and Local part of TMC	same as TMC
Multi-Agency Traffic Management Center (TMC)	Centralized	One TMC – minimum of 25,000 sq. ft.	$8 to 13 million PC system – minimum of 40 workstations	$2.1M per year	10-15 administration staff plus minimum 1 person per agency depending upon task	Federal State Local	Development of plan, phased implementation, creation of special agency, closer coordination between agency and personnel
	Distributed	Each Agency would need = 1,300 sq. ft.	Equipment costs 10 to 20% greater, $6.5 to 9.5 million uses existing facilities	$2.1M per year	Uses existing personnel with some new personnel plus TIC personnel	Sources same as centralized	Same as centralized, but easier to phase, use of existing facilities

deployment plan to qualify for potential federal funding.

3) Obtain funding for system upgrade. Potential funding for the recommended ITS system could come from two possible sources; these being local funding sources such as transportation related tax monies or capital improvement bond funds, and various federal funds administered by the Metropolitan Planning Organization (MPO) and/or Texas Department of Transportation. The metropolitan planning provision of Inter-model Surface Transportation Efficiency Act (ISTEA) has an enhanced role for local governments. The MPO is responsible for developing, in cooperation with the State, a long-range plan, and the Transportation Improvement Program (TIP) must include all projects in the Austin area that are proposed for funding with ISTEA monies. Areas with populations of over 200,000, such as the Austin Area, must be designated as Transportation Management Areas (TMA). Projects in these areas are selected by the MPO in consultation with the State. Also, in each TMA, a congestion management plan must be prepared. The Austin ITS system should be a primary component of this plan. Under ISTEA, two programs offer funding for a project such as the Austin ITS. These programs are the Surface Transportation Program (SIP) and the Congestion Mitigation and Air Quality Improvement Program (CMAQ). The first step in securing Federal funds is getting ITS projects added to the TIP;

4) Commission Design Plans, Specifications, and Estimates (B&E). This step will involve the design of the recommended system including: the preparation of plans, specifications, estimates, and bid documents, process, receipt of bids and award contracts. It is during this step that a plan will be prepared that indicates exactly where and when components will go on the new ITS;

5) System Deployment. This step will include system development and integration, system testing and acceptance, training, and field installation.

6) A Freeway Traffic Management System deployment as should be made over a maximum of six years.

7) The Transportation agencies and Public Safety Agencies should be on a common communication system.

8) The Transportation agencies should incorporate commercial vehicle management and traveler information in a deployment plan.

9) Transit Management Systems should be incorporated in a deployment plan including Capital METRO's smart bus program and signal preemption.

10) The city of Austin Transportation and TxDOT groups should work with the Public Safety Agencies to have an integrated Traffic Management Center.

The first priority is the development of a preliminary engineering report which would include a detailed deployment plan. The deployment plan would include funding strategies The report would be the basis of securing funding from local, state, and federal sources. Currently, federal and state dollars have been available for projects that have a local match, including design plans for construction.

The City of Austin should work with TxDOT, Austin District, to secure possible State and Federal Funds. The City should concentrate their internal planning efforts for the concerned groups, including Public Works, Capital Metro, and Public Safety Agencies. The City should secure local funding for the initial design and local match for State and Federal Funds. One possible option would be a bond election in the Spring of 1996.

With the passage of a bond election in the Fall of 1996, the funds could be available by Spring 1997. A deployment plan could also be in place by Spring 1997. Critical portions of the traffic system could be designed during I997 such that plans would be ready for construction during 1998. Approximately 100 intersections could be upgraded per year with the existing signal contractors.A Traffic Control Center would probably be needed by 2000. An interim center would be needed in 1998. The system would be "fully" implemented by 2005.

Other technical questions to be determined are the type of controller to be utilized, selection of system software, detection methods in selected areas, and communication media utilization. Staffing levels and maintenance/operation finding would need to be adjusted as the system is implemented.

The TxDOT, Austin District, should coordinate its ITS efforts with the City of Austin and other Austin Area agencies. It is recommended that the Freeway Traffic Management be installed within six years. The system should be installed in usable sections not in short segments. Consideration should be given installing the initial sections along IH35 even as an interim design.

A key factor for the successful implementation of an ITS/traffic signal system for Austin would be the establishment of an impartial group of individuals to coordinate and direct implementation effort. This organization would be similar to working groups in Houston and Las Vegas.

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CITY OF AUSTIN TRAFFIC SIGNAL SYSTEM SCOPE OF WORK

Task 1 - Evaluate existing City of Austin traffic control system

Task Description and Milestone

The City of Austin desires a computer controlled signal system which is at least capable of the following functions in the order of importance:

- Accommodates existing system characteristics;
- Integrates signal control, preemption, cameras, signs, and flashers;
- Integrates video from a mobile source;
- Utilizes a distributive architecture;
- Supports a variety of communication mediums;
- Perform multiple tasks simultaneously;
- Provide remote access;
- Automatically adjust signal timings to accommodate traffic demand;
- Evaluate operations based on real-time speeds, travel times, and queue lengths;
- Continuously collect operational characteristics;
- Continuously update color coded maps;
- Display the network in different colors based on congestion;
- Recommend streets which can accommodate diversion during an incident;
- Provide emergency/bus preemption;
- Distinguish emergency/non-emergency preemption;
- Maintain signal coordination during preemption;
- Identify time, agency, and impact of preemption; and,
- Share data with other agencies.

The engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

The work generally consists of identifying and summarizing the facilities and equipment comprising the existing traffic control system. Existing maintenance, personnel, and funding of the system should also be identified along with any planned improvements. Recommendations regarding the ability of the existing resources to provide the functions above in the future should be determined.

Facilities include structures of enclosures necessary to house and operate equipment and personnel and its cost. Existing equipment includes hardware, software, and communications items and their cost.

Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes existing persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing. Documentation of any existing phased implementation plan should be included.

Task 2: Recommend a signal system capable of desired functions.

Task 3: Recommend improvements to the existing City of Austintraffic control system.

Task Description and Milestone

The City of Austin desires a computer controlled signal system which is capable of the following functions in the order of importance:

- Accommodates existing system characteristics;
- Integrates signal control, preemption, cameras, signs, and flashers;
- Integrates video from a mobile source;
- Utilizes a distributive architecture;
- Supports a variety of communication mediums;
- Perform multiple tasks simultaneously;
- Provide remote access;
- Automatically adjust signal timings to accommodate traffic demand;
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- Continuously update color coded maps;
- Display the network in different colors based on congestion;
- Recommend streets which can accommodate diversion during an incident;
- Provide emergency/bus preemption;
- Distinguish emergency/non-emergency preemption;
- Maintain signal coordination during preemption;
- Identify time, agency, and impact of preemption; and,
- Share data with other agencies.

The engineer shall provide the following services for each of the above tasks (1 and 2).

Facilities Summary
Equipment Summary
Maintenance Summary
Personnel Summary
Funding Summary
Implementation/Phasing Summary

The work generally consists of developing a conceptual overview of a traffic signal system for the City of Austin. The work effort will consist of the following two parts: (1) recommending a system capable of the above functions and (2) improvements to the existing traffic control system over the

The work generally consists of developing a conceptual overview of a traffic signal system for the City of Austin. The work effort will consist of the following two parts: (1) recommending a system capable of the above functions and (2) improvements to the existing traffic control system over the next three years that will be compatible with the recommended system. In addition summarize the advantages and disadvantages traffic signal preemption will have on the signal system and traffic. Separate summaries of the facilities, equipment, maintenance, personnel, and funding of these systems should be identified along with a phased implementation plan.

For 1:
Facilities include structures or enclosures necessary to house and operate equipment and personnel and its cost. Equipment includes hardware, software, and communications items and their cost. Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing Documentation of a phased implementation strategy should be included.

For 2:
Facilities include any expansion of existing structures or enclosures necessary to house and operate additional equipment and personnel and associated costs needed during the three year interim. Equipment includes additional hardware, software, and communications items not included in (1) and their cost for the existing system. Costs for additional equipment for the existing system should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes additional persons needed in the interim to design, operate, and maintain facilities and equipment. Funding includes both public and private sources for additional improvements. Documentation of a phased implementation strategy of additional improvements that would be compatible with the recommended system should be included.

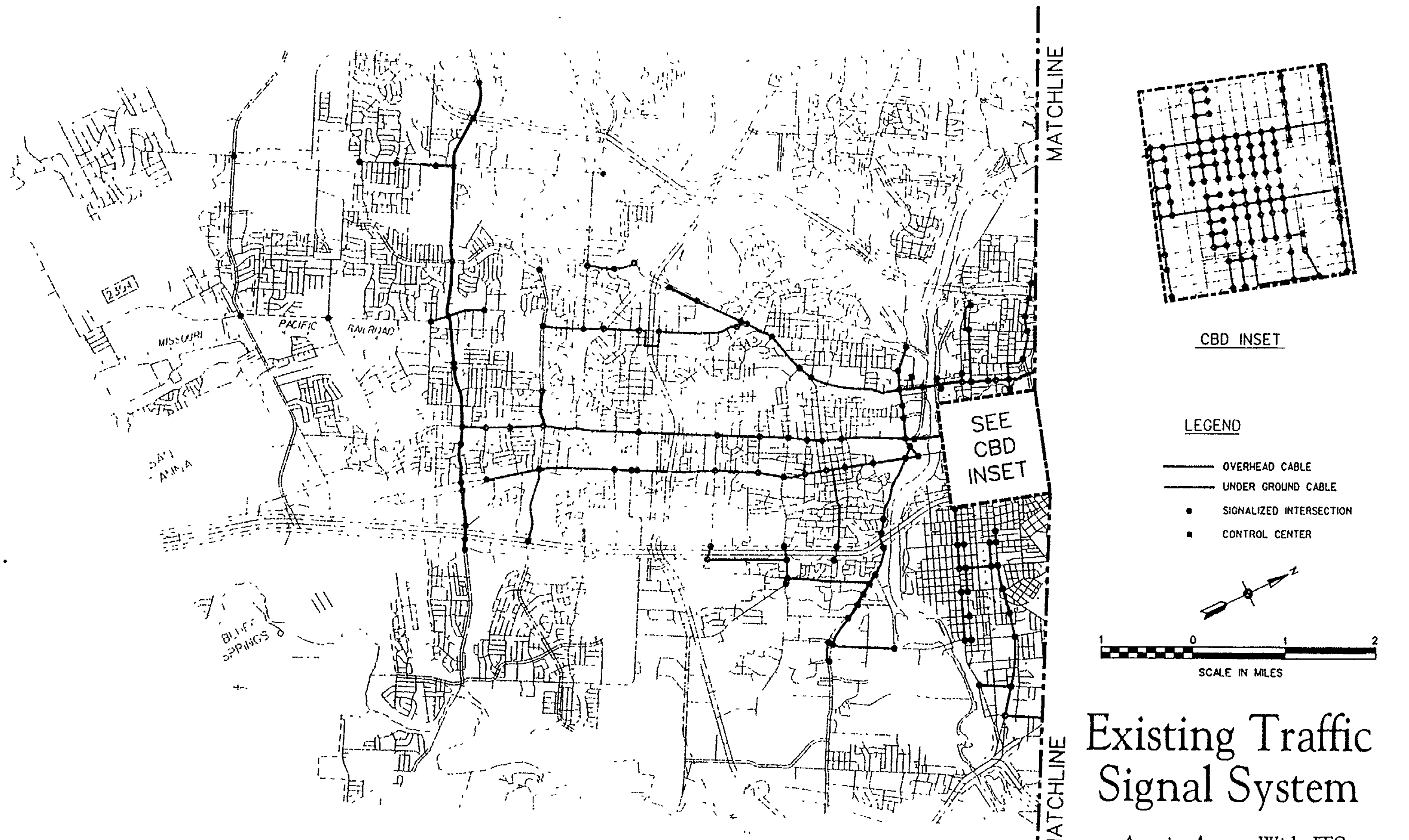
City of Austin Traffic Signal System

The City of Austin implemented a modified Urban Traffic Control System (UTCS) in 1986 using a central computer system and Type 170 traffic signal controllers. This system replaced an IBM 1800 controlled system installed in 1969. The UTCS software was designed to accommodate 800 traffic signals, with emergency vehicle preemption and bus priority capabilities. A personal computer (PC) now controls approximately 400 of the approximately 600 traffic signals located throughout the City, as shown in **Figures II - 1** and **II - 2**. Communications between the central PC and the local intersections are completed over City owned twisted wire pair cable using time division multiplexing. The current PC based system is currently used only to download time of day timing plans to local intersection controllers. The UTCS based operating system is not working as originally designed and has been modified considerably by the City of Austin Staff. The interface has undergone considerable changes.

Existing Facilities Summary

Existing facilities for the City of Austin's Traffic Signal System consists of a Traffic Control Center located on Toomey Road, Transportation Division staff offices located in One Texas Center, and local intersection controller cabinets and hardware.

Traffic Control Center - The City of Austin has a 30' x 18' Traffic Control Center that is housed in the Department of Public Works and Transportation's building at 1501 Toomey Road. This Control Center contains a Data General computer system installed in 1985 that has not been used for some time and a personal computer (PC) system that is currently being used to manage the signal system. There are three desks and a bank of file cabinets in the front section of the Control Center. The PC system resides on these desks. The rear section of the Control Center contains the Data General computer, peripherals, and communications multiplexors.The Control Center has a raised floor; handicapped access; is acoustically treated, has a separately controlled heating, air conditioning, and ventilation; a power source for both 120 and 230 volts at 60 hertz with regulated power to all computer and communications equipment; fire protection system with audible alarm and a halon gas



Existing Traffic Signal System

Austin Area - Wide ITS

Austin, Texas

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CONSULTING ENGINEERS AND PLANNERS
HOUSTON, TEXAS

North American Controls Corporation
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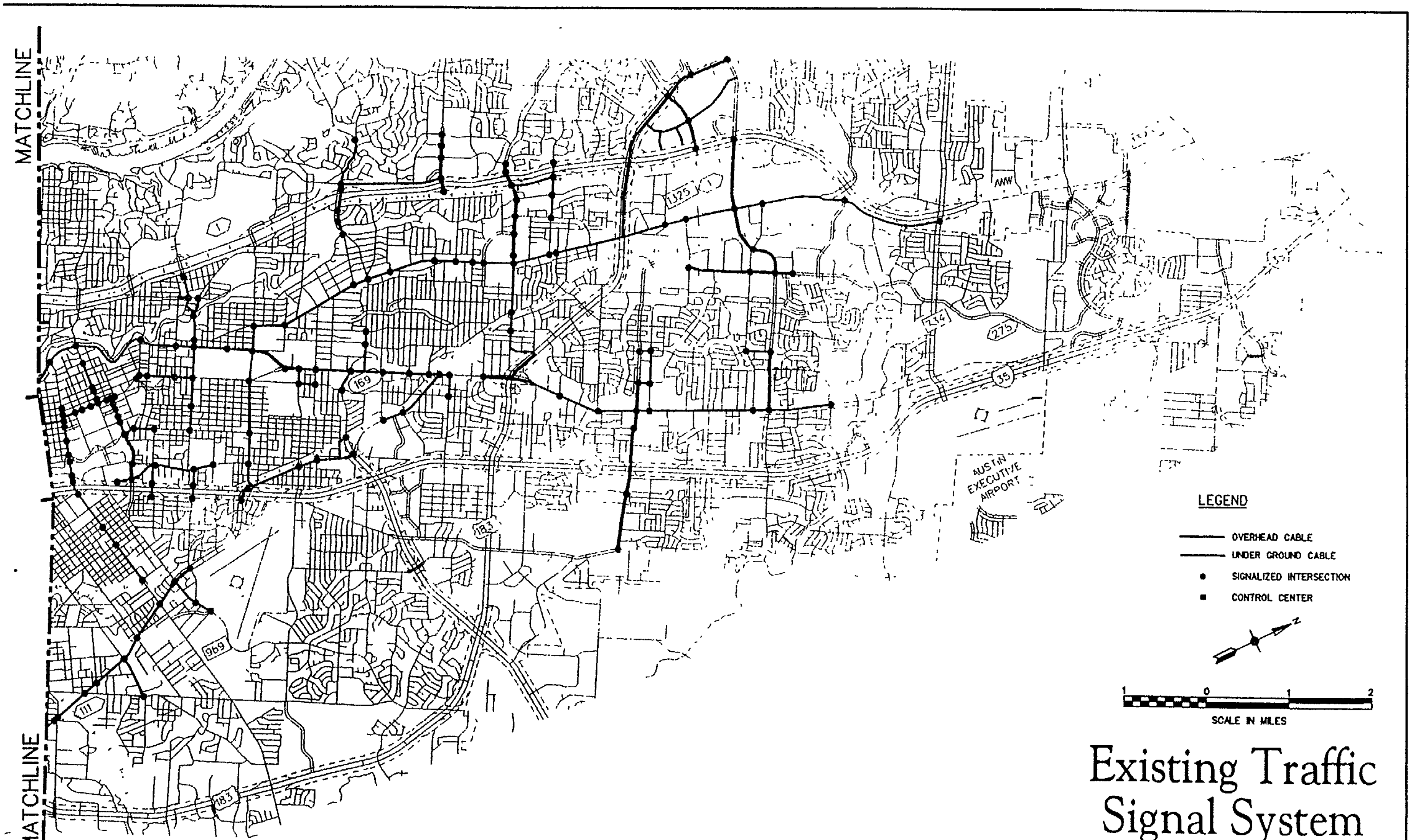
Figure II - 1



Existing Traffic Signal System

Austin Area - Wide ITS
Austin, Texas

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HOUSTON, TEXAS

North American Controls Corporation
Advanced Traffic Engineering
Kessmann & Associates

Figure II - 2

fire extinguishing system; a dedicated telephone line as well as telephone lines from the City's telephone system; overhead lighting; and floor-to-ceiling clearance of 8.5 feet.

Controller Cabinets - The traffic signal controllers at local intersections are housed in Model 332 and 336 type controller cabinets. The majority of the existing cabinets are in usable condition and are less than 10 years old.

One Texas Center - Transportation Division personnel, including management, engineers, and support staff, have offices located on the 8th floor of the One Texas Center building located on Barton Springs Road. Traffic signal system personnel are located at the Traffic Control Center on Toomey Road, parking enforcement personnel are located at the parking meter shop on Rio Grande Street, while all other personnel are located at One Texas Center.

Existing Equipment Summary

The City of Austin Traffic Signal Control System operates with a variety of equipment and components, including traffic signal controllers, system hardware, system software, and communications equipment, as described in the following paragraphs.

Traffic Signal Controllers - The City of Austin's Traffic Signal System consists of 610 traffic signal controllers. There are 410 traffic signals currently operated using the modified UTCS based system controlled by a central PC, with local intersections operating using Type 170 traffic signal controllers. The current system is essentially a closed "loop" pretimed type of system. Each controller assembly includes:

- Type 170 Controller;
- Model 200 Switch Packs with L.E.D. for Output as well as Input;
- Model 204 Flasher Unit;
- Model 210 Conflict Monitor Unit;
- Model 222 Two-Channel Loop Detector Sensor Units;
- Model 242 Two-Channel DC Isolator;
- Model 400 Modem Rev. F with Switch Selectable Anti-Streaming;
- Model 412B Memory Module (256K EPROM and 32K of EEPROM. Configured to run W4IKS software);

- Wapiti Micro Systems' W4IKS with W4lKS software program for communication protocol;
- Model 336 or Model 332 cabinet;
- Associated Input/Output Files and Power Distribution Assemblies;
- Pull Out Drawer;
- Cabinet mounting hardware; and,
- Model PDA-2 Power Supply.

The Type 170 Traffic Signal Controller is a standardized controller that is tried and proven. The controller is built to ensure complete interchangeability of all modules,even those of different manufacturers. The controller is structured around a microprocessor, with the architecture of the device allowing for great flexibility. Flexibility comes from the fact that its operation is controlled by software, which can be changed to accommodate changing situations. Software packages are available for the Type 170 controller from several different software providers. However, the Type 170 controller has reached the end of its life-cycle from an operational standpoint and is inadequate to perform the tasks required by modem ITS type traffic signal control systems and those characteristics identified by the City of Austin for a proposed trafficsignal system. The Type 170 controller uses 1970's technology.

The City of Austin's Traffic Signal Local Controllersare running the Wapiti W4IKS software. W4IKS is a proven software package for the Type 170 and is a package that is often included with the Safetran Type 170 controller. Despite its maturity, this software is limited. Pre-set timing plans by time of day are used without the capability to adjust the timing sequence/split and reassign lanes based on traffic demand. W4IKS has no traffic responsive capability and does not satisfy existing operational needs (Force Offs/Left Turn). The handling of specialized intersections must be done through the "command box" which is very time consuming and not easy to use. W4lKS allows only for up to 8 phases with overlaps.

Hardware - The City of Austin's Traffic Signal System Central Computer is made up of a network of IBM-compatible PCs at the Toomey Road facility running TransLink software under Windows NT. The PC network consists of a 90 MHz Pentium acting as the Windows NT Server and additional 486/Pentium workstations whichare utilized for updating the database.

More than half of the present intersections do not have detectors. At one point there were about 80 system detectors in the city on various arterials. They have not been used for some time and their status is therefore unknown. There is a high probability that the majority of these detectors do not work.

Software - The City of Austin's Traffic Signal System Central Computer is currently running TransLink software, a software package developed and supported by a Safetran employee. This central computer program is designed to operate in a Wapiti Closed Loop System. It is a Window's Based application, and the package is very user friendly and easy to use. The updating and modification of timing plans of the local intersection via dial-up line is very simple, straight-forward, and relatively quick.

The graphical intersection display software, included in the PC system, has the ability to be easily modified to reflect the actual local intersection configuration. Although numerous screens are available, most screens can only be viewed one at a time. The Zone display allows monitoring of more than one intersection at a time, but only A-Phase Green is shown. To monitor all intersection data, an intersection display must be called. This display is not viewable concurrently with the zone display or additional intersections displays, and only one Zone may be viewed at a time.

The system also provides for emergency pre-emption and transit signal priority, with Opticom. The system distinguishes between emergency and non-emergency preemption and logs the time and vehicle ID number. During non-emergency pre-emption, the software system maintains signal coordination, but during emergency pre-emption, the signals are "kicked out" of coordination. The system is capable of identifying time and the agency prompting the pre-emption, but it does not identify impact.

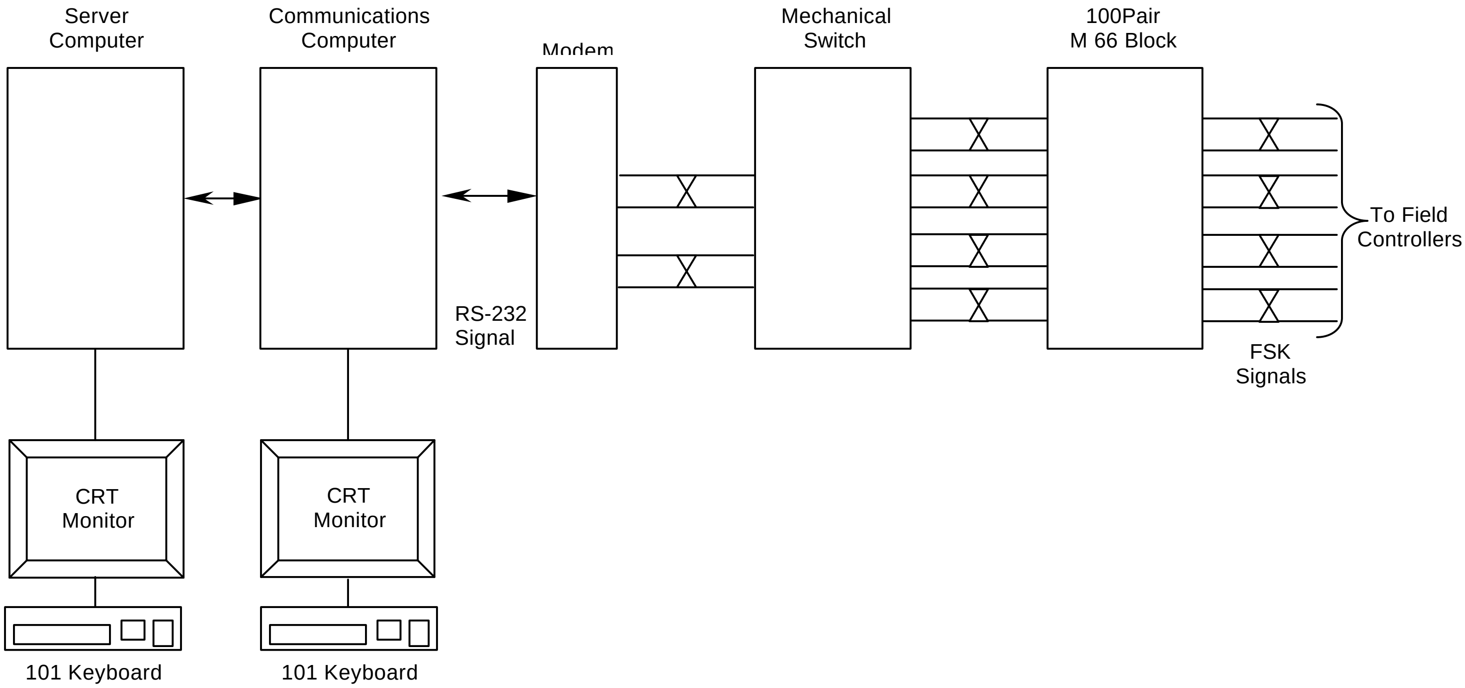
The software does not provide any map displays or the capability to display the network in different colors based on congestion. The system also does not have the capability to recommend alternate routes for diversion during an incident. There is no sharing of the data available in the system by agencies, and the system does not integrate signal control and flashers (school). In addition, cameras, signs, or video capabilities are not being controlled by the system. The system does no hardware failures diagnostics (i.e. no indication of signal on flash, loop failure, bulb burned out).

Communications - The existing traffic signal communications control system is illustrated in Figure II - 3, Existing City Traffic Control Center. This figure illustrates the twisted pair input system using 100 pair and 150 pair cables over a frequency shift keying (FSK) communications network. The network utilizes a 1200 Baud FSK modem for all sequential transmission throughout the city infrastructure. Increased baud rates appear to generate more communications tries, which slows the communications throughput. Therefore, this results in a poor Bit Error Rate of the existing copper cable plant system. The existing copper cable plant with modification could be utilized to provide most of the desired system characteristics for a traffic signal system except real time video.

The functional operation of the system is via two computers accessing the field controllers. First, the communications computer controls all input/output communications to the field cabinets. Second, the server computer (or applications computer), connected to the communications computer, selects the application to be run for intersection controls.

The Server computer communicates to 410 local intersection controllers using the city's own twisted pair communications network. Communications to the PC is through a digiboard which is tied to the server, as shown in Figure II - 4. The fact that the system is communicating via the digiboard limits the capabilities of what the central computer can monitor at one time. Only A-Phase Green is able to be monitored on more than one intersection at a time. This is done by the Zone Display, not multiple intersection graphic displays.

The cable plant design is based on a 66 M Block system with common termination throughout the networks, as shown previously in Figures 2A and 2B. Redundancy in communications is missing. If there is a failure in communications with the local controller, drift occurs on the controller clock.



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HOUSTON, TEXAS

NORTH AMERICAN CONTROLS CORPORATION
ADVANCED TRAFFIC ENGINEERING
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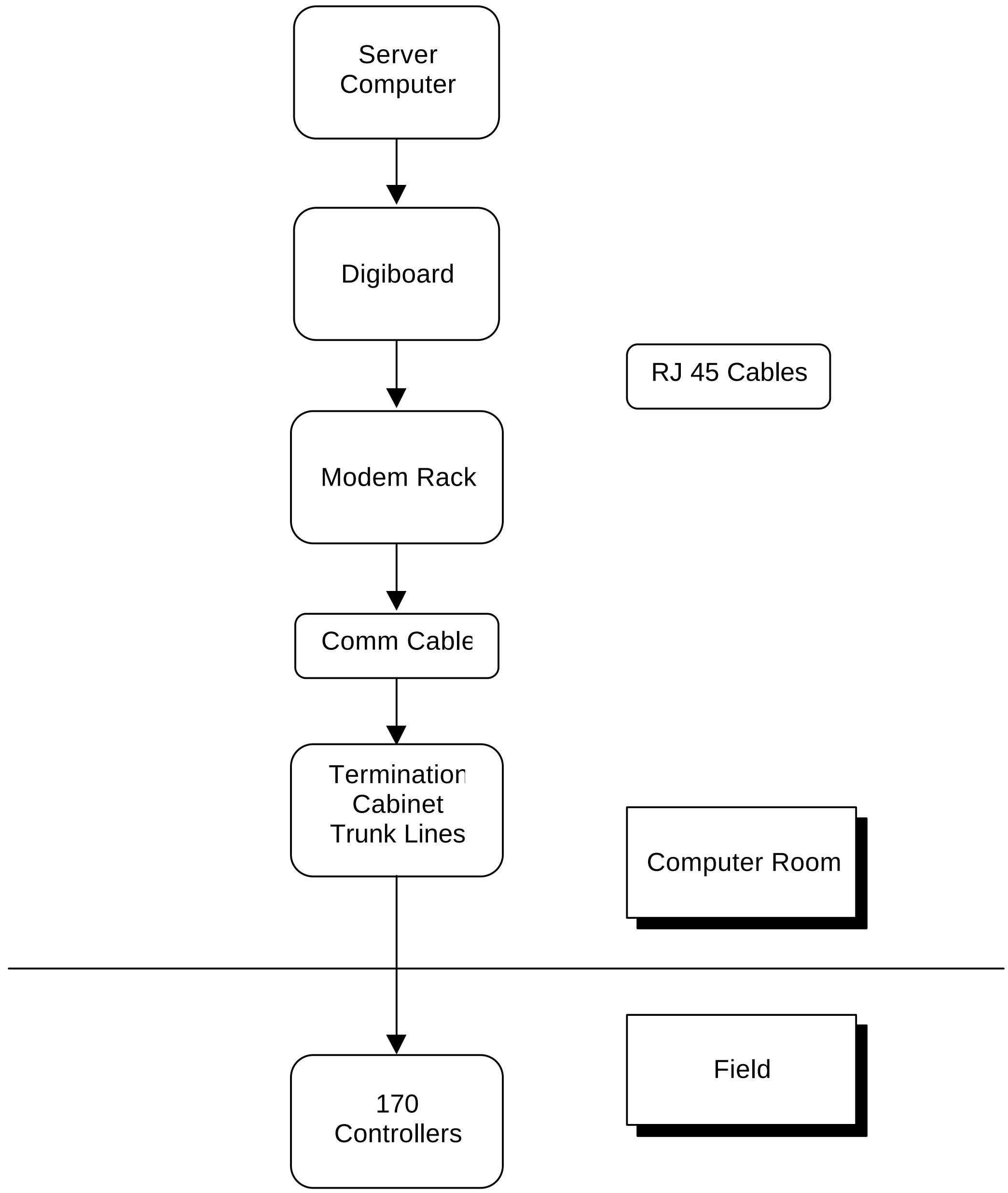
Existing City Traffic Control Center Communications System

Austin Area-Wide ITS
Austin, Texas

Figure II-3



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Communications Block Diagram

Austin Area-Wide ITS

Austin, Texas

Figure II-4

Existing Maintenance Summary

Existing maintenance for the City of Austin's Traffic Signal System is completed in house with existing maintenance personnel. Maintenance operations consist of response maintenance, which includes all maintenance activities that occur due to an equipment failure or citizen complaint. A preventive maintenance program, in which traffic signal installations are routinely inspected and repaired before major problems occur, is currently not underway. Funding constraints only permit a minor amount of preventive maintenance per year. The City staff have updated and maintained traffic control patterns so that the system probably operates as well as it can under fixed time operation. This area of operational maintenance has offset some of the deficiencies noted in achieving the desired traffic signal operations.

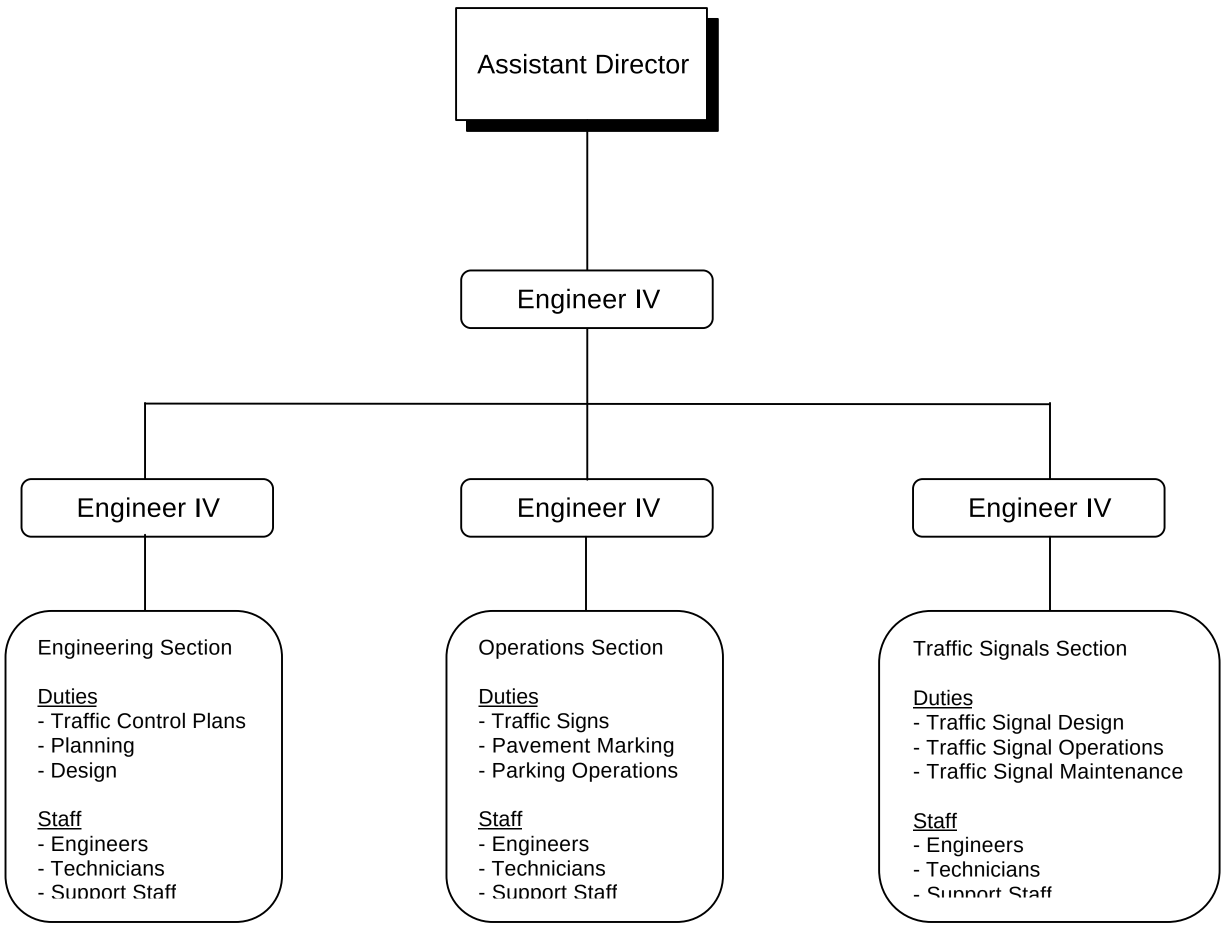
Personnel Summary

A chart depicting the current organization of the City of Austin Department of Public Works and Transportation, Transportation Division is shown in **Figure II - 5**. The division is divided into three sections, with the Engineering Section responsible for citizen concerns, traffic control plans, planning, and design; the Operations Section responsible for traffic signs, pavement markings, and parking operations; and, the Traffic Signals Section responsible for traffic signal design, operations, and maintenance. The Transportation Division currently occupies three offices, with the traffic signal section and sign shop located at the Traffic Control Center on Toomey Road, the parking enforcement section on Rio Grande Street, and the engineering and operations sections located at One Texas Center.

The Traffic Signal Section currently employs 2 engineers (with one additional engineering position currently vacant), 3 signal operations technicians, 9 installation/communications technicians, and 6 maintenance technicians. The signal operations technicians have between 7 and 22 years experience in traffic signal systems. The maintenance technicians, however, range from 1 to 12 years of experience in traffic signal maintenance, with 5 technicians at 6 years of experience or less. Seven employees have experience in the installation of communications cable, with experience ranging from 3 months to almost 14 years. Five of the seven employees have five years or less of communications installation experience. Based on the education, and type and years of experience reported for

Department of Public Works and Transportation

Transportation Division



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Organization Chart

Austin Area-Wide ITS

Austin, Texas

Figure II-5

communications maintenance employees, it appears that the majority of the communications staff lack the skills needed to operate and maintain a complicated fiber optics communications system. The communications and maintenance staff should be trained in fiber optics before implementing an advanced fiber optics communications system. The equipment necessary to maintain an advanced traffic signal system/communications system will need to be obtained.

Table II - 1 identifies the average staffing levels of major metropolitan areas in 1984. Due to budget cuts in most metropolitan areas, staffing levels have not grown significantly in the past ten years and are assumed to be similar to the 1984 levels. According to the table, the City of Austin, with a population of approximately 600,000, should have a staffing level of approximately 16 professionals, 18 traffic engineering technicians and 60 maintenance workers to be at an average level compared to other metropolitan areas. These staffing levels are for the entire Transportation Division, including the engineering section, the operations section, and the traffic signal section (including sign and pavement marking staff). Parking enforcement staffs not included.

The City of Garland, Texas conducted a personnel survey in 1992 to compare staffing levels at numerous cities throughout Texas. The City of Austin reported a technical employment level of 68 persons, including 5 registered engineers, 18 engineering assistants/draftsmen, 19 signal technicians, 15 sign and marking technicians, and 11 other personnel. In addition, the City reported 34 office and clerical personnel. Therefore, the City of Austin's current staffing level is consistent with the average staffing level of other metropolitan areas. The entire personnel survey from the City of Garland is included in **Appendix II - A**.

Existing Funding Summary

The City of Austin Transportation Division currently obtains funding from the City of Austin through both the General Fund and the Capital Improvement Program (CIP). In fiscal year 1994-1995, CIP funding for the Traffic Signal Section totaled approximately $2.207 million, while funding from the General Fund totaled $1.187 million. Funding levels for the Traffic Signal Section for fiscal year 1995-1996 are anticipated to remain constant at approximately $2.3 million CIP funds and $1.2 million General funds. Annual salaries, benefits, and overhead costs total approximately $1.18 million.

Table II – 1

Urban Traffic Engineering Agency Staffing, 1984
Austin Area-Wide ITS
Austin, Texas

		Personnel per 100,000 Population*								
	No.	Professionals			Traffic Engineering Technicians			Maintenance Workers		
Population Group	of Cities	Mean	Median	Range	Mean	Median	Range	Mean	Median	Range
50,000 - 100,000	33	3.3	3.1	1.1-7.4	2.8	1.6	0.0-15.7	13.0	12.2	3.4-28.7
100,000 - 250,000	31	2.8	2.3	0.6-6.9	2.4	1.9	0.0-11.8	12.1	10.9	2.5-29.9
250,000 - 500,000	12	2.4	2.0	0.8-5.9	2.9	1.9	0.4-11.0	16.3	14.3	7.9-34.9
500,000 - l,000,000	8	2.7	2.8	0.5-5.1	3.2	2.8	0.5-06.5	11.1	10.5	7.2-17.4
All Cities	84	2.9	2.6	0.5-7.4	2.7	1.9	0.0-15.7	13.0	11.9	2.5-34.9

* 1980 Census

SOURCE: Traffic Engineering Handbook, Fourth Edition, Institute of Transportation Engineers, 1992.

During the past three years, between $1.5 and $2.1 million per year has been provided forsignal system improvements, which include new signal installations, loop detector installations, communications cable, signal system upgrades (i.e. left-turn signal heads, signal timing plans, etc.), and salaries of maintenance and operations personnel who perform these tasks. The amount of funding is dependent upon City Council approval and will vary from year to year.

Table II - 2 identifies average funding levels for traffic engineering agencies in 1984. Due to budget cuts in most major metropolitan areas, funding has not increased much or kept up with inflation. Current funding levels are assumed to be similar to 1984 funding levels. For the entire Transportation Division, including the engineering section, operations section and signal section, funding for a City the size of Austin should average approximately $5 million.

Funding levels are not anticipated to vary greatly from present levels in the near term. However, funding for recommended improvements to the existing City of Austin Traffic Signal System will more than likely have to come from another source. Potential funding sources for recommended improvements are discussed in the cost and funding section.

Desired System Characteristics

The City of Austin has identified 18 characteristics or functions which they desire their traffic signal system to be capable of performing. The functions include many Intelligent Transportation System (ITS) strategies which are accomplished using state-of-the-art technology. The desired functions, listed in order of importance by the City, include the following:

- Accommodates existing system characteristics;
- Integrates signal control, preemption, cameras, signs, and flashers;
- Integrates video from a mobile source;
- Utilizes a distributive architecture;
- Supports a variety of communication mediums;
- Perform multiple tasks simultaneously;
- Provide remote access;
- Automatically adjust signal timings to accommodate traffic demand;
- Evaluate operations based on real-time speeds, travel times, and queue lengths;

Table II – 2

Urban Traffic Engineering Agency Funding, 1984 (Dollars per Capita*)
Austin Area-Wide ITS
Austin, Texas

		Budget Category								
	No.	Maintenance			Operations & Engineering			Both Categories		
Population Group	of Cities	Mean	Median	Range	Mean	Median	Range	Mean	Median	Range
50,000 - 100,000	17	8.30	5.0	0.5-28.8	4.05	2.05	0.9-18.5	12.4	8.30	2.3-31.4
100,000 - 250,000	22	5.50	4.7	2.1-17.7	3.15	1.70	0.7-10.4	8.7	6.85	3.1-23.3
250,000 - 500,000	10	8.70	6.5	2.6-22.1	2.70	2.10	0.6- 7.4	11.4	7.80	3.4-29.4
500,000 - l,000,000	5	5.10	4.2	1.3-10.4	3.30	3.50	0.9- 5.0	8.4	8.00	2.2-15.4
All Cities	54	6.95	5.1	0.5-28.8	3.40	2.05	0.7-18.5	10.3	7.60	2.2-31.4

* 1984 dollars; population as per 1980 Census

SOURCE: Traffic Engineering Handbook, Fourth Edition, Institute of Transportation Engineers, 1992.

- Continuously collect operational characteristics;
- Continuously update color coded maps;
- Display the network in different colors based on congestion;
- Recommend streets which can accommodate diversion during an incident;
- Provide emergency/bus preemption;
- Distinguish emergency/non-emergency preemption;
- Maintain signal coordination during preemption;
- Identify time, agency, and impact of preemption; and,
- Share data with other agencies.

Each of these items are important to the City to be included in a traffic signal control system. However, since the goal for the greater Austin area is the eventual completion of a multi-agency Traffic Management Center, the desire to share data with other agencies should be near the top of the list of importance, not at the bottom. Now is the time to coordinate and communicate with other agencies to determine a standard communications medium and protocol so that data from all agencies will be available to everyone.

Existing System Conclusions

The current system is not capable of accomplishing all of the desired functions identified above. In order to accomplish these tasks, a system which includes Intelligent Transportation Systems (ITS) technologies should be implemented. Several different modes of system operation are needed to achieve the operation that will be required in the future. Implementation will be investigated in later sections. In addition, limitations for installing and maintaining advanced technologies exist with some personnel, primarily maintenance and communications staff. The current funding levels for construction, maintenance and operation of the existing traffic signal systems are not compatible with the needs of a system to satisfy the requirements of a system that has the City of Austin's desired characteristics.

Proposed Traffic Signal Functions

The City of Austin's Traffic Signal System, proposed by the City of Austin to have the previous identified characteristics, is to be a hybrid traffic signal system architecture utilizing distributed control intelligence, a central database, non-proprietary components, off-the-shelf standard hardware interfaces, and open compatibility with future ITS (Intelligent Transportation Systems) capabilities.

The system should support the use of video surveillance as a critical component of the control and surveillance systems. It should also be capable of utilizing a variety of recommended communication mediums, including the existing Austin-owned twisted pair cable, Greater Austin Area Telecommunications Network (GAATN), and leased lines.

The Austin Traffic Signal System should have the capability of four modes of traffic signal timing plan generation on a subsystem basis. These modes are:

- time-of-day traffic signal control;
- generation traffic signal control;
- 1.5 generation traffic signal control; and,
- real-time, traffic-adaptive signal control.

The time-of-day mode calls for the system to operate in a fixed time coordinated mode through use of time base coordination. The intersection controller can implement preselected traffic control patterns on a time-of-day basis. The preselected patterns should be stored in each intersection controller and additional patterns can be down loaded from the central computer.

The based 1.0 generation traffic signal control software selects from traffic control patterns for each subsystem based on information from detectors at selected locations within the subsystems. The change from one traffic control pattern to another would be made through a software package that provides operator established threshold values which are based on the database developed from the selected detectors. Subsystems can be redefined by the central computer on an as needed basis.

The 1.5 generation traffic control mode should perform all on-line functions supported by the 1.0 generation software package. Included in the package is the ability to collect and store traffic count data from vehicle detectors. This data will be used to compute design hour total flow volumes for use in TRANSYT-7F network files. This integrated package would automatically detect and log inefficient timing plan performance while the system is operating in the on-line mode. The on-line man/machine interface would allow the operator to schedule off-line functions for execution as well as display or print timing plans or performance statistics which have been generated in the off-line mode. The control functions would include selecting and implementing signal timing plans in the traffic signal network, commanding the local controllers to follow the timing plans, providing for surveillance of traffic flow conditions, and monitoring the operational status of field equipment. Since the 1.5 generation software provides data required for use in the TRANSYT-7F model and detects and logs inefficient timing plan performance, it could require more detectors than the 1.0 based generation traffic signal control.

The real-time, traffic-adaptive signal control mode would allow traffic patterns to be implemented in advance of the need for them on the street. This would be done through the use of a predictive model simulating anticipated origin and destination movements. This mode of traffic signal control would be open-ended by allowing sufficient Random Access Memory (RAM) to be reserved in the local controller software to accommodate the future developments in the real-time traffic adaptive control area. The real-time mode could require system detectors on all approaches to traffic signal controlled intersections.

The traffic signal system should be designed for subsystem operation as is done with the existing system. Each of the four modes of operation should be available for use in each subsystem. The selection of the mode for each subsystem would be dependent on level of service (LOS) and traffic pattern variations (including incident management). One subsystem for example could operate on a time-of-day basis throughout the day while the adjacent subsystem could operate time-of-day during the off-peak and traffic adaptive during peak periods and/or incident conditions based on traffic demand. When any two adjacent subsystems are operating time-of-day, and or real time, it should be optional through central computer control to require both subsystems to operate in an integrated manner with coordinated offsets when both systems are operating at the same cycle length. The subsystems could be reconfigured quickly by the central computer on an as needed basis.

Timing Plan Selection - Under the real-time traffic-adaptive control mode, timing plans will be automatically generated on a real-time basis in anticipation of travel patterns predicted to exist on the street. For 1.0 and 1.5 generation control modes, algorithms will be prepared to provide for timing plan selection based on threshold values for volume, speed, and/or occupancy. Timing plan selection for time-of-day traffic control mode will be based on historical data to determine necessary changes in timing plans, based on variations in traffic volumes historically recorded in the central computer data base.

Under both real-time, traffic-adaptive control mode and 1.0 and 1.5 generation control modes, subsystems are dynamic in that intersections may be added or dropped from subsystem structures. Under both real-time, traffic-adaptive control mode and 1.0 and 1.5 generation control mode, if a detector in the system fails then the system reverts to historic data to make a traffic control decision. If no historic data is available, then the subsystem will revert to time-of-day time-based coordination operational control.

Timing Plan Implementation and Operation - All timing plans or software components which are brought together by the local controller to formulate a timing plan, are resident and operational at the local intersection level. Mirror images of these timing plans are resident in the central computer database. A major advantage to having the timing plans resident in the local controllers, is that time-of-day changes will be locally available to provide backup capabilities. Under traffic adaptive and 1.5 generation control mode, timing plan changes are commanded from central control and downloaded to the local controller using the local database. If communication is lost to just one intersection of a group, then the entire subsystem will fall back to the predetermined time-of-day control mode.

Timing Plan Evaluation - Traffic signal timing plans should be able to be evaluated through the use of three methods. Evaluation capabilities should be provided through a tiered-level security access system. The first method is the use of a time-space diagram program used to evaluate signal control operation, through use of the 1.5 generation and traffic adaptive control software and properly located/designed intersection detectors. These programs should accumulate real-time field color returns and plot a time space diagram using this data for the selected grouping of intersections. The operator may then implement split, offset, and phasing changes to improve the green band coordination on the coordinated street. A second mode of signal timing plan evaluation involves the use of traffic simulation/optimization models such as TWF-NETSIM/PASSER/SYNCHRO. Measures of effectiveness from the models and field detectors would be used to determine delay and number of stops. The first method of signal timing plan evaluation will involve the combined use of video surveillance cameras and average vehicle speeds. The cameras should be strategically located throughout the Austin system to provide the capability of monitoring critical locations in the network. Upon observing substandard conditions through the use of a camera, the operator may implement strategies to alleviate those conditions. The traffic responsive system needs system detectors only at key locations. Traffic adaptive control generally need more system detectors. However, with predictable traffic patterns at known locations, the number of detectors needed are essentially the same. If changes in phasing to accommodate cross streets or turning vehicles is needed, more system detection inputs are also needed.

Distributed Traffic Signal Systems

There are two types of distributed systems used in the United States which respond to changes in traffic functions. These are traffic responsive and traffic adaptive. Traffic responsive systems match adaptive systems traffic control patterns provided accurate threshold values are given for parameters (e.g. volume, occupancy). The traffic responsive system traffic control patterns function for a period of time (five to fifteen minutes) before changes can occur at each intersection through the use of traffic actuated controllers which provide detections for the pedestrians, turns, and/or cross street phases.

Traffic adaptive controllers are more adaptable to changes in traffic patterns in that the system can change traffic control patterns each cycle length. Further, adaptation to traffic patterns for time of day, traffic responsive, and traffic adaptive modes can occur at each intersection through the use of traffic actuated control.

There are also some functional differences in the concepts of traffic responsive and traffic adaptive control. Traffic responsive systems have the flexibility of activating patterns based on either maximum band width (e.g., UTCS, Eagle Monarch, BI-Trans) or minimum delay whereas a traffic adaptive system operates on either a minimum delay (e.g., SCOOT, OPAC) or fractional peak period progression band (e.g., SCATS). Also, traffic responsive operation permits changes in left turn sequence (dual left, lead lag) to further improve the progression band width. These differences can be important when deciding whether optimum delay or maximum band width is the most important criteria in system or subsystem operations.

The extent to which traffic control needs to respond to changes in traffic patterns depends on the:

- number of significant changes in traffic patterns during a week;

- relationship between intersection capacity and tragic demand; and,
- predictability of traffic pattern change.

When traffic pattern changes are predictable and do not change very often, pretimed system control is satisfactory. When traffic pattern changes are not predictable and/or change often, either traffic responsive or traffic adaptive control can provide the best traffic control. Depending on the number of detectors in the system, traffic adaptive should provide a better operation during periods of saturated traffic flow (V/C >1.0). With the use of traffic actuated control, however, the difference in improvement between traffic responsive and traffic adaptive control may be quite small during periods of saturated traffic flow.

Traffic Responsive Operation

Most of the more recent traffic responsive systems store tragic control patterns (turning phases or components when tied together by the computer forming traffic control patterns) in the intersection controller and the central controller. Where an on the street master controller is provided, it also stores the timing pattern. New timing plans developed at the central computer are downloaded to the intersection controller. System detector information is usually gathered by intersection controllers and periodically (e.g., 10 seconds to one minute) sent to the master and/or central computer. Major forms of traffic responsive systems include:

- Computran Modern Traffic Control System (MTCS)
- PB - Farradyne Management Information Systems for Traffic (MTST);
- JHK Series 2000;
- B1 - Trans;
- Sonex Escort; and,
- Kessmann, and Associates /State of Nevada System, and New York State Systems.

System detector data is sent directly to the central computer on a second by second basis in one or more of these systems. There are some differences between the commercial systems, but the operation of these systems has been found to provide successful operation. All these systems can provide the following:

- Subsystems control - different signal timing for different subsystems.

- Critical Intersections Control (CIC) which permits a saturated intersection to assign splits based on traffic demand.
- Development of traffic patterns on an off line basis in the 1.5 generation mode.

The 1.5 generation systems permit the development of traffic patterns using the TRANSYT-7F model and should be able to do so (with modification) using the PASSER II, III and IV models. The selection of the model to use is dependent on whether maximum band width or optimum delay is preferred for a given set of conditions within a subsystem during a given period of the day. If a new traffic pattern is selected, it can be downloaded into the computer. The traffic signal system in Los Angeles is a 1.5 generation traffic control system.

Traffic Adaptive Operation

There are presently two types of traffic adaptive traffic signal systems in operation within the United States – SCOOT(2,3,4) and SCATS(5,6).

SCOOT - Detection data is transmitted to the central computer on a second by second basis. Signal timing is calculated at the central computers and downloaded to the local controller as each phase changes. SCOOT uses a derivative of the TRANSYT computer model. Although TRANSYT can be based on designated factors and provides for progression on selected streets, it is generally used in determining optimum delay signal timing.

SCOOT permits increases and decreases in cycle lengths in small increments each cycle. By placing or utilizing existing detectors far enough upstream of a subsystem on selected streets, it is feasible to "predict" future traffic control patterns and implement them more rapidly.

SCATS - As with SCOOT, SCATS increases cycle lengths and splits more rapidly than with traffic responsive systems. It utilizes a preferential progression design providing optimum affect during high volume periods and two-way progression during lower volume periods. As with other systems, the cycle length is determined at the master or central computer. Split adjustments are made at the local intersection.

Others - The Federal Highway Administration (FHWA) is currently analyzing three new type systems under its Real Time Traffic Adaptive Control Systems (RT TRACS) master project. These systems, which are traffic adaptive, are not ready for implementation at this time but will be in the future.

Another system is being developed in France. Known as PRODYN[8], the system provides for two-way communications between intersection controllers as well as two way communications between the central computer and each intersection controller, This type of system has not been considered for the City of Austin because of its complexity and cost of communications.

Analysis - There are intersections in Austin which operate well at present under pretimed control and intersections that could benefit from traffic responsive operation during portions of the day. Frontage roads and freeway corridor streets fit into this category as do high volume streets. (e.g., US 183, Lamar Blvd., US 290, William Cannon Blvd.). As traffic increases, traffic patterns may increase on certain streets so that progression breaks down and afternoon delay becomes the primary design factor. Traffic adaptive control would be suited to a location where the signalized intersection is expected to function an as interchange (e.g. intersections along South Lamar, FM 2222, North Lamar/Burnet Road Corridor, and US 183 north and south).

There are options to traffic adaptive control. These include the use of Critical Intersection Control (CIC) as is being done in Los Angeles and holding back traffic upstream of the point of saturation as is being done on Manhattan Island. Also, timing plans using PASSER models could be developed using the 1.5 generation for off peak periods and TRANSYT for saturated traffic conditions. The latter will not be as efficient as the traj3ic adaptive approach (assuming both system operates in a fine-tuned manner) because it will not have the "prediction" approach or cycle by cycle change.

The operational concept recommended by the WSA team provides the optimum operation for each subsystem for the next 15 year period. However, there are options which could be selected as a result of the system design study. These include, but may not be limited to,

(1) Pretimed plus 1.0 generation system;

(2) Pretimed plus 1.0 and 1.5 generation system; and,

(3) Pretimed plus 1.0 and 1.5 generation plus Traffic Adaptive (SCOOT, SCATS, RTTRACS) now or in the fixture.

It may be desirable to install pretimed plans 1.0 generation software now with the ability to add the other two options in the future as traffic develops. Or it might be desirable to choose the second option (up to 1.5 generation) now with the option to add traffic adaptive control in one or more subsystems in the future. If initial installation with future expansion is desired, the step from IJTCS 1.5 generation to traffic adaptive would not be as great as the step from UTCS 1.0 generation to traffic adaptive.

A cost estimate for increasing costs of each addition to the system is given in **Table II-3** along with the reason for the added costs. If the city decides not to install traffic adaptive control at first, it is recommended that a UTCS 1.5 based system be installed with the capability of adding traffic adaptive control in the future.

Recommended Traffic Signal System Premises

The traffic signal system recommended for the City of Austin is based around the following premises gained from carefully reviewing comments received from both the City of Austin and TxDOT regarding the existing systems and the prescribed Scope of Work:

1) Be enduring. The Austin Area desires an ITS System that would have a lifespanof at least 10 to 20 years.

2) Be easily expandable. The desired system would provide for ease of additions, deletions, and expansion.

3) Be reliable and easily maintained. The desired system would maximize reliability and fail safe operations. In the event of a failure, traffic operation’s performance should not be severely compromised.

4) Be flexible. The desired system would provide all functionalities present in the existing systems yet be capable of adapting to changing short and long term patterns and needs easily.

Table II – 3

Cost Comparison of Control Methods
Austin Area-Wide ITS
Austin, Texas

Type of Control	Cost per Intersection	Components*
1.0 Generator Control	$50,000	Hardware & software for 1.0 generation operation plus average of two system detectors per intersection
1.5 Generation Control**	$65,000	Add to 1.0 generation operation an average of seven detectors per intersection and new turning movement count detectors.***

* All systems shown include fiber optics, 2070 ATC Controllers, and CCTV.
** Expansible to Adaptive Traffic Control in selected subsystems in future (under future contract).
*** Left turn phase detectors should be of the traffic counting type.

5) Be easily operated. The desired system would improve traffic operations and flows. The system would make the traffic flow more efficiently, would reduce congestion and delays, decrease fuel consumptions and emissions, and reduce accidents.

6) Be self-monitoring. The desired system would provide the ability of the system to monitor itself and report on system performance.

7) Be implemented at minimal life cycle costs with minimal negative impacts or disruptions. The desired system would be capable of being implemented with minimal negative impacts related to the deployment of new hardware, software or control algorithms while utilizing as much as the existing equipment or communications structure as possible to reduce costs. This would require making maximum use of existing communications system; minimizing traffic flow disruptions during changeover or deployment; making maximum use of existing staff knowledge and skills.

8) Be easily accessible. The desired system would provide the traffic engineer with easy access to the remote controllers from a central or lap-link location.

9) Be easily monitored and controlled. The desired system would provide the traffic engineer with the capability to quickly and easily monitor the system operational status and be capable of doing this from remote locations as well as the TMC. This status includes controllers failed, controllers in flash, controllers in pre-empt, in fully traffic actuated operation, or coordinated operation.

To this end, it is our professional opinion based upon evaluating, designing and deploying computerized Traffic Signal Systems throughout the U.S. and around the World for over 25 years that such a system must adhere to the following system objectives:

1) Open Systems/Open Architecture
2) 1.0/1.5 Generation Control

The system shall be designed on Open System Interconnection (OSI) and Open Software Foundation (OSF) standards to insure compatibility, inter-compatibility, and portability of system components and software. The software shall be in the public domain and be easily portable to different computers. All interfaces between components shall be of Electrical Industry Standard (EIS) design. All communication protocols shall be public domain to insure compatibility.

Open Systems Interconnection (OSI) is a standard coordinated by the International Standards Organization to put an end to problems of multi-vendor networking.

Open Software Foundation (OSF) is a non-profit, industry-supported research and development organization founded in 1988. OSF functions as an integrator and implementer of technologies, building on existing standards and specifications, and helping in the definition of new standards where none currently exist. More than 130 organizations are members of OSF.

Traffic Signal Pre-emption

There are several methodologies available for pre-emption of signals. Two of the most prominent methods are hard pre-emption and soft pre-emption. Under the hard pre-emption scenario, the signal coordination is immediately disrupted to service the pre-empt phase when the pre-empt signal is received. Under the soft pre-emption scenario, the signal continues its normal phase sequencing. However, the pre-empted phase may be either advanced or extended depending upon when the pre-empt signal is received during the controller sequence.

Hard pre-emption is very disruptive to the coordinated flow of traffic in a grid network. However, this method gives the pre-empting vehicle the immediate right of way. Hard pre-emption is utilized for fire, police, and emergency vehicles.

Soft pre-emption is less disruptive to the coordinated flow of traffic. However, the pre-empting vehicle may have to be delayed before the pre-empted phase becomes active. Soft pre-emption has been utilized for transit vehicles.

would allow the traffic engineer to define when and how in the signal cycle to allow a pre-emption to occur. Consideration should be given to providing far-side or mid-block bus stops if soft pre-emption is utilized.

Soft-preemption allows a transit vehicle to have a higher probability of receiving a green light at an intersection. Without progression, a transit vehicle might have a 50-50 chance of arriving at an intersection on red. With progression the probability might rise to 70% of arriving on green. With progression soft pre-emption the probability of a bus passing through the intersection might rise 90% or higher. There will be some delay or disruption to vehicle flow on the side streets with preemption. Overall person flow should be increased if the buses are traveling on the major approach. However, consideration in assessing the effectiveness of soft pre-emption should be given to vehicle -delay, person-delay, fuel consumption, and emissions before finalizing an overall pre-emption strategy.

Recommended Facilities

The City of Austin should continue to utilize the facility at Toomey Road as an interim Traffic Control Center. The facility allows adequate room for the recommended system and space for supporting personnel. This facility should be utilized until funds are available for a Traffic Management Center (TMC) that would house additional Traffic Management participants.

Consolidation of the City of Austin Transportation Division operations into one facility should also be provided for in conjunction with TxDOT. The current separation of the City of Austin transportation operations into two separate facilities (One Texas Center and Toomey Road) prevents direct communication and access to needed data. Engineers working on traffic control plans or roadway designs should have direct access and communications with traffic signal timing plans, signal technicians, and available traffic signal operations data. It would be good for them to work together in the development of traffic signal plans and the mitigation of recurring and non-recurring congestion.

Recommended Equipment and Cost

Equipment needs for operating the recommended traffic signal system should include utilization of existing equipment as much as possible. Equipment needs include traffic signal controllers, controller cabinets, vehicle detectors, system hardware, system software, and communications.

Cost of Facilities - The facility cost estimate is based on estimates obtained from the Los Angeles Automated Traffic Surveillance and Control system. The estimated cost is $39,000,000 for 600 intersections or $65,000 per intersection. This includes the cost of computer hardware and software, intersection controller with software, detectors, CCTV and fiber optics communications cable and connections with the FTM and GAATN cable systems. No major upgrades to the intersection are included in these costs. Major upgrades include improving geometries, replacing most arms and signal heads, adding pedestrian signal heads and push buttons, improving and/or adding wheelchair ramps. The estimated costs for adding a controller and cabinet ($12,000 and eight loop detectors ($8,000) is $20,000). It is estimated that CCTV cameras would be located at major intersections with the ability to install additional CCTV cameras at the remaining signalized intersections. Costs for facilities, maintenance, and operation of the system are summarized later in this chapter.

Traffic Signal Controllers – The City of Austin should continue to utilize intersection Traffic Signal Controllers that are based around complete interchangeability of all Type 170 modules such as NTCIP. Open systems, open architecture, industry standards, non-proprietary protocols are a must. Future controllers should have additional capabilities not available in the Type 170 in order to perform the operations desired by the City of Austin's Transportation Division which should have faster processors and additional memory (see attached **Table II-4**). The future controllers should be one of the following types:

- The Model 170 or,
- 170/Add in Board (170/AIB); or,
- The 2070 ATC (Advanced Transportation Controller).

The City of Austin should begin to evaluate Traffic Signal Controller software and hardware requirements for the 2070, 170/AIB, and the Model 170 controllers which would best serve the City's needs. This evaluation should include future possible ITS requirements (CMS, LCS, Lane Designation Signs). All controller software and communications protocol should be non-proprietary. All modules should be programmed in the C programming language to the maximum extent possible. The software should offer all the functions currently present in Wapiti W4IKS. The local controller software should also have the capability to adjust the timing split, phasing, phase sequence changes, and reassign lanes based on demand, offer traffic responsive capabilities, satisfy existing operational needs (Force Offs/Left Turn), and be user friendly without the need to handle specialized intersections through a separate "command box". The software should also offer more than 8 phases with overlaps. The City of Austin is interested in the 170/AIB controller as compared with the 2070. The City is considering utilizing Opticom preemption with 170/AIB controller module. If the City desires to use the 170/AIB, the software provided should work with the board as well as with the

Table II - 4
Comparison of Traffic Signal Controllers
Austin Area-Wide ITS
Austin, Texas

Category	170	170/AlB	2070
Processor:	Motorola 6802	Motorola/Intel 68000/ 80C186	Motorola 68030
Processor Speed:	765 Khz	16 bit/32bit 16 Mhz 18 bit/XL5 Mhz	32 bit/25 Mhz
RAM:	16K	32 K/256 KSRAM	32K/256 KSRAM
ROM:	512K	512K	2Mb
Modem Capability:	1200 baud	19.2 baud	19.2 baud
Potential Signal Phases	8 phases	32 phases	32 phases

2070. The three major add-in board suppliers which provide 170/AIB are Safetran, Matrix, and Eagle Signal. The following is a general comparison of 170/AIB.

170/AIB

The 170/AIB have the following features:

1. Output ports are provided which can operate at different baud rates or the same baud rate if desired.

2. Up to two hardware units (e.g. preemption devices, detector devices, environmental monitoring) are applied -to each port provided the two devices (hardware units) operate at the same band rate and use the same protocol. As an alternate, up to 14 detectors can be tied to one port (sec. detector work stations) or four video ringing cameras operating throughout a video usage process.

3. Output port can be used to carry out diagnostics of the conflict monitor.

4. Up to 56 local controllers can be communicated with per distributed master 170/AIB master controller. Also the central computers can monitor the operation of each controller through each master controller.

5. As a minimum the video imagingfunction using one port can achieve one still image picture or in 30 seconds or four still image pictures (one for each of four approaches) in two minutes.

6. The 170/AIB output ports connect to separate hardware units for different functions (e.g. preemption, detector, environmental monitoring) and as such serves an interface between the hardware units and the TMC with information to and/or from each hardware unit and the TMC processed at the same board note (e.g. up to 115 k band).

7. The 170/AlB have either faster Motorola or INTEL chips (16 Mhz 16/32 bit).

8. The modem rates are faster (19,200 baud).

9. More IL4M and ROM and capability of handling greater than 8 phases.

The cost of a 170/AIB module varies from $700 to $2,000 depending oncomplexity of the operation. In addition a 170 base unit (dispatcher) which operates the intersection costs $900. This totals to $1,600 to $2,900 per 17O/AIB in a new 170 dispatcher unit.

2070

The 2070 has the following features:

1. It has the capability through four traffic signal control relatedmodules (non VME card slots and four to eight (or more) serial ports per VME slot for each of four VME card slots to handle 16 or more internal hardware unit functions. One supplier presently has a VME card that has four serial ports per VME slot in the back of the unit and could make one that would provide input with eight or more serial ports per slot. The diagnostics for the conflict monitor is part of the four modules and not part of the VME bus cards.

   An example involves the controller unit for a chargeable message sign (CMS). The control functions for the CMS would be on one VME card and communications with the CMS would be through one of four (or eight) serial ports from one VME board. The separate CMS controller would not be needed in the field.

2. The control functions could either be internal (as with the CMS control noted above) an external as with the 470 AIB. An internal Video Imaging hardware unit is being developed at present which will fit into the 2070 and will take two of four VME card slots. This is because all of the video imaging processing is being done by the VME cards. If an external hardware unit is used for the video imaging processor (e.g. Autoscope control unit), only one of four (or eight or more) serial ports for that VME card would be used for communications between the external video imaging processor and the 2070. Where the video imaging processor is internal as now being designed, there would still be four (or eight or more) serial ports for each of the other two cards. Assuming a total of eight serial ports (four for each VME card where the other two VME slots are used for the internal imaging hardware), they could provide internal hardware/software for:

   (1) CCTV video control
   (2) HAR control CMS control
   (3) Roadside to vehicle communications
   (4) CCTV image processing to the TMC
   (5) Environmental Monitoring
   (6) Spare for future ITS operation
   (7) Spare for future ITS operation

3. Each control unit output on a VME card can operate at a different baud rate from the other control units.

4. The cost of a 2070 is between $3,500 and $5,000 at present depending on quantity. The 2070 can also provide video pictures to the TMC at a T1 based rate compared with the 470 AIB 115 K based rate. The use of T1 baud rate can provide for foster CCTV image transmission.

Comparison

1. The 2070 could at present provide internal control for 16 control units (up to 32 if eight processors and serial ports are provided per VME card) as compared to three to maximum six

control unit functions (as discussed above). The 170/AIB controller would still need external hardware for each of the three to six hardware units.

2. The internal software (operating software) for the 170/AIB would be proprietary and could limit competition. But then only limited companies make the 2070 at present.

3. Depending on complexity (number of functions), the 17O/AIB could cost $2,900 on a small order basis compared with $5000 for the 2070.

4. Both the 170/AIB and the 2070 utilize NTCIP communications protocol. The 2070 is preferred for its flexibility and low maintenance cost (one 2070 with all control unit provided internally should provide a lower maintenance cost than a 17O/AIB and all of its external hardware). Also, a 2070 will permit many more ITS functions to be carried out which could be important over the 10 year life of the controller.

   If the need for many ITS functions (more than two from a practical standpoint) is not warranted at selected locations, then the 170/AIB might be the best for selected locations. The added cost of $2,100 per intersection for a 2070 might also be a factor. If so, it might be possible to provide 170/AIB controllers at some intersections and 2070 at others with software that could permit a 2070 to be provided at an intersection with a 170/AIB at a later date if this is found to be needed. If it is determined to use T1 communications with fiber optics, this will not be possible since the 170/m communicates at 115 K.

The recommended system should consist of a local intersection controller that follows the philosophy of the Type 170/179. Specifically, this philosophy consists of providing a public domain and standard specification which can be met by many suppliers. Controllers that are in this category are the Model 170/179, the Type 170/AIB (add in boards) and 2070/ATC. There are several types of AIB's and they would allow the City of Austin to retain their existing Type 170s as these products are merely board enhancements to the Type 170. This would allow for cost savings by not having to purchase new controllers. However, the availability of non-proprietary, public domain software that offers all the functions requested by the City of Austin's staff for these controllers is unknown. The 207O/ATC provides all the benefits of being an Open Systems/Open Architecture Local Controller and there is non-proprietary, public domain software currently under development for this device that meets all the requirements put forward by both the City of Austin Traffic Signal staff and TxDOT and incorporates 1.0/ 1.5 Generation Control Algorithm. A System Design specification for the Local Controller hardware and software needs to be prepared and bids taken to determine which package to utilize.

Controller Cabinets - The existing traffic signal controller cabinets are generally large enough to accommodate both traffic signal controllers (Type 170 or 2070), so cabinet replacement would probably not be required. However, for intersections where numerous vehicle detectors, ITS components, or CCTV cameras are in operation, a larger cabinet would be required. The existing cabinets provide for up to 16 load switches, which should be sufficient for average intersections, but would be inadequate for intersections with CCTV or ITS capabilities.

Vehicle Detectors - The City of Austin should evaluate several different detector technologies for use throughout the signal system. Queue length detection at intersections should be included in the analysis. Methods to be considered include inductive loops, video image processing, microwave detectors, and infrared detectors. New technologies for detection could be applied initially in the form of demonstration projects. An example could be a 2070 with internal video image processing. The 2070 with detection could be installed as an actual controller at complex high volume intersections and freeway diamond interchanges. Inductive loop detectors should be used for much of the local intersection detection. Where the results of the demonstration projects of newer detection technologies show favorable, these technologies should replace inductive loops.

Traffic Flow Surveillance - Timing plan evaluation will also include monitoring variations in traffic flow and comparing these variations to archived data. These data are continuously compared to track changes in traffic flow patterns. When predetermined thresholds are reached the new timing plans are implemented which will better accommodate the observed traffic flow patterns. These thresholds are operator selectable.

It would be desirable for all system detection locations to be sufficient for supporting 1.0 generation and 1.5 generation control modes and real-time traffic-adaptive control mode requirements. Where it is not possible to provide for traffic flow surveillance in all subsystems at first, the system should be designed for this capability in some subsystems initially with expansion capabilities for the eventua1 application to all subsystems. Traffic data derived from the traffic flow surveillance system will be stored and used in several ways: for transportation planning, traveler information, commercial vehicle information, transit system management, public safety agency information, and for timing plan development and evaluation. For transportation planning, raw data would be used to develop traffic count files and for supporting transportation programming decisions.

For timing plan development and evaluation, local intersection detector data would be fed into an algorithm which will be used to estimate turning movement volumes at the local intersection. The turning movement volumes would be automatically dumped into a traffic signal timing optimization model for continuous evaluation The model would continuously evaluate the operation of the actual timing plans in the field. Potential improvements to timing plans would be identified for the operator to evaluate. The general traffic flow/operation information could be shared interested agencies (public and private).

Equipment and Maintenance Database - All traffic signal equipment should be inventoried and assigned a unique bar code that can be scanned by a portable bar code reader to access the maintenance database. Upon accessing the maintenance database, an operator would have a complete historic record of all prior maintenance involving this piece of equipment. Included in these records would be maintenance and operations-related performance measures such as mean time before failure and mean time to repair data.

The display modes would include A-Phase Green status, future status, critical intersection control status, and threshold (volumes, speed, occupancy) status. In conjunction with the video surveillance capabilities, an operator will have the ability to observe a group of intersections under failure status mode and at the same time actually observe the MC conditions by watching the CCTV picture returns.

Each workstation should be capable of generating its own custom reports. Standard reports to be generated include failure status, maintenance status, and volume summary.

Intersection Monitoring and Failure Diagnostics - The system should have the capability of monitoring any or all intersections on a once per second basis. It should also have time slicing capabilities to allow once per second polling in addition to simultaneous timing plan download/upload capabilities. The system should have capability of monitoring the failure status of each intersection on a 30 second basis. If a failure is detected, an alarm will be sent to the Traffic Control Center. Appropriate failure diagnostics would be in effect to allow the operator to fully understand the degree of failure.

Soft failures would be self-corrected and logged to the central computer system. Surveillance data would be uploaded to the Traffic Control Center every five minutes if so desired. The communications system should be capable of supporting a worst case scenario of once per second intersection monitoring occurring at the same time as uploading traffic count data, uploading a signal timing plan for verification, and conducting failure status poll.

Central Hardware - The City of Austin should continue on their present course of implementing a distributed central computer system of networked PC workstations. The computer system should consist of a dedicated server that is a Pentium-type PC with multiple processors. Workstations of the Pentium-type PC type with a minimum of 21" monitors should be available to transmit the data to the Local Controllers plus monitoring and controlling all intersections on the system. Linkage to the local intersections should be over a LAN with bridger and routers. This approach should employ open system requirements so that future computer resources may be easily added as the need may arise. Open system standards provide for the following options:

- choice of the best hardware product from multiple vendors;
- integration of hardware from diverse manufacturers regardless of the underlying technology;
- distribution of processing power to improve individual and organizational productivity; and,
- presentation of investment in applications software.

With this approach, additional users should be able to be added to the system via the network even if they do not reside in the same facility. waving proper authorized access, any of the workstations on the network should be capable of using all the resources of the system. Security should be provided to prevent unauthorized access.

Control Displays and Reports - Each system workstation should have a large monitor (minimum of 21"), with an additional 72" monitor provided in the Control Center. Each display would have the capability to display an entire system or operator definable sections in color. The displays would be capable of viewing different locations or different system functions, including video surveillance pictures, at the same time.

Software - The City of Austin should implement a distributed Windows NT Central computer system that is a multi-user, client-server, networked environment using PC workstations. The central computer software should offer all the capabilities mentioned above under Existing Software. This software should be non-proprietary and not tied to any computer hardware vendors' equipment. All applications should be programmed in the C++ programming language to the maximum extent possible and should be comprised of preexisting off-the-shelf modules. The 1.0/1.5 General Control type software is a proven software that has been utilized by many agencies. This type of software is provided by several vendors. It provides flexibility in the traffic signal operations by allowing the operation of the system in a fixed time mode. The local or system master to select an operation pattern based on thresholds, or the continual recalculation of timing patterns based upon detector inputs. At a later date portions of the system could be upgraded to a tic responsive/adaptive system at a later time. Our recommendations are that the system consist of a Central System of PCs running Windows NT Operating System and non-proprietary Public Domain Traffic Control software programmed in C++. Alternative Central Systems would not meet the above premises or system objectives. There are such packages currently available or under development that meet the recommended system (i.e. Las Vegas Area Computer Traffic System). Possibly the supplier of the City of Austin's existing Central System would be willing to make the modifications and additions needed to that package to incorporate the functions that are presently non-existent plus provide the City of Austin with source code, if they have not already done this, so that the City's own staff or selected provider could maintain/enhance/modify the package in the future. A System Design specification for the Central System needs to be prepared and bids taken to determine what software package to utilize.

The system should employ software components that are non-proprietary, none-copywritten, Public Domain to the maximum extent. The source code should be written in a language which is industry standard and portable to machines of differing makes and models. Source code should be provided in Austin. This approach provides for the future modification/enhancement and maintenance of all software by the City of Austin/TxDOT personnel or their selected provider and ensures future life of the software. It also provides the benefits of being able to extend this software to additional platforms without having to pay additional royalties. All software should be written in C++ or C language so that the software may be ported to future platforms.

The system should employ a control strategy that provides for the capability to generate traffic signal timing plans on-line, and in real-time in an operator-selectable, higher-generation control mode. The control logic (software) for this mode should be developed and implemented to accommodate current and projected traffic flow data. The system should also provide for a 1.5 Generation mode in which automatically generated timing plans are retrievable for analysis and fine tuning by the operator. In addition to the above modes, the system should provide for Manual and Time-of-Day Modes.

The software should include continuously updated color coded maps and have the capability to display the network in different colors based on congestion on a once-per-second basis. The capability to monitor multiple intersections simultaneously is a must. More data (intersection operation, phasing, detector actuations, and signal indicators) than just A-Phase Green should be provided on multiple intersection displays. The ability to evaluate operations based on real-time speeds, travel times, queue lengths and to estimate and obtain MOEs whenever needed is also an important part of the system.

Through the use of 1.0 and 1.5 generation traffic control and tic adaptive control, the system should be able to identify incidents and offer alternative routes, have the ability to contro1 cameras and signs plus integrate flashers (school) and signal control, and be capable of automatically diagnosing hardware failures, (i.e. notificationof loop failure, signal onflash, etc.) and why the failure occurred. The central computer should also be able to interface with Local Controller software other than W4IKS, since W4IKS does not meet all of the future traffic signals operation requirements. Additionally, there should be sharing of the available system data with other agencies as discussed in the Freeway Traffic Management Section.

Emergency/non-emergency pre-emption should be provided and the goal should be that some coordination be maintained during pre-emption or the system be brought back online as soon as possible in order to minimize the impact on traffic. The system should be capable of distinguishing between emergency and non-emergency preemption and identifying time, agency, and impact of each preemption. Software currently exists that provide these functions.

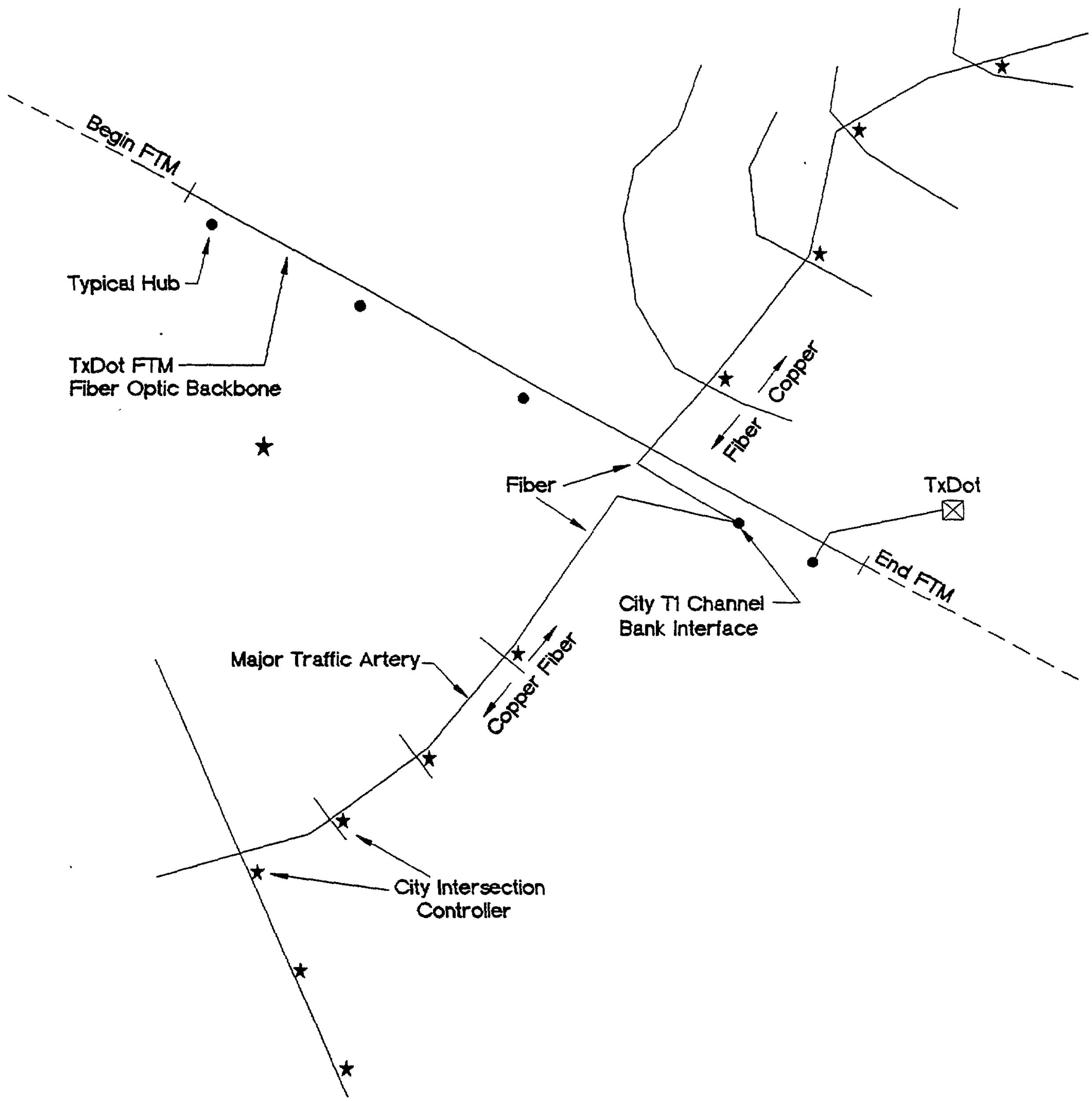
Recommended Communications System

The currently recommended communications system for the Austin area is threefold that will include the Freeway Traffic Management System (FTM), Greater Austin Area Telecommunications Network (GAATN), and temporary Cellular phone systems. However, the Austin Area should carefully monitor the experiences of METRO in Houston Areas. METRO is considering utilizing private companies to provide the communication system for Houston Area traffic signal systems. A local telephone system made an unsolicited offer to provide communication to 2800 signals and maintain and operate the system for 20 years for $35 million. METRO is in the process of requesting a cost proposal from 3 communication companies. The companies were previously selected based upon technical and qualification proposals. The companies include a local telephone company, a cable TV group, and a local communication integrator/provider. If the Austin Area had a similar process, the communication costs might be less than $10 million for all freeway and arterial communication systems.

FTM System - The FTM system fiber optics communications backbone infrastructure can be used as a temporary or permanent communications system as the FTM is being implemented throughout the major corridors in Austin. **Figure II-6,** Typical FTM System Communications Interface, illustrates how
TxDOT's FTM and High Occupancy Vehicle (HOV) lane system Fiber Optics Backbone System can effectively provide the communications infrastructure needed to control the major arterials off the main lanes of the freeway, for all data, voice, and video communications. A T1 carrier system is recommended due to the fact that this technology provides:

- standardization;
- commonality;
- maintainability; and,
- portability.

The cost of the communications system is resident only to the major arterial crossing an operation FTM system. Where the major T1 carrier interface the major city street, the FTM communications backbone would require 2 fibers for all data, voice and video controls. An additional



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Typical FTM System
Communications Interface
Austin Area-Wide ITS
Austin, Texas

Figure II-6

2 fibers would be required for video transmission back to Central. The approximate costs of the interface are as follows:

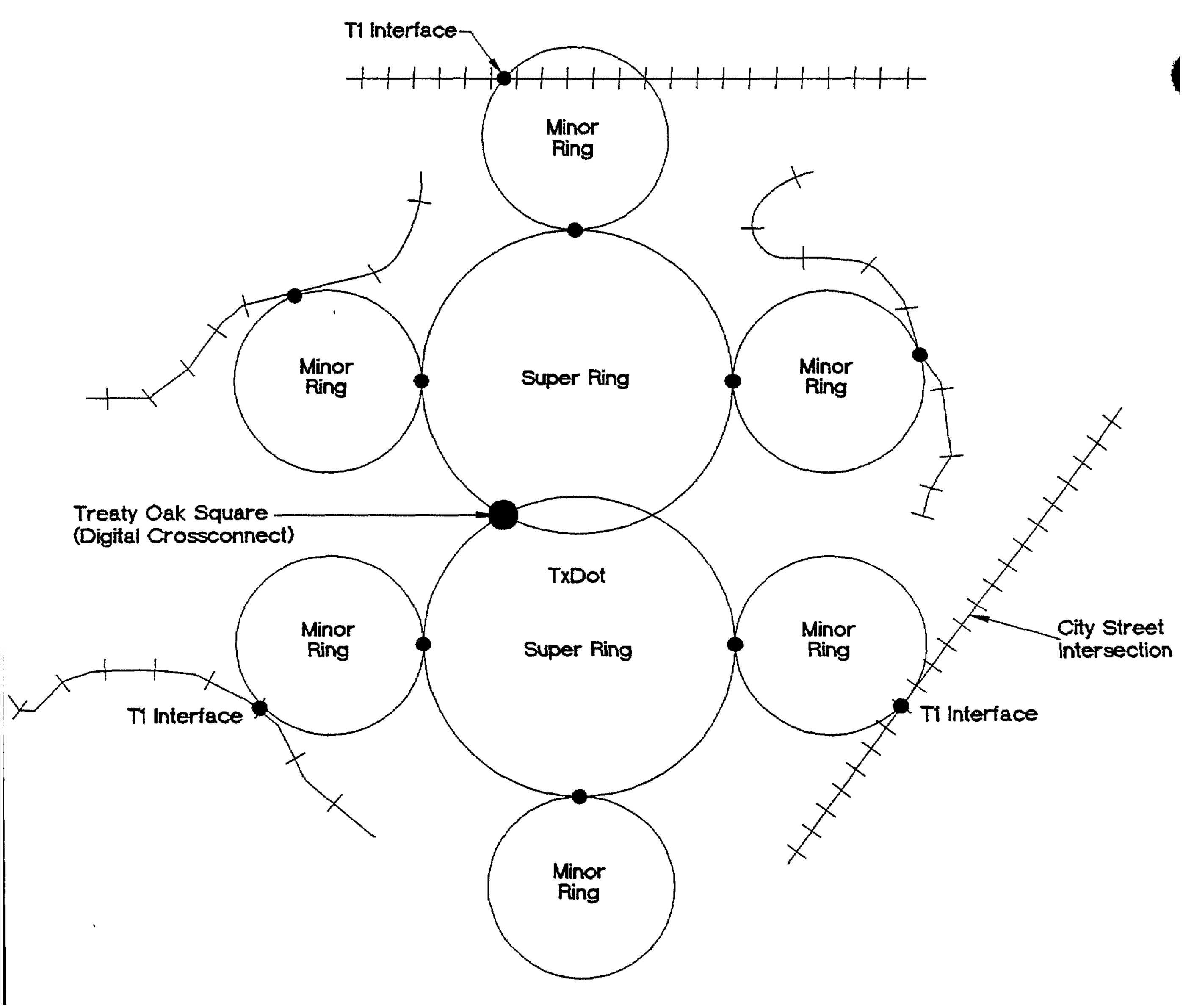
T1 channel bank	$ 12,500	
T1 transceiver	1,300	
Mis. Fiber optics	2,400	
Interface cabinet	0	(None Required)
Average Fiber Optics	30,000	(Run = 3,000 ft.)
Limited distance Modem	2,500	
TOTAL	**$ 48,700**	

Approximately 25 to 30 traffic signal intersections can be interfaced adequately to oneT1 channel bank DSO. The capability of such an interface in a star configuration can yield upwards to **400 intersections or more** per T1 channel.

GAATN System - The GAATN system offers a wide geographical area potential for controlling the City intersection controller systems. Since the GAATN network consists of six minor rings and two super rings over a large span of the City of Austin, as illustrated by Figure II-7, the minor ring network system lends itself by providing DS3 access to most any portion of the Austin area. This access is commonly partitioned in bandwidth to accommodate several T1 carriers over 2 fibers in the entire City.

Figure II-7 illustrates how the T1 interface, which can bring in upwards of 400 intersections per T1 channel bank can be distributed throughout the minor ring infrastructure. At this time for a 600 intersection deployment plan no more than 10% of the bandwidth of a DS3 channel will be occupied. That is to say, that for the Austin area, it is possible to control all of the city intersections with a bandwidth of less than 4.5 MHz (i.e. less than 3 T1 carrier channels for the entire City of Austin). A further discussion of bandwidth is included in the Transportation Management Center section.

A digital cross connect at the Treaty Oak Square is recommended to ensure that the data streams of the Minor T1 rings are switched properly from the super rings to the Traffic Management Center and/or City Traffic Signal System facility at dfferent parts of the City.



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GAATN Telecommunications System

Austin Area-Wide ITS

Austin, Texas

Figure II-7

The estimated cost of this deployment of the T1 interfaces and digital crossconnect is as follows:

Minor ring T1 Interface	
T1 Channel Bank Chassis and Electronics	$ 12,500
T1 Line interface unit	1,800
Limited distance modems	2,500
DS3 subrate T1 gear	8,500
Each T1 interface total:	$ 25,300
Treat Oak Square	
Digital Crossconnect System	$ 58,000
Network set up	8,000
Treaty Oak Square total: (One Time Cost)	$ 66,000

Cellular Telephone/Telephone Line Drops - A cellular telephone system offers a unique advantage during construction phases of the city streets in that control of the intersection system can be accomplished in even the most remote areas where a telephone lime drop, FTM or minor rings of the GUTN are not available. This approach can be done on an interim basis during the construction and can be done on demand. This is to say that the cost factor is on the minutes used on the air during communication. The typical bandwidth of this channel is 2400, 9600 or 14,400 (compressed) Baud. A maximum of 25 to 30 intersections can be adequately handled using one interface of this type.

The cost of each interface that will interface 25 controllers is as follows:

Cellular Phone	$ 200	
Digital interface	650	
Modem	350	
Monthly bill	$ 150	(per month per interface)

Maintenance Requirements of Recommended System

Maintenance activities will need to be restructured once the recommended traffic signal system is complete. Current maintenance activities can largely be categorized as response maintenance activities, meaning that traffic signal system components are not maintained until they are not functioning as designed. Maintenance activities of the new traffic signal system should be preventive maintenance, meaning that traffic signal system components are maintained on a regular interval. Preventive maintenance and response maintenance activities are described in the following sections.

Preventive Maintenance - Routine preventive maintenance is an important element in an effective risk management program. If a defect in traffic signal control equipment has existed for an unreasonable period of time, the City should have discovered the defect and is therefore assumed to have received constructive notice of its existence. Faulty traffic control system equipment causes increased motorist costs, increased maintenance, increased liability, and poor air quality. Preventive maintenance programs help to eliminate many equipment failures and reduce the consequences.

Preventive maintenance typically requires the largest commitment of maintenance personnel, time, with approximately 75% time allocation to preventive maintenance and 25% to other maintenance. **Table II -5** identifies estimated time requirements for recommended typical preventive maintenance items. Each of these time estimates was developed assuming equipment is identified and labeled and maintenance manuals and wiring diagrams are available.

Response Maintenance - Response maintenance is the initial response to any reported traffic signal system malfunction. Response maintenance activities typically have five steps:

- Receive notification from public;
- Secure the site;
- Diagnose the problem;
- Perform interim repairs; and,
- Document the activity;

Activity documentation should include the date and time of initial report, location and description of the problem, date and time of response activity, and identification of personnel completing the maintenance. Response maintenance activities can vary greatly because they are dependent upon characteristics of the signal equipment and unpredictable occurances. Responses maintenance activities are unavoidable, but can be kept at a reasonable level by a regular preventative maintenance schedule. Response maintenance activities require an average of approximately 20% to 25% of maintenance personnel time allocation.

Table II-5

Summary Preventive Maintenance Time Estimates

Austin Area-Wide ITS .

Austin Texas

Item	Maintenance Interval and Time *			
	Months			Years
	3	6	12	2 to 5
Cabinet (per unit)	--	7	19	3 hr.
Signal Heads (per unit)	--	27	12	1 hr.
Nighttime Check (per approach)	--	10	--	--
Mast Arms and Poles (per unit)	--	--	20	8 hr.
Span Wire and Poles (per unit)	--	--	25	--
Detector				
Sensors (per approach)	2-5	--	--	--
Amplifiers (per approach)	20	--	--	--
Junction Boxes and Handholes (per unit)	--	--	10	--
Electromechanical Control Equipment (per unit)	--	--	8 hr.	--
Solid State, Analog, and Microprocessor-based Control Equipment				
General (per unit)	--	5	20	--
Conflict Monitor (per unit)	--	--	10	--
Load Switches (per unit)	--	--	5	--
Auxiliary Logic (per unit)	--	--	30	--
Relays, Flashers, Switches, and Terminal Connections (total)	--	--	25	--
Interconnect Equipment (per unit)	--	--	25	--
Miscellaneous	As Required			

* Time in minutes except as noted.

SOURCE: Traffic Signal Installation and Maintenance Manual, Institute of Transportation Engineers, 1989.

Maintenance Costs - A study conducted by the General Accounting Office indicated that the cost of operation and maintenance of advanced traffic signal systems will be approximately 7.6%of the cost of the installation. Based on their information, it is estimated that the cost of maintenance and operations will be $2,964,000 per year when complete and that the total for the 15 year design We of the system will be $33,460,000.

Personnel Requirements of Recommended System

Personnel needed to operate and maintain the recommended traffic signal control systemconsist primarily of the existing staff, with additions desired in a few technical areas, including communications and maintenance. The recommended system includes new communications requirements, which will require communications specialists with extensive training with fiber optics and cellular communications. Maintenance and operations staff will also need to be trained for proper operations and maintenance of the recommended traffic signal controllers. Required personnel can be categorized into the following four functional categories:

Management Staff - Management staff typically consists of the director of an agency's transportation department or division. Much of the day to day management of traffic signal system operations and maintenance is usually performed by keymembers of the engineering staff. Support personnel, such as secretaries and administrative assistants, are also part of the management staff.

Engineering & Technical Staff - Both traffic signal technicians and transportation engineers are needed for successful and efficient operation of a computerized traffic signal system. The traffic signal technicians should have extensive training and knowledge in electronics, software, and operations of all equipment. The traffic signal technicians are also responsible for diagnostics and repair of signal controllers. The transportation engineers are responsible for traffic signal design, design modifications, traffic signal timing plans, and administration of traffic signal installation and maintenance. The transportation engineers should have the appropriate training (i.e. college degree(s)) and be registered professional engineers.

Operations Staff - Operations staff include system operators and software specialists. System operators are responsible for the day to day operation of the traffic signal control system. The operator can identify system problems and notify appropriate maintenance personnel. The system operators should be computer literate and capable of performing many computer-related skills. If the traffic signal control system is operated in a traffic management center, the system operator will also need to be familiar with operating other management system functions, such as changeable message signs and ramp metering.

Software specialists provide a support function to assist in maintaining the signal system software and keep it operating. Real-time signal system software is typically maintained by contract, but there is still a need for programming support within the operating agency. Software specialists may or may not work on a full-time basis, but are necessary to support the systems operators.

Maintenance Staff - Maintenance staff can be classified into three groups: Traffic signal mechanics, communications specialists, and traffic signal technicians. Traffic signal mechanics are responsible for diagnostic maintenance up to the device exchange level in the field, including maintenance of traffic signal controllers. Traffic signal mechanics should also be capable of performing routine maintenance on traffic signal installation components (i.e. signal heads, replacement of lamps, etc.) and diagnosing a failure and initiating corrective action.

Communications specialists keep the communications system running so that operations staff can communicate with the local intersections as much as possible. Communications specialists must be trained in electronics and a variety of communications systems supporting both voice and data transmissions. Communications specialists provide the critical link in making the traffic control system work, and are perhaps the most important members of the staff.

Traffic signal technicians are responsible for assisting the traffic signal engineer with troubleshooting and testing of new equipment as well as the implementation of new traffic signal timings in the field (as specified by an engineer) if communications systems fail for extended periods of time.

Cost and Funding Summary

The estimated life cycle cost for the traffic control system, as shown in **Table II-6** will be $72,460,000. This includes an initial installation cost of $39,000,000 for 600 intersections and $34,460,000 for operation and maintenance. Costs for facilities, operations, and maintenance were itemized in previous sections of this Chapter. Funds for the implementation of the traffic control system for the Austin Area should be obtained from three sources: Federal, State and local. The Federal funding would fall under ISTEA.

The various titles and programs of ISTEA include the following:

Title I - Surface Transportation - This title includes a number of programs and provisions oriented toward providing funding primarily for highway related projects. Some of the key programs within this title include the following:

- *National Highway System (NHS)* - includes finding for highway improvements on Interstate routes, a large percentage of urban and rural principal arterials, and national strategic highways;

- *Interstate Highways* - specifically allocates funds, beyond those included under NHS, for the completion and maintenance of the Interstate Highway System;

- *Surface Transportation Program (STP)* - is a block grant type program that may be used by states and local governments for any road (including MS) that are not functionally classified as local or rural minor collectors. Each state must set aside 10 percent of STP funding for safety construction activities (i.e., hazard elimination and rail-highway crossings) and 10 percent for transportation enhancements (highway beautification, bicycle/pedestrian facilities, etc.);

- *Congestion Mitigation and Air Quality Improvement Program* - directs funds toward transportation projects in Clean Air Act (CAA) non-attainment areas for ozone and carbon monoxide. The City of Austin is currently not a non-attainment areas for both ozone and carbon monoxide; and,

Table II-6

Estimated Cost of Traffic Signal System

Austin Area-Wide ITS

Austin, Texas

Installation Costs		
Traffic Control Room		
Hardware	$1,000K	
Software	2,000K	
		$ 3,000K
Intersection Control * 65K x 600 intersections		39,000K
	Subtotal	$42,000K
New Traffic Control Center Building		Minimum $2,000K
Maintenance Costs Over 15 Year Life of System = $42,000K x .076 x 15 / 1.33 ** =		$36,000K
Total Cost =		$78,000K

* Includes new intersection controllers, detectors, fiber optic cable and connection with FTM and GAATN Cable Systems.

** Assumes installation for 600 traffic signals, requires 7.5years and the system has a 15 year design life.

- Special Projects - includes federal funding for 539 Congressionally designated highway projects in 6 broad groups, including High Cost Bridges; Congestion Relief High Priority Corridors; Rural and Urban Access; Priority Intermodal; and, Innovative Projects.

The National Highway System (NHS) and the Surface Transportation Program (SIP) are two key programs included under this title which are likely to offer the most amount of funding resources available for the recommended City of Austin traffic signal system

Additional ISTEA Titles - ISTEA provides additional funding opportunities through the remaining titles and programs in the Act. A summary of the remaining titles are as follows:

- *Title II - Highway Safety* - Funding opportunities are offered through this title for non-construction highway safety programs, including state and community grants through the 402 Program to develop initiatives for reducing injuries and deaths caused by speeding, alcohol or drug use, and motorcycle or bus accidents;

- *Title III - Federal Transit Act Amendments of 1991* - Transit formulas (Sections 9 and 18) and discretionary programs (Section 3) from previous laws are extended through this title, with greater flexibility in the transfer of funds between highway and transit projects. Authorizations are provided for traditional rail and bus programs with initiatives provided for transit planning and research, as well as equipment needs related to requirements of the Clean Air Act (CAA) and Americans with Disabilities Act (ADA);

- *Title IV - Motor Carrier Act of 1991* - This title of ISTEA relates to motor carriers and reauthorizes the Motor Carrier Assistance Program and sets deadlines for state participation in federal registration, fuel taxation, and operations for motor carriers;

- *Title V- Intermodal Transportation* - Intermodal transportation is promoted through this title which makes grants for the development of intermodal transportation plans.

- *Title VI - Research* - This title covers research development in the following three areas: 1) Programs, Studies and Activities; 2) Intelligent Vehicle-Highway Systems Act (IVHS); and, 3) Advanced Transportation Systems and Electric Vehicles. Significant opportunities are offered to state and local agencies for the conduct of engineering, planning, and research studies, the development and implementation of prototype IVHS systems, and development of electric/alternative fuel transit systems;

- *Title VII - Air Transportation* - This title concerns amendments to the Metropolitan Washington Ah-ports Act of 1986; and,

- *Title VIII - Extension of Highway-Related Taxes and Highway Test Fund* - Highway-related user taxes and the Highway Trust Fund are extended under this title with certain modifications.

Title III, Federal Transit Act Amendments of 1991, is a key title which may provide additional funding if the function of the City of Austin's traffic signal system incorporates the desires of and will benefit Capital Metro.

To receive ISTEA funding, transportation projects must be included in the area Transportation Improvement Program (TIP). The Austin Transportation Study (ATS), which serves as the Metropolitan Planning Organization (MPO) for the Austin metropolitan area, annually prepares the area TIP. The TIP identifies those transportation projects (including roadways and transit) which are planned to be implemented in the Austin metropolitan area, and indicates project priority, year of initiation, and finding source(s). Steps should be taken as soon as possible to effectively coordinate with ATS and to ensure that traffic signal system improvements recommended in this study are included in the TIP.

Once the eligibility of projects for ISTEA finding are determined, the funding should be diligently pursued. There is considerable competition at the national and state levels for use of the federal funds. Unless actively pursued by local officials with strong support by their congressional and legislative representatives, the project could be "lost", assigned a low priority or postponed to some future year. The issue of securing ISTEA funding should be a cooperative effort with ATS.

State Funding - State funding for transportation related projects is obtained through the Texas Department of transportation (TxDOT). TxDOT's funds are obtained from a motor vehicle gasoline tax, vehicle registration, and vehicle inspection revenues. State funds are typically available for transportation related improvements on State operated and maintained roadways. State funds for the Austin area are administered through TxDOT's Austin District office.

Local Funding - Local Funds from the City of Austin for transportation related improvements are typically obtained from either the General Fund, the Capital Improvement Program (CIP), or a municipal bond election. For the purposes of implementing the recommended traffic signal system, the General Fund and existing, authorized CIP funds are not anticipated to be able to provide the needed amount of funding. It is anticipated that funding for the signal system will involve a municipal bond election, in conjunction with funds received from the Federal government and TxDOT.

Implementation and Phasing Strategy

The implementation of a traffic signal system for a City the size of Austin would be an ongoing process over many years. Since many agencies have similar needs as discussed in other Chapters, the concerned agencies should pool and coordinate their funding, planning, and design efforts. One building for a Traffic Management Center could house many agencies and have one communications hub center.

Recommendations for improvements to the existing system over the next three years consist of:

1) Form an Operations Management Committee comprised of a representative of each participating agency to oversee the Traffic Management System. Consideration should be given to establishing an operating entity with an Executive Director as done in Las Vegas, Nevada and Houston, Texas.

2) Develop a Deployment Plan for submittal to the MPO immediately showing expenditures vs. time. This step could be done simultaneously with Step #l and could be completed prior to the completion of Step #l. Steps #3 and #4 below could proceed while Step #l is being completed. The first priority is the development of a preliminary engineering report which would include a detailed deployment plan. The deployment plan would include finding strategies. The report would be the basis of securing funding from local, state, and federal sources. Currently, federal and state dollars have been available for projects that have a local match, including design plans for construction.

3) Obtain funding for system upgrade. Potential funding for the recommended ITS system could come from two possible sources; these being local funding sources such as transportation related tax monies or capital improvement bond funds, and various federal funds administered by the Metropolitan Planning Organization (MPO) and/or Texas Department of Transportation. The metropolitan planning provision of ISTEA feature has an enhanced role for local governments. The MPO is responsible for developing, in cooperation with the State, a long-range plan and the TIP must include all projects in the Austin area that are proposed for funding with ISTEA monies. Areas with populations of over 200,000, such as the Austin Area, must be designated as Transportation Management Areas (TMA). Projects in these areas are selected by the MPO in consultation with the State. Also, in each TMA, a congestion management plan must be prepared. The Austin ITS system should be a primary component of this plan. Under ISTEA, two of the programs offer funding for a traffic control project such as the Austin

ITS. These programs are the Surface Transportation Program (SIP) and the Congestion Mitigation and Air Quality Improvement Program. The first step in securing Federal funds is getting this project added to the TIP.

4) Commission Design PS&E. This step will involve the design of the recommended system; the preparation of plans, specifications, and estimates; bid documents, bidding process, receipt of bids and award contracts. It is during this step that a plan will be prepared that indicates exactly when each intersection will go on the new system.

5) System Deployment. This step will include system development and integration, system testing and acceptance, training, field installation.

6) Retire existing System.

The City of Austin should work with TxDOT, Austin District, to secure possible State and Federal Funds for a City/State integrated system. The City should concentrate their internal planning efforts for the concerned groups, including Public Works, Capital METRO, Fire, Police, and EMS. The City should secure local funding for the initial design and local match for State and Federal Funds. One possible option would be a bond election in the Fall of 1996.

With the passage of a bond election in the Fall of 1996, the funds could be available by Spring, 1997. A deployment plan could also be in place by Spring, 1997. Critical portions of the traffic system could be designed during 1997 such that plans would be ready for construction during 1998. Approximately 100 intersections could be upgraded per year with the existing signal contractors. A Traffic Control Center would probably be needed by 2000. An interim center would be needed in 1498. The system would be "fully" implemented by 2005.

Other technical questions to be determined are the type of controller to be utilized, selection of system software, detection methods in selected areas, and communication media utilization. Staffing levels and maintenance/operation funding would need to be adjusted as the system is implemented.

A key factor for the successful implementation of an ITS/traffic signal system for Austin would be the establishment of an impartial group of individuals to coordinate and direct implementation effort. This organization would be similar to working groups in Houston and Las Vegas.

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FREEWAY TRAFFIC MANAGEMENT SYSTEM
SCOPE OF WORK

Identify resources for sharing data between TxDOT's FTM, HOV and City traffic control systems.

Task Description and Milestone

TxDOT Traffic Management Systems

TxDOT Traffic Operations Division has developed a modular, microcomputer based, distributed processing system architecture to manage the movement of traffic on streets and highways. Four management systems have been developed:

- Freeway Traffic Management (FTM)
- High Occupancy Vehicle (HOV)
- Arterial Traffic Management (ATM)
- Signal Coordination System (SCS)

Of these only FTM and HOV have been selected for further development.

These systems consist of the following components:

- Multi-tasking Manager
- System Control Unit (SCU)
- Local Control Unit (LCU)

The first system deployed in Austin is planned for November 1995. An FTM system will be deployed along US 183 from the Williamson county line to IH35. This system will include thefollowing technologies:

- inductive surveillance loops
- changeable message signs (CMS) .
- lane control signals (LCS)
- closed circuit television (CCTV) cameras

Communications within this system willtake place over twisted wire pair, coax, and fiber optic cable. Inductive loops and duct bank have been installed. Communication protocols for each of the components have been defined by the TxDOT Traffic Operations Division.

Task Description and Milestone continued

City of Austin Signal System

The City of Austin desires a computer controlled signal system which is capable of the following functions in the order of importance:

- Accommodates existing system characteristics;
- Integrates signal control, preemption, cameras, signs, and flashers;
- Integrates video from a mobile source;
- Utilizes a distributive architecture;
- Supports a variety of communication mediums;
- Perform multiple tasks simultaneously;
- Provide remote access;
- Automatically adjust signal timings to accommodate traffic demand;
- Evaluate operations based on real-time speeds, travel times, and queue lengths;
- Continuously collect operational characteristics;
- Continuously update color coded maps;
- Display the network in different colors based on congestion;
- Recommend streets which can accommodate diversion during an incident;
- Provide emergency/bus preemption;
- Distinguish emergency/non-emergency preemption;
- Maintain signal coordination during preemption;
- Identify time, agency, and impact of preemption; and,
- Share data with other agencies.

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

The work generally consists of identifying the data that should be shared between the two traffic control systems. Summaries of the facilities, equipment, maintenance, personnel, and funding needed to share this data should be listed. A phased implementation plan for sharing data between traffic control systems should also be devised.

Facilities include structures or enclosures necessary to house and operate equipment and personnel and its cost. Equipment includes hardware, software, and communications items and their cost needed for sharing data. Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing. Documentation of a phased implementation strategy should be included.

Freeway Traffic Management System

Freeway Traffic Management (FTM) begins with freeway construction and continues through day-to-day operation, As discussed below, FTM improves the total operation and safety of a freeway through providing traffic control where needed, traveler information, and incident management. FTM should be included both to minimize the impacts of highway construction and as ongoing activity to reduce accidents, vehicle emissions, fuel consumption and vehicle delay while increasing overall vehicle throughput.

FTM includes the following Intelligent Transportation Systems (ITS) functions:

- Advanced Traffic Management Systems (ATMS);
- Advanced Traveler Information Systems (ATIS);
- Advanced Public Transportation Systems (APTS); and,
- Commercial Vehicle Operations (CVO).

The limitation of roadway construction funds has reduced the ability to meet the freeway traffic demands. In the Austin area, for example, highway and street construction has not been able to keep up with current traffic demand. In addition, Austin borders on becoming a non-attainment area for vehicle emissions. Because of this, there is a need to make optimum use of all of the major transportation arteries; to provide for improved public transportation and to encourage an increase in High Occupancy Vehicle (HOV) ridership. An important aspect of assuring optimum operations includes traffic safety which occurs as part of improved operation along freeways through Freeway Traffic Management (FTM). The utilization of Changeable Message Signs (CMS), Lane Control Signals (LCS) and Highway Advisory Radio (HAR) provides an opportunity to advise motorists of congestion ahead and of alternate routes which are available. In so doing, congestion can be decreased and the chance of accidents reduced.

In addition, ramp meter control can reduce accidents and delay while increasing main lane throughput when in use as part of FTM along high volume freeways which are operating under low speed conditions (e.g. below 40 mph). Examples of this would be IH 35 and MOPAC / Loop 1 during peak periods and incident conditions. A study of seven Freeway Traffic Management systems found that after ramp meter control was installed accidents were reduced by an average of 31% and reduced congested freeway travel by an average of 65% while increasing average main lane speed by an average of 20% (including ramp delays) or 29% if ramp delays are not included.[1]

A 1981 installation of three isolated (non interconnected) traffic responsive ramp meter controllers located along the northbound lanes of IH 35 between Ben White Blvd. and Riverside Drive in Austin increased vehicle throughput along the main lanes by 10% while reducing the total travel time delay by 152% while ramp meters were in operation.[2] The ramp meter control was removed because congestion was eliminated when IH 35 was widened.

An analysis of the effect's of Freeway Traffic Management as it applies to Texas freeways with continuous frontage roads was conducted by the TxDOT Division of Traffic Operations during 1988-1989. Consideration was given to the effects of system computer control, ramp metering, CMS, LCS, CCTV, and incident management for the freeway main lanes and use of multiphase sequence (three phase and four phase) traffic responsive traffic signal control, lane designation signals and split changes along the frontage roads. The results of the study showed that total throughput for a six lane freeway (three lanes in each direction) could be increased by 25% through application of the Freeway Traffic Management functions noted above. This increase did not include the effects of HOV lanes located within the center median.

Incidents on freeways have been found to cause *55%* to *60%* of the delay on freeway[3]. A study in Los Angeles showed that where incident management is applied as part of FTM, 4 to 5 minutes of delay was saved by each motorist for each minute that vehicles are removed from the freeway.[3]

The Freeway Traffic Management System being developed in Austin should be designed to include each of these at present or in the future through:

- Traffic Control and Information (CMS, I&W, LCS, CCTV, Ramp Control, Coordination with other Traffic Control Systems);
- High Occupancy Vehicle (HOV) Operations (HOV Lanes with Traffic Control and Enforcement);

- Traveler Information and Formation on Alternate Routes for all vehicles including Commercial Vehicles;

- Incident Management (e.g. Accidents, Vehicle Breakdown, Motorist Assistance such as "May Day" calls, Road Construction/Maintenance, Special Events);

- Close Coordination (e.g. Integration) with City Traffic Control Public Safety Agencies (PSA) providers;

- Automatic Vehicle Location (AVL);

- Automatic Vehicle Identification (AVI);

- Weigh-In-Motion (WIM);

- Improved Incident Detection (through use of 911 *or* a Separate Three Number Telephone Reporting System in place of 911 such as Star -- to supplement vehicle detectors) for reporting Incidents on freeways and streets;

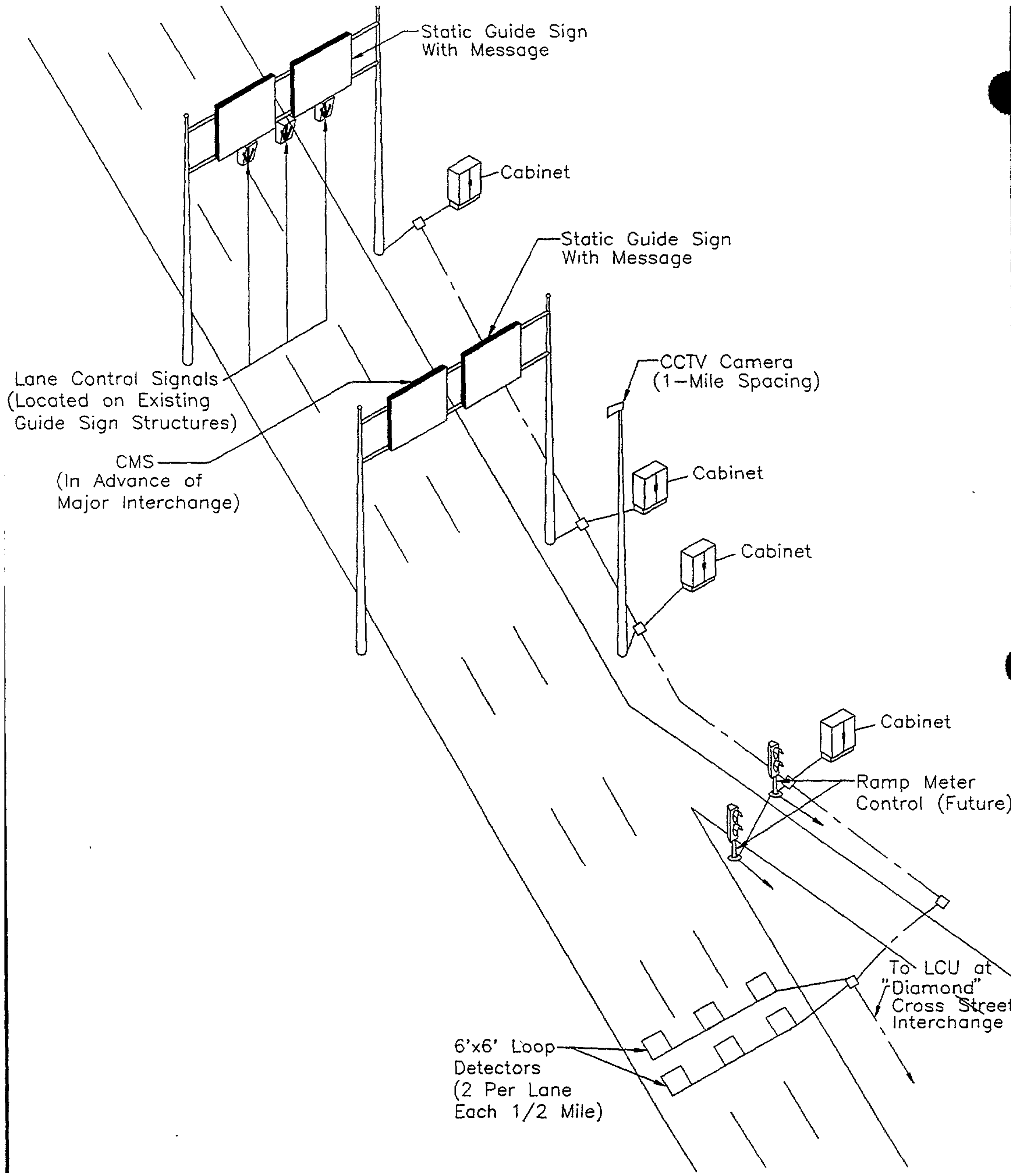
- Route Diversion; and,

- Improved Speed Determination (e.g. Use of vehicles such as trucks as probes).

Some of these applications are shown in **Figure II - 8.**

The Freeway Traffic Management System needs to be flexible in design in order to carry out all of these and other functions along a freeway corridor within the region. To be most effective, FTM should be carried out on a corridor and regional basis. The design and application of the functions mentioned above will require a close working relationship between agencies within the Austin region. These include:

- Texas Department of Transportation (TxDOT);
- City of Austin Public Works and Transportation Department;
- City of Austin PSA (Police, Fire, EMS, 911);
- City of Austin PSA Center;
- Capital Metro;
- Texas Department of Public Safety;
- Austin Airport Authority;
- Travis, Williamson, Hays and Bastrop Counties; and,
- Other Cities in Region (e.g. San Marcos, Bastrop, Round Rock, Georgetown, Cedar Park, West Lake Hills).



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Freeway Traffic Management
Field Installation Components
Austin Area-Wide ITS
Austin, Texas

Figure II-8

A working committee should be organized to carry out the close working relationship initially during design and later during ongoing operations.

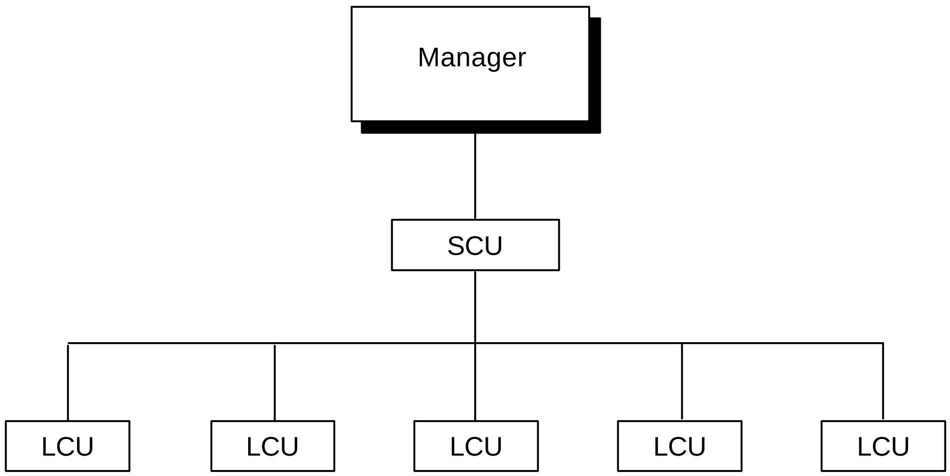
In addition, a close working relationship will also need to be developed with private organizations such as motorist information (e.g. radio, television), railroad, truck (freight and delivery including air cargo), and bus (e.g. Greyhound, charter, sight seeing companies). This working relationship should include firms from Mexico and Canada with the anticipated increase trade due to the North American Free Trade Agreement (NAFTA).

Freeway Traffic Management System Overview

It is not anticipated that all of the functions and services previously described will be carried out immediately but Austin's Freeway Traffic Management System should be designed and developed to provide for those not installed under initial contracts. This can be done through the construction of a Traffic Management Center, in conjunction with cooperation, coordination and communication between the agencies.

The Austin District freeway design calls for vehicle volume and speed detectors located each one-half mile, CCTV cameras located each mile (plus additional cameras where needed at cross street grade separation), CMS at approximately two to three mile spacings and LCS on existing overhead guide sign bridges.

The FTM system hardware is shown graphically in **Figure II - 9**. Local Control Units (LCU) provide for control and traffic data collection at field units (e.g. vehicle detectors, ramp gates, ramp meter control). The System Control Unit (SCU) which is located in a satellite building located along a freeway gathers traffic data information from LCUs and, in turn, distributes traffic control information to each of these units. The SCU also determines traffic control patterns for one or more freeways on a stand alone real time basis (no personnel required at the satellite building) and automatically implements these traffic control patterns. The SCU advises the Manager (PC) located at the Traffic Control Center of action being taken.



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Basic Freeway Traffic Management System
Austin Area-Wide ITS
Austin, Texas

Figure II-9

The operator at the Manager monitors and modifies SCU traffic control patterns as required. When an incident occurs, it is noted by the LCU/SCU combination and the operator is advised through the Manager. Where entrance ramp control exists, the SCU can automatically activate the proper ramp meter or ramp gate. The SCU can also recommend CMS messages and LCS displays for operator implementation at the TMC. The FTM system design is the same as that being implemented in Houston, Fort Worth and El Paso.

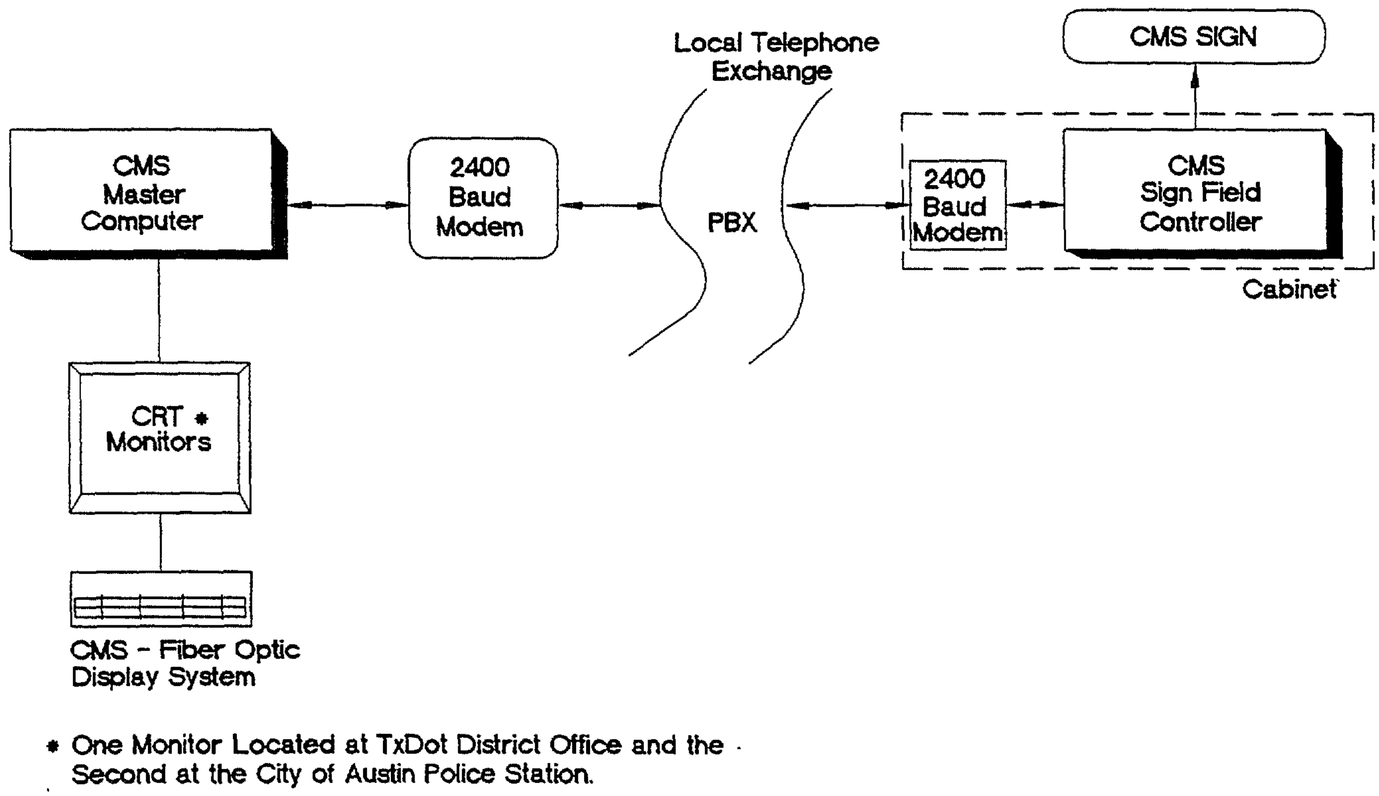
Existing TxDOT Austin District Freeway Traffic Management System

Facilities Summary - The Freeway Traffic Management (FTM) system in Austin presently consists of two Changeable Message Signs (CMS) and supporting Lane Control Signals (LCS) located at each end of the "express lanes" bridge structure on IH 35. The CMS and LCS can be operated either from a PC computer console located at the City of Austin police station or from the TxDOT Austin District traffic control room. The District also has a Systems Control Unit (SCU) and Manager which are not in operation at present.

The CMS and the LCS are presently operated through the CMS and LCS computers. The current fiber optic message type CMS system, replaced a combined CMSACS system installed in the early 1980s. The LCS, which was part of the original CMS system (original CMS and LCS operated by the same PC computer), are still operated by the original CMS system computer. The District plans to incorporate the CMS and LCS systems into the existing SCU and Manager through use of Windows 95.

CMS messages and LCS displays are presently stored in computer memory. Additional messages and displays can be developed as requested by the City Police and stored for use in the future by the TxDOT engineer and police dispatch as needed. The development of new CMS messages and LCS displays on a real time basis is not carried out at present. Real time development of messages and displays will be possible when the TxDOT operator is located at the TMC.

As shown in **Figures II - 10** and **II -11,** communications between the District Office (and the City police system) and the CMS and LCS system are carried out through use of leased telephone lines. The police and/or TxDOT Control Center operator can select the desired CMS message and



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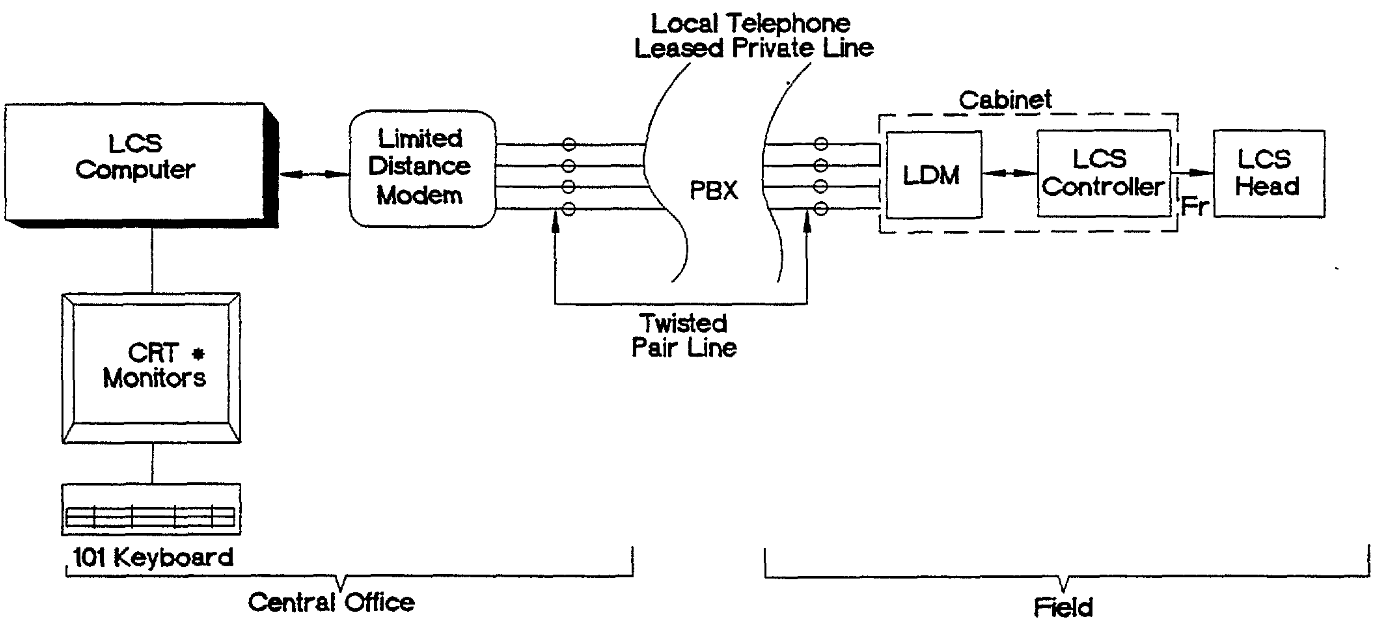
Changeable Message Sign Controls System
Austin Area-Wide ITS
Austin, Texas

Figure II-10



LCS - Lane Control Signal Central Office
LDM - Limited Distance Modem
* One Monitor Located at TxDot District Office and The Second at the City of Austin Police Station.

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Existing Lane
Control Signal System
Austin Area-Wide ITS
Austin, Texas

Figure
II-11

LCS displays from available combinations; however, implementation by the police must be made by making two telephone calls -- one to the CMS computer and the second to the LCS computer. The need to make two phone calls and the communications problems with the LCS noted below has discouraged use of the LCS by the police department dispatchers.

Figure II - 10 illustrates the existing communications infrastructure for the CMS consists of Southwestern Bell PBX (Public Telephone Exchange) service. The CMS master computer provides all the applications and communications control to the 2400 Baud modem with auto-answer and autodial functions for a standard telephone line. The CMS master computer controls the two existing sign field controllers . All field connections to the communications infrastructure (PBX) are provided with a telephone line drop. One CMS master computer and modem have the capability to control over 150 CMS. Access times are slow if the number of signs increase beyond 10 signs with a one modem configuration and the access repeats are numerous. This is due to the diagnostics and the maintenance functions of the master controller software (overhead) for keeping the signs current and active.

Figure II - 11 shows the present configuration for the LCS system. The communications medium is over a leased private line system provided by the local telephone company. The modem system in this case is a limited distance modem (LDM) that is designed to operate over a private twisted pair copper communications cable plant system. The twisted pair system is leased from the local phone company. At this time, the communications performance needs to be improved. Basically, the LCS are non-functioning due to communications problems. In order to examine and resolve the communications problem, a random 511 character communications tester (such as HP-4952A) will be required. This device will examine and pinpoint the fault of the present communications system.

The tester can be connected at the Master computer site RS-232 asynchronous communications line and a loop back plug installed at the field controller site over the LDM interconnection and the local telephone leased lines. This test will examine bit error rate and bandwidth and yield absolute performance measurement numbers.

The District also plans to purchase a Highway Advisory Radio (HAR) unit and is presently working with the Division of Traffic Operations in doing so. The District is also awaiting installation of freeway detectors for integration of the CMS and LCS systems at the SCU. Work is also underway to develop a Courtesy Patrol.

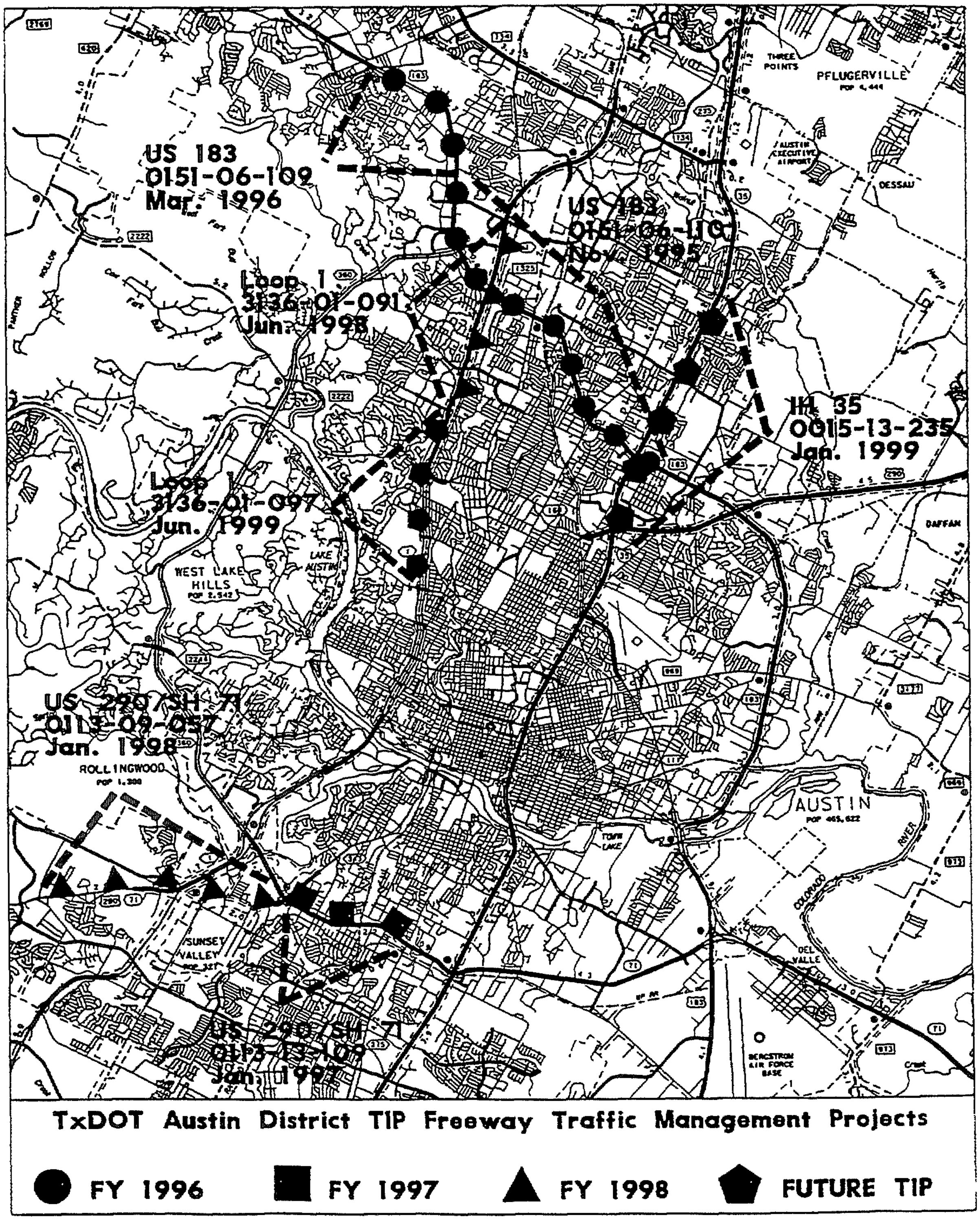
TxDOT Operations and Maintenance - TxDOT originated CMS messages and LCS displays are implemented by one Engineer on a part-time basis. He isthe only person who can fix a problem involving the control center hardware/software. Maintenance of the two CMS and the LCS is currently carried out by District traffic signal maintenance personnel.

The integration of operations of the total CMS, LCS, SCU/Manager system should be given immediate priority. Integration of the various components appears to be best handled through use of the SCU/Manager and through use of windows 95 (or similar computer model). In addition, a second TxDOT operator needs to be trained to operate the system. There is also a need to overcome the current CMS and LCS communications problems as soon as possible.

Further, there is a need for TxDOT to coordinate more closely with the City of Austin police personnel in determining and implementing new CMS messages and LCS displays. Close coordination is also required to develop and implement the Courtesy Patrol. These activities could be done along with improving the existing CMS, LCS, SCU/Manager System by making additional personne1 available.

Funding and Personnel Summary - Additional emphasis needs to be given to the FMS program. This includes increased funding and time for upgrading the existing CMS, LCS and SCU/Manager System and provisions made for an additional employee for Freeway Traffic Management development. The additional employee(s) would serve as an alternate operator for the operation of the CMS, LCS and SCU/Manager System and work on the development of PS&E for the FTM System.

Implementation/Planning Summary - As is shown in **Figure II - 12,** the District has scheduled the initial development of FTM along IH-35, US183, US290/SH7 (Ben White Blvd.) and Loop 1 (Mopac) over the next five years with planned extensions along these highway during the following seven years. Additional installation beyond 2012 is in the planning stage. Initially, FTM development will involve the installation of loop vehicle detectors, CMS, LCS, HAR and CCTV.



SOURCE: Texas Department of Transportation, Austin District

WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Freeway Traffic Management System Field Installation Schedule Austin Area-Wide ITS Austin, Texas	Figure II-12

Communications will be carried out through the use of fiber optic cable installed as part of the FTM installation on the projects shown in Figure II - 12. Traffic management is planned to be initially controlled at an interim traffic control room at the District office.

In addition, studies are underway on the desirability of incorporating HOV lanes along IH 35 similar to the design being applied in Houston and planned for in Dallas. There is also a study underway to develop mitigation approaches at freeway bottleneck locations. These approaches may utilize ITS applications.

FTM applications by TxDOT will improve operations and safety along freeways and freeway corridors. Even better operation and safety can be expected through coordination in sharing and utilizing information with other public agencies and the private sector in improving operations and safety in the Austin region. This could best be done through agencies being located in one Traffic Management Center and development of a means of integrating their traffic management activities.

Recommended Method of Sharing and Utilizing Data

In order to carry out a regional traffic management system, there is a need for all agencies to share and utilize traffic and other related information. It is also necessary to work closely with private companies such as the news media and passenger/goods movement companies. Included in this is the management of incidents along freeways and streets and notification of traffic conditions to travelers and motorists in adjacent cities (e.g. Georgetown/Round Rock, Leander/Cedar Park, San Marcos, Bastrop). In this way, improved operations will be achieved throughout the city and the entire region - both from a mobility and traffic safety standpoint. Although it is not essential for all transportation operations agencies to be located in one Transportation Management Center (TMC), communications, cooperation and coordination could be greatly improved if they were located within one TMC. In addition, it would be desirable for the City and TxDOT to share and utilize traffic data through an integrated approach.

It would be highly desirable to complete the IH 35, US 183, Mopac, SH 290 fiber optic cable loop at an early date. It would also be desirable for this cable to be available for use in both FTM and City traffic signal control. It is recommended that consideration be given for the cost of installation of the fiber traffic optic cable loop be shared equally between the City and TxDOT. This approach would provide a trunk line for FTM and signal control and permit the city to change to the use of fiber optic cable as desired. This could include installation of CCTV at selected signalized intersections (e.g. spacing each 0.5 to 1 mile between cameras). The Houston District and Metro have shared the installation costs for .fiber optic cable along the freeway system in the Houston area. The trunk line would also provide a two-direction traffic control and data input between the TMC and field units.

Shared Data - It is essential in providing good traffic management for public agencies and private sector participants to share traffic data and other related information, and to work together in utilizing this information. A listing of traffic data and other information which can be shared is given in **Table II - 7**. The listing shown is the basic information needed. This information will need to be summarized and tabulated to meet each public and private sector needs. The organization of how the information is presented to each organization will need to be developed as part of overall system development.

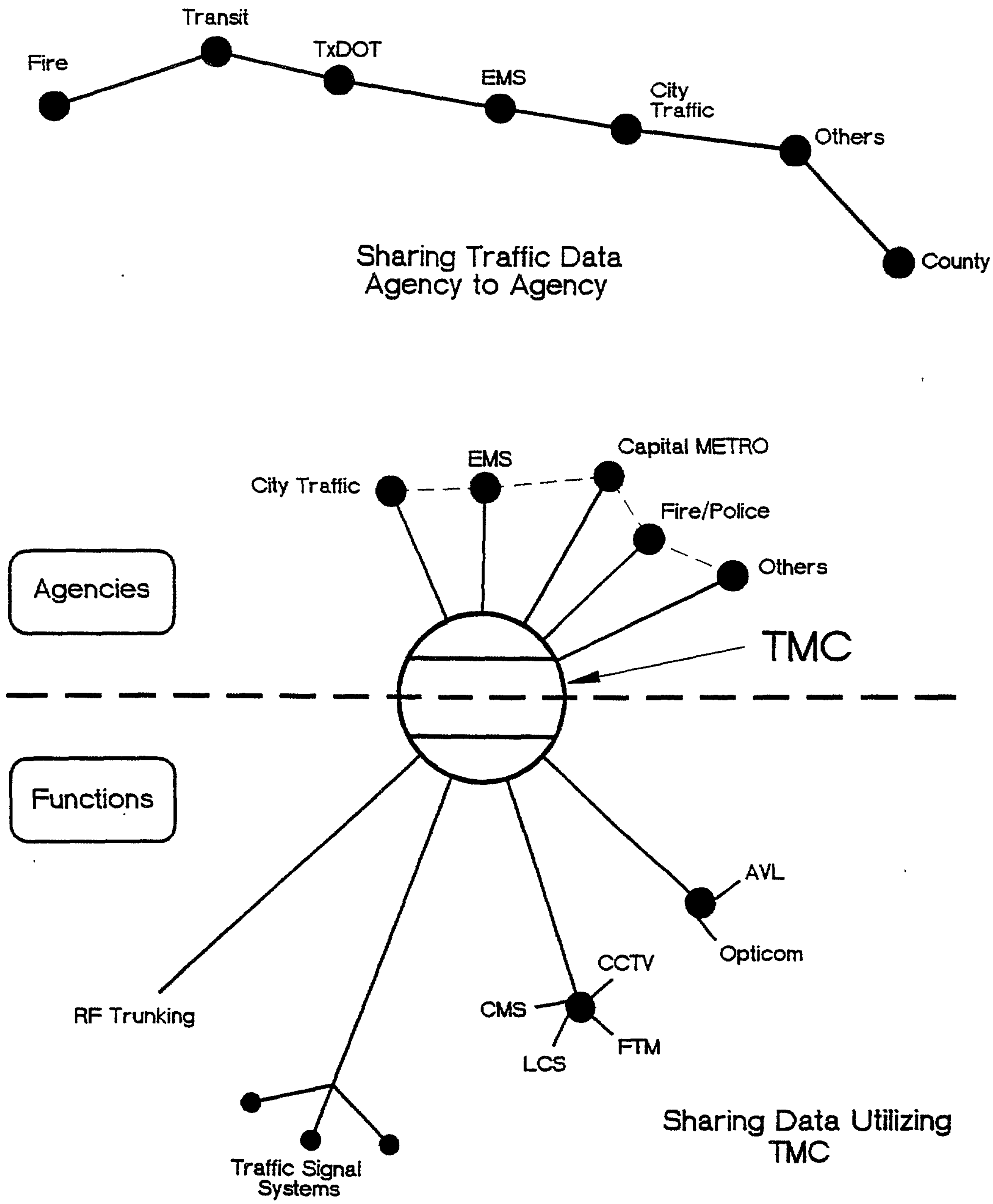
Two approaches of sharing information are given in **Figure II - 13**. In the first, each agency Traffic Management Center or Communication Center sends information to other Agency Centers. In the second, also shown in Figure II - 13, information is transmitted to a Traffic Management Center where it is organized and tabulated. The resulting information is then sent to each organization as requested and/or as a standard format. Each agency will determine the information its personnel can use and request the needed information. All information will not need to be sent to each agency. For example, PSA organizations may want to know where major congestion exists and/or CCTV pictures of a particular accident where they are available.

In addition to sharing traffic data, additional information needs to be considered (e.g. location of incidents, work zones, inclement weather conditions, fire scene activity, 911/CCTV noted problems). Incorporating these reports into the data analysis routine (known as data fusion) will assist in determining traffic control patterns being called for (or recommended) by the computer(s).

In addition to sharing traffic data and other information, it is important to develop an approach for utilizing the information during both recurring and non-recurring congestion and to provide incident management. This can best be done through a form of integrated traffic control between the

Table II-7
Agencies and Information to be Shared
Austin Area-Wide IVHS
Austin, Texas

TxDOT Freeway Management	City Traffic Management	County Sheriff/Road	Capital Metro	City of Austin Emergency Management
Main Lane, HOV Lane and Frontage Road, Traffic Volumes/Lane Occupancy, Average Speed, Travel Time	Major and Minor City Arterial and Collector Street Traffic Volumes, Lane Occupancy, Average Speed, Travel Times	Location of Accidents and Severity	Location of Buses (AVL)	911 Reports on Emergencies Best Handled by City or TxDOT Traffic Management Operators
Incident Locations, HOV and Main Lane Queues, Estimated Delay	Incident Locations on City Streets, Queues, Estimated Delay	Roadwork n County Roads	Travel Time along Routes	Reports on Accidents/Fires and Public Disturbances and Extent of Problem
Queues along Frontage Roads and Cross Streets at Freeway “Diamond” Interchanges	Level of Service and Available Capacity on Major and Minor City Arterials and Collector Streets	Possible Alternate Routes for Traffic and EMS	Reports on Observed Incidents that May not Have Been Reported	Reports on Problem Locations Noted by Officers in the Field (Officers work through their organization to report incidents)
Location of Courtesy Patrol Vehicles	Construction Underway on City Arterials and Collector Streets		Reports on Motorists Who are Driving in an Erratic or Hazardous Manner	Traffic Management Underway at Incident Locations
Level of Service and Available Capacity on Main Lanes, HOV Lane(s), Frontage Roads and cross streets at “Diamond” Interchanges	Maintenance Activities along City Arterials and Collectors		Reports on Signalized Intersections Where Pedestrians Do Not Have time to Cross the Street Safely	
Estimated Traffic Diverted along Frontage Road(s) caused by Ramp Control (when installed) and Need for Frontage Road Traffic Signal Coordination to Better Handle Traffic Diverted by Ramp Control	Traffic Signal Equipment Malfunctions		Reports on Signalized Intersections and Arterial Locations Where Delay Exists	
Need for Change in Traffic Signal Sequence at “Diamond” Interchanges	Accident and Fire Locations, Estimated Delay and Alternate Routes which are available to Motorists		Location of a Bus Breakdown	
Location of Wreckers Available for Incident Management (e.g., Removal of Vehicles from Freeways and Other Major State Arterials	Effects of Preemption of Traffic Signals by Buses and EMS Vehicles			
Location and Information on “Thru Traffic” Commercial Vehicles (AVI, AVL, WIM, Permit Limitations)				
Construction Activities Along Freeways and Other Major State Arterials				
CMS and HAR Messages and LCS Displays				
Maintenance Activities along Freeways and Other Major State Arterials with Lane Closures Where Applicable				
Traffic Control and Traveler Information Malfunctions				
Traffic Management Underway at Incident Location				



WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Two Concepts for Traffic Data Sharing Austin Area-Wide ITS Austin, Texas	Figure II-13

City of Austin and TxDOT Traffic Management systems -- preferably at one Traffic Management Center. Integration can be carried out in one of three approaches as discussed in the following scenarios:

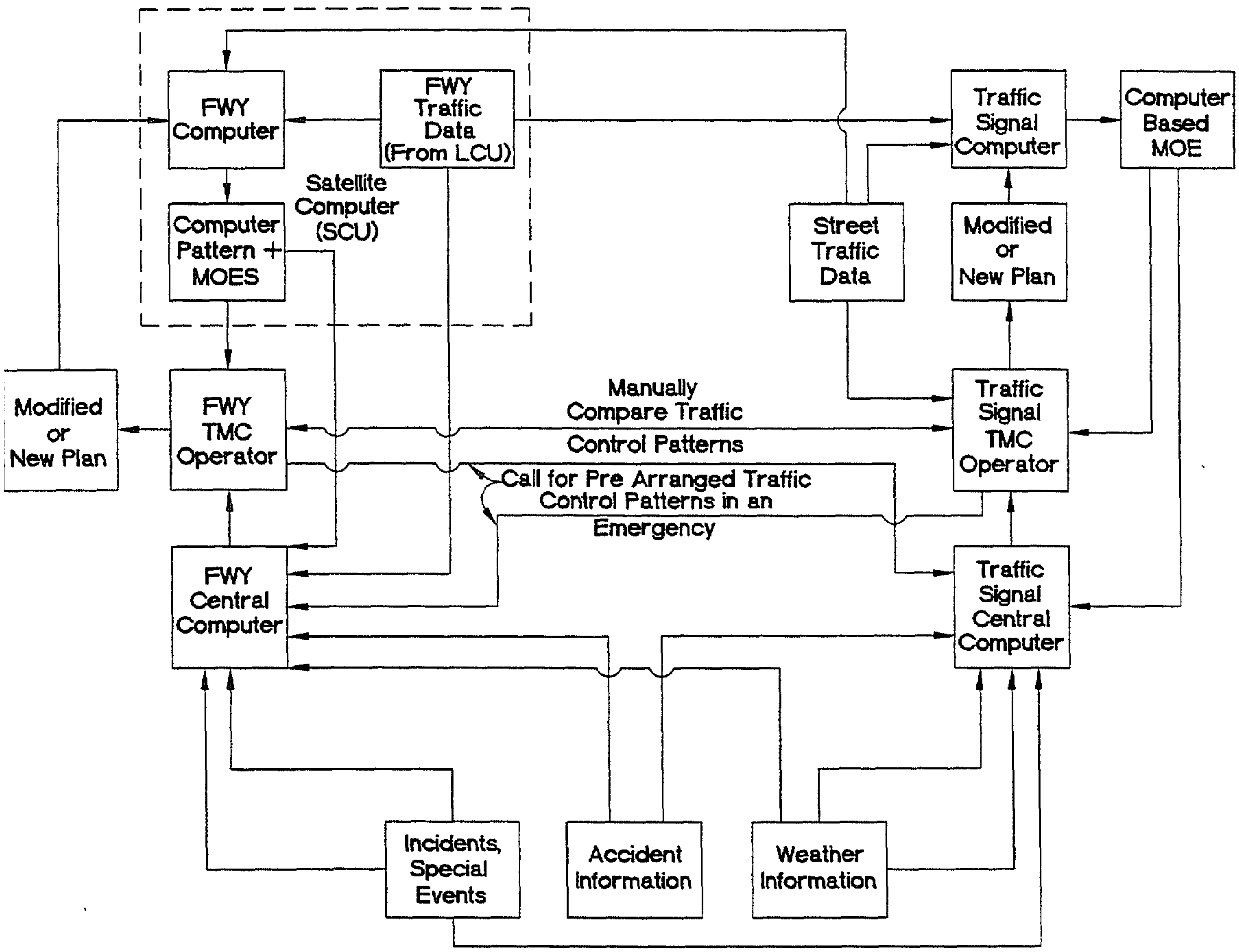
1. Sharing Detector Information. This approach permits both the City and TxDOT to request detector information and CCTV pictures from the other agency as needed -- the requested information can be displayed through the use of Windows on one computer or preferably on a second computer screen at the work station. Utilizing the same detector and CCTV information within a corridor will permit operators of the two systems to decide on similar courses of action. Each computer will determine traffic control patterns through independent action. The traffic control patterns can be modified as verbally agreed upon by both operators.

   This approach is the least complex from a hardware/software standpoint but does require the utilization of two operators agreeing under pressure which traffic control patterns need to be implemented. Even with the operators located at one TMC, this approach would be the least desirable.

2. Utilization of Each Other's Detector Data. This approach, which is shown in **Figure II - 14,** will permit each agency's computer(s) to automatically receive selected detector information from the second agency's system. As an example, the City of Austin computer would receive detector data from the freeway system as well as from the street system. The City computer could then provide a traffic control pattern based to a certain extent on freeway as well as street data, if desired, the computer could also provide recommended alternate routes along the freeway corridor using both street and freeway detector information. The TxDOT computer could likewise recommend improved traffic control patterns – including recommended alternate corridor routes (e.g. providing frontage road and parallel street progression patterns when the demand by traffic desiring to enter the freeway is too high -- especially where ramp control is provided). Traveler information messages could also be recommended by each agency's computer.

   The cost for Approach 2 should be approximately the same as that for Approach 1. The traffic control patterns and traveler information recommended by the two computers could be compared by the two operators, as in the first scenario. This scenario will permit the operators to make a more educated decision on which traffic control patterns to select for the two systems.

3. Coordination for Two Computers. In this scenario, which is shown in **Figure II - 15,** a third computer would utilize the traffic data from both traffic management agencies as in Scenario 2 and provide an expert system based diagnostic routine as an assisted approach to the two operators. The diagnostic routine could also consider other information as part of the analysis.



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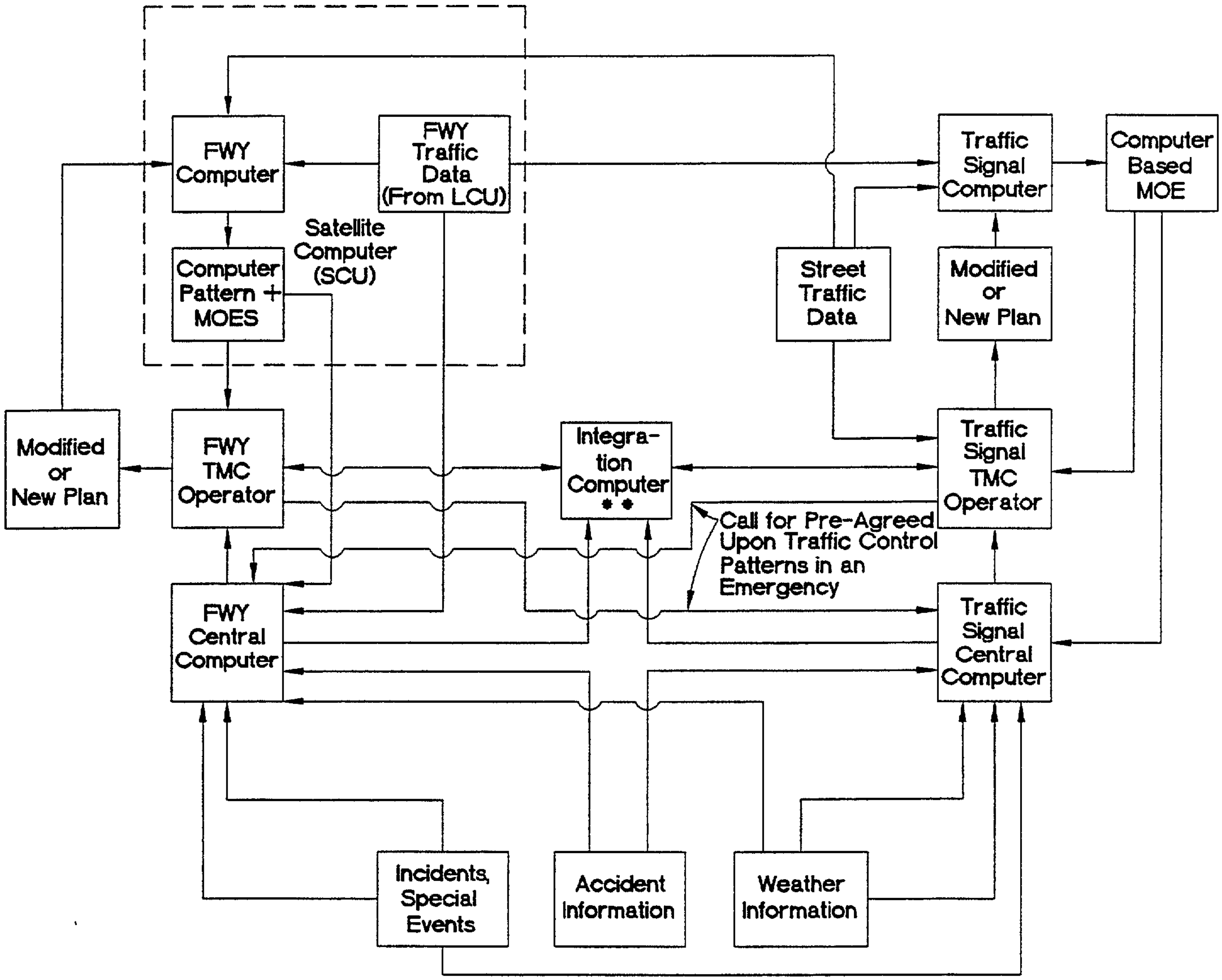
Traffic Management System Integration (Scenario 2)

Austin Area-Wide ITS
Austin, Texas

Figure II-14



** Frontage Road, Corridor Streets Agreed Upon Traffic Control Pattern

WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Traffic Management System Integration (Scenario 3) Austin Area-Wide ITS Austin, Texas	Figure II-15

This scenario is more complex than the first two scenarios but could provide the best approach since diagnostic assistance is provided to the two operators in their determining which traffic control pattern to implement.

Of the three scenarios, the third would be the best and is recommended as part of either the freeway or city traffic control system design Implementing the third scenario as part of the Freeway Traffic Management system implementationwill permit the use of diagnostic analysis at an early date. The cost for the third computer and software could increase the overall cost of the FTM system by $300,000. This amount will need to be added to the TMC costs shown later in Table II - 10.

With any of these scenarios, it will be desirable for the operator from either agency to be able to call for pre-agreed upon traffic patterns within both systems during emergency conditions. In this way, certain actions can be taken in an emergency should one agency operator be absent from his/her workstation.

Although the functions noted above could be carried out to some extent through separate TMC's, it would be best to have one TMC. One TMC will permit greater efficiency because the operators would be able to work together in the same location. Personnel working together can make better coordinated decisions and better developed traffic control patterns for both the traffic signal and freeway traffic management systems. Further, one TMC provides a greater opportunity for Public Safety Agencies (PSA) personnel to have input to development of traffic control patterns and jointly analyze resulting outputs. The PSA personnel will also be readily available with the system operators during incident management emergencies,

<u>Facilities Needed to Share Data</u> - It is recommended that one TMC be provided for all agencies and that work stations be located in one traffic control room within the TMC. This would include one or more workstations for each Public Safety Agency (PSA) and for Capital Metro. The work station concept will enable personnel to discuss problems face to face and work together closely during major incidents and special events. These personnel can more easily solve problems caused by accidents and recurring congestion. In order for the TMC and traffic control room to operate efficiently, it is recommended that the design be carried out by a committee represented by all agencies to be housed in the TMC.

It is also recommended that the two Traffic Management Systems be integrated to the extent discussed previously in Approach 3 as shown in Figure II - 15. If this is not possible at first, Scenario 2 should be implemented as shown in Figure II - 14 with provisions made to implement Scenario 3 at a later date.

The TMC should also provide hardware and software which will:

- Display the freeway and street a network traffic conditions on a regional map. Different colors (e.g. red, yellow, green) could be used to represent different levels of operation along each arterial. In addition, CCTV monitors should be provided in conjunction with wall map.
- Display traffic conditions as described above together with MOS and CCTV monitors at each work station.

The computers will need to communicate with each other through a standard communications protocol.

In addition to use of CMS, LCS and CCTV, consideration should also be given to incorporating entrance ramp control (i.e. ramp meter control and ramp closure control) as part of the initial system along IH 35 and Mopac/Loop 1 (and possibly US 183 and Ben White Blvd. (US290) when average main lane speeds fall below 45 mph).

The Freeway Traffic Management Computer must be flexible enough to incorporate the HOV system when it is implemented and capable of expansion to incorporate additional FTM and ITS components and application of future real time algorithms. It is anticipated that the FTM System will operate for a minimum of 15 years provided that the computer(s) and field equipment will be replaceable and/or upward compatible with future hardware and software, and provided satisfactory maintenance is carried out.

Equipment Needed to Share Data - The computer hardware previously discussed is required for the FTM system The design will require one or more local control tits (LCU's) at each frontage road/cross street "diamond" interchange. The LCU(s) will collect freeway and street system loop detector information and periodically send consolidated information (e.g. each 30 seconds) to the SCU. The LCU also provides control for the LCS and for entrance ramp control where provided. The LCU(s) could also operate the CMS and CCTV camera controls when software is developed to do so. A 2070 controller could function as a LCU.

Communications to and from the CMS and CCTV control is brought to the frontage road/cross street interchange where it is sent to the SCU. The LCU and associated field equipment is housed in a field cabinet located at the interchange.

The SCU gathers information from the LCUs and in turn, transmits traffic control information to the CMS, LCS, CCTV and entrance ramp control. The one SCU, which is located within a building along a freeway, is designed to provide data acquisition and traffic control for one or more freeways (e.g. US183 and Mopac). Using the traffic data received from the LCUs, the SCU makes initial calculations for traffic control for the freeway(s) it controls and implements needed traffic control patterns as well as recommending messages and displays for the CMS and LCS. The SCU is a stand-alone unit; however, a Laptop computer can be used to provide manual control.

The SCU, in turn, transmits the traffic data received from the LCU and its traffic control actions to the Central Computer at the TMC.

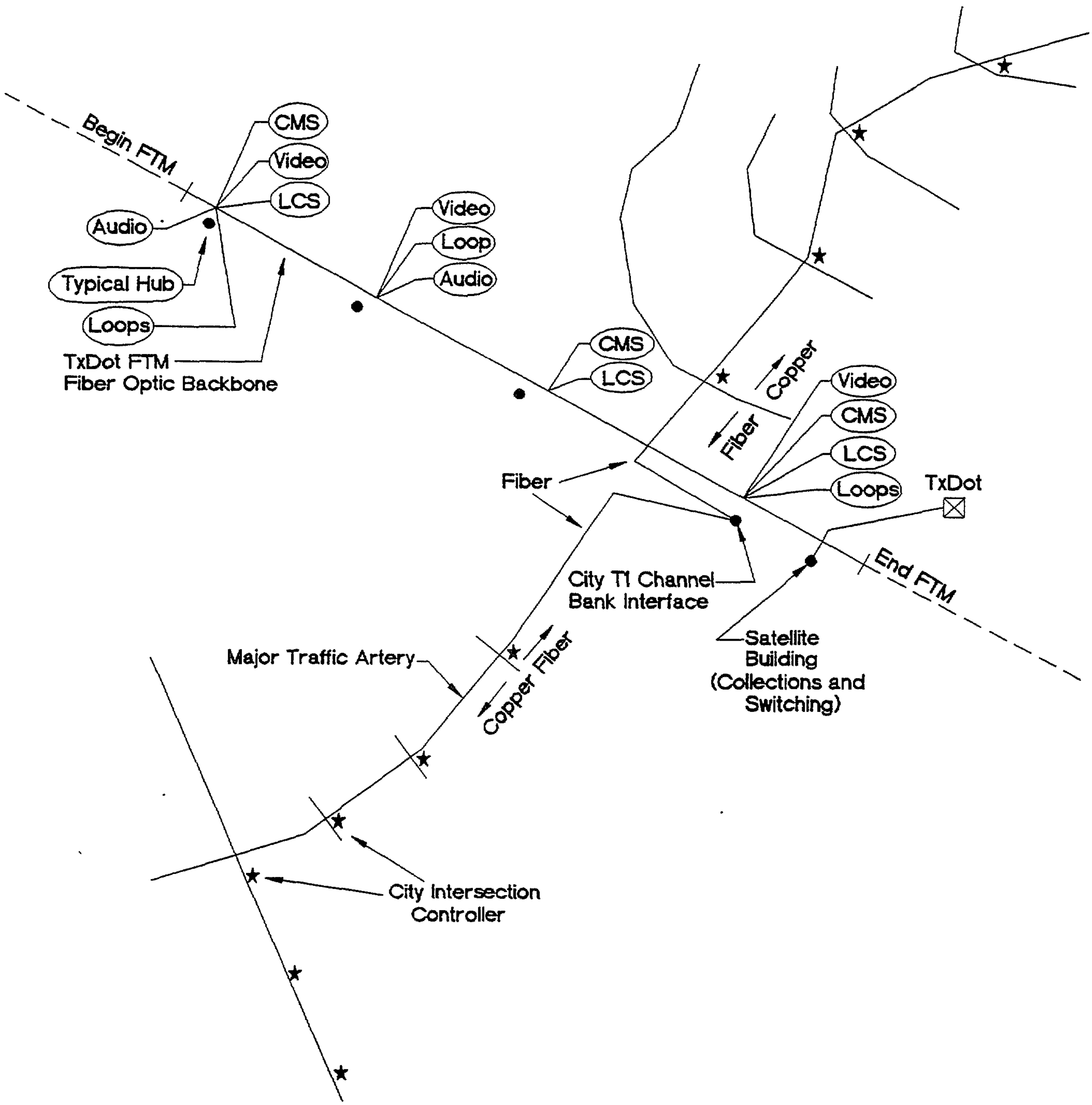
Recommended Communications- The type of shared data needed for an Integrated Traffic Management System involves Multi-Agency use in Voice communications, Video communications for verification and Digital Data for computer resources.

The recommended communications system predicates an Information system that will lend itself to provide voice, video and digital data throughout different parts of the City of Austin and the surrounding community, including the Traffic management Center with equipment and a network configuration that will provide:

- Standardization
- Commonality
- Maintainability
- Portability

The recommended system is two-fold and consists of the TxDOT Freeway Traffic Management system fiber optic communications backbone system and the Greater Austin Area Telecommunications Network (GAATN), using a fiber optics backbone system.

1. TxDOT FTM System Communications The on-going FTM system fiber optics communications backbone system can be used as temporary or permanent communications system along the major corridors in Austin. **Figure II - 16** illustrates how TxDOT is integrating their FTM system with Video Camera for verification, LCS, CMS, Traffic speed and occupancy and other functions such as HOV along the major corridors. By implementing a fiber optic backbone system with a standard T1 carrier system or a DS3 system, all data, voice and video can be transported because most all of the carrier manufacturers can interface into this protocol standard. A proper deployment plan coupled with a phased implementation plan to allow communications to the TMC via Austin's major corridors, effective use of the backbone by many agencies can be realized. This type of effective shared or collective agency cooperation is now being implemented in the East Coast, Central Florida I-4 and in Houston, Texas.



WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Typical FTM System Communications Interface Austin Area-Wide ITS Austin, Texas	Figure II-16

This backbone system in a shared environment can carry over 800 city intersection controls, County functions, as well as PSA functions including audio, digital data and video over a 48 fiber cable plant system, leaving 36 fibers to TxDOT functions. As discussed, a proper deployment plan, identifying the endequipment interfaces for the different agencies will result in decreased bandwidth allocation for the shared functions of the backbone system thus allowing for spare bandwidth allocation for the present and future.

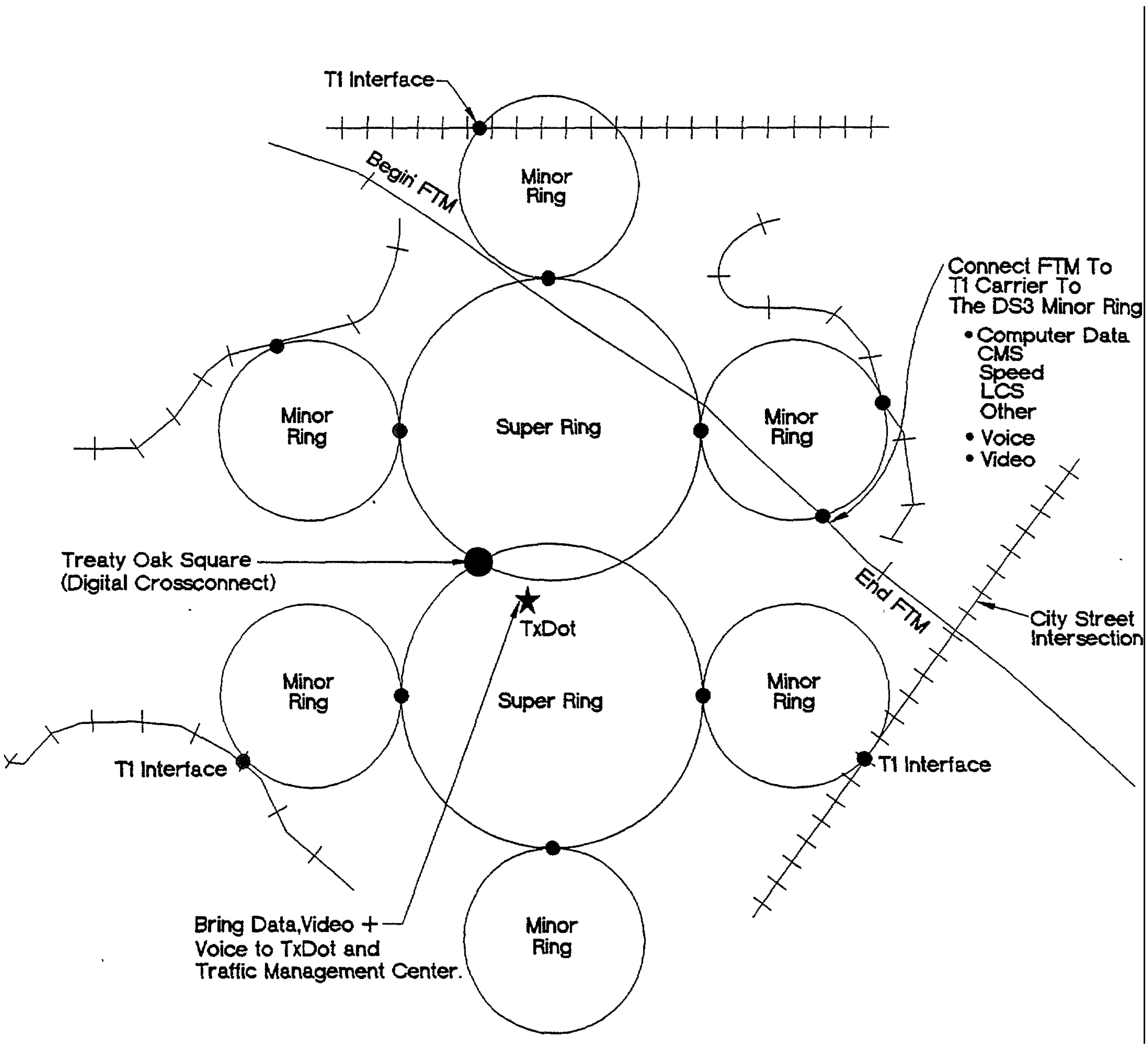
2. GAATN Communications System. The GAATN, an existing system communications infrastructure, offers a wide geographical area potential for providing communications for TxDOT functions along the major corridors of Austin Other agencies have been striving for this type of city wide communications, the systems have been late in deployment, and are costly to implement, due to local area geography. The GAATN system is available for use at this time and appears to be in its infancy. Proper care in bandwidth allocation deployment will be needed in carrying out the design of the communications system. For instance, at what points will the GAYI'N system be bridged with the FTM system communications?

   Due to the freeway project phasing, some of the planned FTM fiber optic backbone systems will be in different parts of the City of Austin, with no communications tie ins with the TxDOT traffic management center (during construction). GA4TN lends itself to tie in these projects by integrating the Satellite Building communications electronics into the minor rings of the GAATN network system.

   This approach can be effective in that the upgrades of the major corridors for FTM systems can be widely segmented throughout the county with little impact on communications and controls. The primary impacts will be the interface cost to the minor ring and should not exceed $90,000 per connection to the ring, including video. This amount is included in the cost estimate shown later in Table II - 10.

   Figure II - 17 illustrates how an FTM corridor can bring in voice, video and computer data from a remote part of town to the TxDOT facility or a traffic management center. The FTM system will bring voice video and data to a hub on the minor ring of GAATN. This minor ring will transfer the information at the Treaty Oak Square digital cross connect switch allowing any minor ring or super ring information, including voice, digital data and video, to be shared by any agency on the rings and by TxDOT.

3. Possible Alternative System. Although the confirmation of the use of State owned fiberoptic cable and the GAATN is recommended, consideration should be given to a private communication system as previously discussed.



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GAATN Telecommunications System

Austin Area-Wide ITS

Austin, Texas

Figure II-17

Maintenance Summary - Maintenance of the City and State traffic management system computers could be carried out through a maintenance contract. Since computer maintenance costs will increase with time, the cost of the contract should be low at first and increase over the remaining life of the system. The maintenance contract should require that the contractor provide replacement parts along with normal maintenance. The maintenance contract should also call for preventative maintenance inspection. Routine maintenance of the field equipment should be carried out on a scheduled basis, along with periodic visual inspection of the CCTV, CMS and LCS equipment and daily review of system computer logs for intermittent failures. Visual inspection could be carried out by the Courtesy Patrol drivers and by the District personnel traveling to and from work sites as well as by system maintenance personnel.

A minimum of two sets of demonstration equipment should be purchased as part of the system to demonstrate and visually check the appropriate operation of two CMS and LCS stations. This would permit the operators to implement strategies and visually analyze the results before implementing a message/lane control concept in the field. Demonstration equipment parts could be used as replacements to faulty equipment and replaced by the maintenance personnel.

Routine maintenance can be handled initially by one trained maintenance crew that also maintains TxDOT traffic signals. Eventually, however, till time personnel will be required. Once full time personnel are required, consideration should be given to entering into a maintenance contract with a qualified contractor. The response time for replacement of faulty parts will need to be included in the agreement.

The use of maintenance contracts will require qualified inspectionby the District to assure that the maintenance work is carried out properly in accordance with the specification(s) and agreement(s). The person inspecting maintenance work could also work with the Project Engineer and Chief Inspector on inspecting FTM components (e.g. fiber optics, loop detectors) installed as part of construction projects.

If agency personnel maintain the system, qualified personnel will be required with scheduled training provided to assure that the maintenance personnel will be able to make needed repairs. The personnel wiI1 need an increased budget for repairs and diagnostic/maintenance/installation equipment.

Personnel Required to Share Data and Carry Out System Engineering, Operations and Maintenance - An essential part of traffic management involves the personnel needed to operate and maintain the system There is a need to have a staff sufficient in size to carry out the required work.

It is proposed that the Traffic Management Center (TMC) be operated as a minimum from 6:00 a.m. until 7:00 p.m. Monday through Friday. It is also recommended that the TMC operate on Saturdays and Sundays when special events are scheduled (e.g. football games, AquaFest) and when emergencies occur. The City of Austin police dispatch personnel presently have access to the two CMS. It is recommended that the procedure be continued for all CMS, LCS, and HAR units on a 24-hour, seven-day basis.

A survey was conducted of three existing Freeway Management Systems by TxDOT[4] during 1988. The systems and 1988 freeway center line miles were:

- Detroit, MI 32+ miles
- Minneapolis, MN 37 miles (scheduled to be increased to 74 miles)
- Seattle, WA 78 miles

These three systems had characteristics and system components similar to the Houston and Ft. Worth freeway systems being planned at that time and the Austin freeway system at present. The Detroit, Minneapolis and Seattle systems operated approximately 13 hours each day from Monday through Friday and had CMS, ramp meter control and CCTV. In addition, the Minneapolis system provides traveler information by radio.

Based on the results of the survey, the initial full time Freeway Traffic Management engineering operations and maintenance staffing along with that required by 2002 and by 2007 are given in **Table II-8**. The recommended allocation of full time personnel are based on 13 to 16 hours of operation for the TMC and overtime work when necessary on Saturdays and Sundays. Engineering and maintenance personnel are shown in Table II - 8. Vehicles will also be required and these are given in **Table II - 9.**

Additional personnel from other agencies will also be needed in the TMC for their agency operations together with one additional person who will provide overall management of the TMC as discussed previously.

Cost Summary - As shown in Table II-10, funding for the Freeway Traffic Management (FTM) System portion of the overall ITS plan includes the cost of the TMC, the FTM system, the HOV system and maintenance over a 12 year period. The estimate assumes that half of 25 miles of HOV lanes wiI1 begin operation over a seven year period (2000-2007) and that the TMC will be in operation during 2000.

The estimated 1995 cost for installation is an average cost based on information obtained on the Houston and San Antonio FTM system costs and Austin District cost estimates for conduit and detectors. The resulting cost estimate was %1,000,000 per mile. This included:

Conduit and Detectors =	$ 260,000 per mile
Field Equipment (SCU, CMS, LCS, Ramp Meter Control) =	$ 740,000 per mile
Total =	$1,000,000 per mile

Allowing for conduit and loop detectors being installed as part of some roadway construction projects, an average cost of $900,000 per mile was calculated for use in the estimate (The $900,000 per mile provides for ramp metering at two entrance ramps [$30,000 per ramp]). Since HOV control

Table II - 8

Full Time Personnel Needs for Estimated Center Line Miles
Freeway Traffic Management
(Based on 13-16 Hrs. Operation at TMC)
Austin Area-Wide ITS
Austin, Texas

Center Line Miles of Freeway	10 Miles	35 Miles	65 Miles
Estimated Date	1997	By Year 2002	By Year 2007
Management/Traffic Management			
Supervising Engineer	1	1	1
Assistant Engineer	0	2	2
Secretary or Administration Tech.	1	1	1.
	2	4	4
TMC Operations			
Supervisor	*	1	1
Traffic Control Specialist (Two Shifts)	2	3	4
Software Programmer**	0	1	1
Communication Specialist**	0	1	1
Secretary or Administration Tech.	0	0	1.
	2	6	8
Maintenance* **			
Supervisor	1	1	1
Field Maintenance Technicians	1	4	5
Shop Technicians	1	1	1
Administration Technicians	0	0	1
	3	6	8
Total No. of Personnel	**7**	**16**	**20**

* Function carried out by supervising engineer
** Traffic Operations Division may be able to take care of this work.
*** Function could be carried out by contractor but at least one inspector would still be needed to assure that the work is done properly,

Table II - 9

Vehicles Needed for Engineering, Operations and Maintenance
Austin Area-Wide ITS
Austin, Texas

Year	1997	By 2002	By 2007
Engineering/TMC Operations			
Automobiles	1	2	2
Maintenance			
Field Vehicles (Equipment Vans	1	2	2
Automobiles or Vans	1	1	2
"Cherry Pickers"	1	1	1.
Total	4	6	7

Table II – 10

Life Cycle Costs*
65 Miles of FTM and 25 Miles of HOV by 2007
1996-2007
Austin Area-Wide ITS
Austin, Texas

Construction

Freeway Traffic Management	65 Miles x $900 k/mi	=	$58,500 K
HOV	25 Miles x $200 k/mi	=	$5,000 K
TMC	Building, Hardware, Software**	=	$4,000 K .
Subtotal			$67,500 K

Maintenance and Operation

FTM (9%/yr) =	$58,500 K x .09 x 12 yrs / 2	=	$31,590 K
HOV (9%/yr) =	$5,000 K x .09 x 7 yrs / 2	=	$1,575 K
TMC=	$4,000 K x .09 x 7 yrs	=	2,520 K
Subtotal			$35,685 K
Total			$103,185 K
Cost/Year	$104,427 K/12 yrs	=	$8,599,000/yr
		≈	$8,600,000/yr

* Life cycle costs should be based on a 15 year period. The information available as shown in Figure II - 12 is only for a 12-year period. Costs do not include those for the City Traffic Signal System.

** Does not include additional $300,000 for approach 3 of the integration computer hardware and software discussed previously.

and surveillance will be required for the HOV lane, a separate estimated cost of $200,000 per mile was allocated (this does not include HOV roadway construction costs). This amount is based on a discussion with the Austin Central Office personnel.

It is estimated that a building of approximately 25,000 s.f. is needed to house the agencies. The estimated cost of $4,000,000 for the TMC is based on the cost for the Fort Worth District cost which includes:

Building = $2.5 million
Hardware/Software/Integration = $1.5 million

This includes offices for personnel and the hardware/software costs for integration of the traffic signal and freeway systems. The cost of the TMC will be worthwhile since it brings all engineering and operations personne1 together in one location.

From a review of the information obtained from the 1988 TxDOT survey mentioned previously and a survey conducted in 1991 on freeway operations projects in North America,(5) it was found that operations and maintenance costs vary between 7.5 and 11 percent. A value of 9% was selected for this project.

As is shown in Table II - 10, the life cycle cost for the FTM and HOV systems and the TMC will average $8,700,000 per year for installation operation and maintenance (including the TMC costs). This amount includes personnel and vehicle costs.

Funding Summary - It appears at present that funding for the TMC and system implementation will need to be provided from District construction and maintenance/operation funds from State and Federal sources. If Austin becomes a non-attainment area, CMAQ funds may be available as has been the case for the TMC at the Fort Worth District office.

Recommended Implementation/Phasing Summary

Implementation/Phasing Summary - The District's implementation plan shown in Figure II - 12 is based on the installation of 65 miles of FTM. In addition, 25 miles of HOV by 2007 has also been included. It is estimated that the design life of the FTM system will be 15 years. The design life is based on the system components being upward compatible so that minimal changes to the software will be required during the life of the system. The TMC building should be designed for expansion so that its effective design life will be 30 years or more. The implementation plan will be possible to achieve if the system is properly designed at this time to include ITS function and equipment expected to be installed over the next 15 years.

Recommended Phasing Time Schedule - It is anticipated that the new city traffic signal system will begin to be installed by 1998 with completion of the 600+ traffic signal system by 2005. Based on this estimate, it is recommended that a building suitable to house all agencies be completed by 2000 so as to house the entire city/state/public transportation control center at that time. It is also recommended that TMC operators have work stations within the same control room. As previously stated, it is recommended that work stations be provided for each agency in the traffic control room.

It is recommended that the Freeway Traffic Management system be installed within six years. Dividing the installation of systems into relatively short segments as shown in Figure II - 12 will increase the cost per mile of installation. Reducing the installation time from 12 years to five to six years will reduce total cost of construction, permit the implementation of traffic management along an entire section of freeway, and provide information on alternate routes along US 183 West, MOPAC South, and Loop East and/or US 183 South or US 290 East, and SH71 West in lieu of IH 35 during an incident. Reducing construction time to five or six years will also permit more refined integration with the city traffic signal system and the city Public Safety Agencies for incident management on a city wide basis. For these reasons, it is recommended that the planned schedule of deployment shown in Figure II - 12 be escalated to be completed in five to six years. It is also recommended that additional funds be provided for the design of the Freeway Management to assume that the system will be completed within six years.

Regarding the implementation plan, it is recommended that consideration be given for overhead fiber optic cable to be placed as an interim installation along IH-35 as soon as possible with temporary overhead microwave detectors mounted on bridge structures and guide sign structures, CCTV cameras mounted on existing poles, and ramp meter control for use until construction for widening the freeway is carried out. If properly located, most of the equipment could be used during and after widening of the freeway.

References

(1) Traffic Engineering Handbook, 1992, Chapter 12, pp 368 and 369, Institute of Transportation Engineers, Washington, DC.

(2) Marsden, Blair, "Ramp Meters and Travel Quality in Austin, Texas", April 1981, Texas Department of Transportation, Austin Texas.

(3) Traffic Engineering Handbook, 1992, p 362.

(4) "Operations and Maintenance Needs for Freeway Control and Surveillance", October 1988, Traffic Operations Division, Texas Department of Transportation.

(5) "Freeway Operations Projects in North America - Inventory Update", compiled March 1991, Transportation Research Board, Washington DC.

PUBLIC TRANSPORTATION MANAGEMENT WORK ORDER SCOPE OF WORK

Task - Identify metropolitan areas with desirable AVL/radio characteristics

Task Description and Milestone

It is desirable for an area wide AVL/radio system to have the following characteristics:

- Architecture common to all local agencies
- Equipment compatible among multiple vendors
- Share a common database with traffic control and incident management

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

The work generally consists of compiling summaries of the facilities, equipment, maintenance, personnel, funding, and implementation of a system exhibiting the above characteristic deployed in other metropolitan areas. Two metropolitan areas should be considered.

Facilities include structures or enclosures necessary to house and operate equipment and personnel and its cost. Equipment includes hardware, software, and communications items and their cost. Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing. Documentation of a phased implementation strategy should be included.

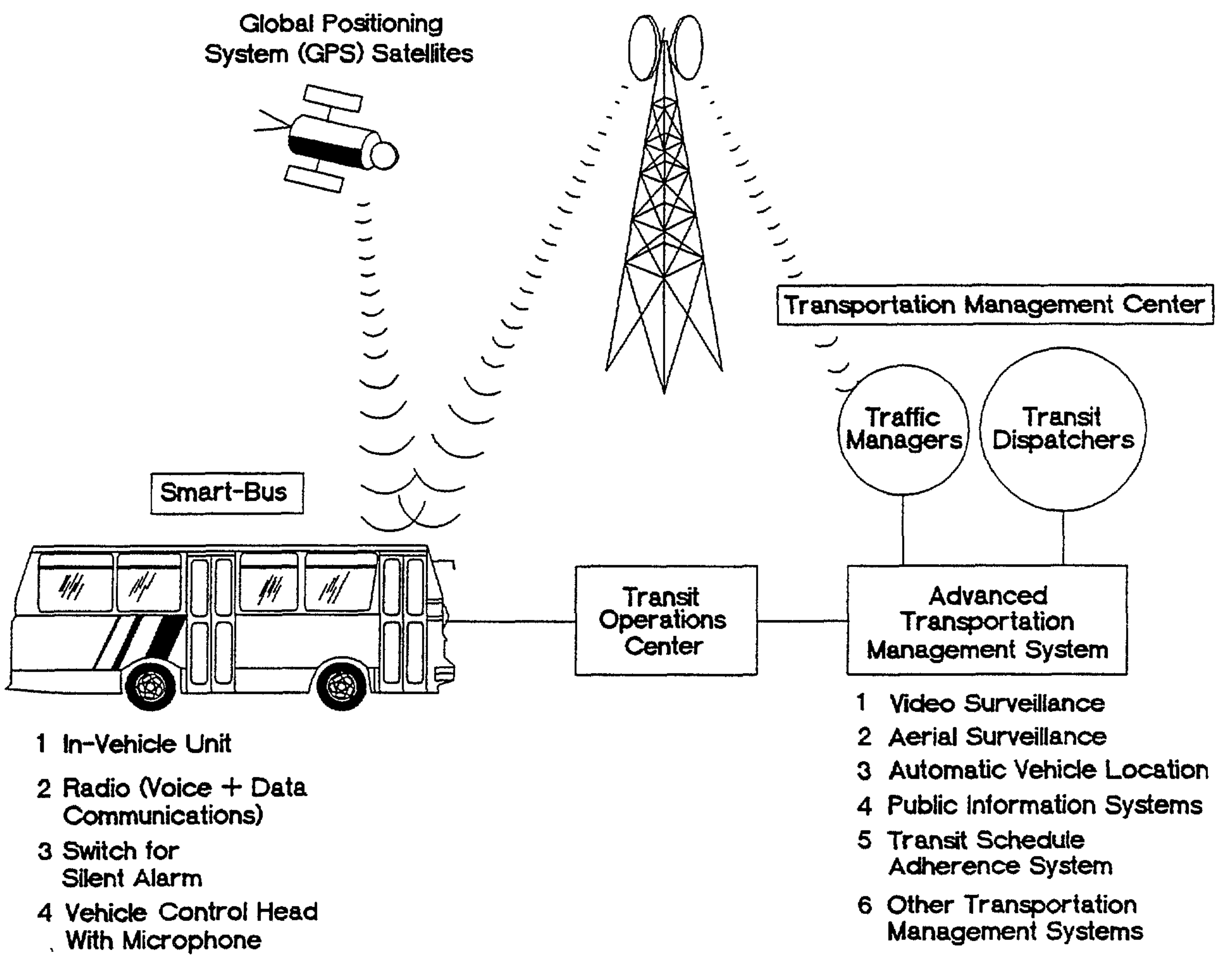
Public Transportation Management

Intelligent transportation systems (ITS) are findingincreased applications in public and private agencies especially in the management of large vehicle fleets (i.e., mass transit, emergency vehicles, and transportation fleets). Public and private agencies are incorporating computer-aided dispatch (CAD) systems and satellite based automatic vehicle location (AVL) systems as an integral part of their transportation management strategies. Several transportation management systems using AVL systems were surveyed to develop a basic understanding of the technologies presently used in intelligent transportation systems.

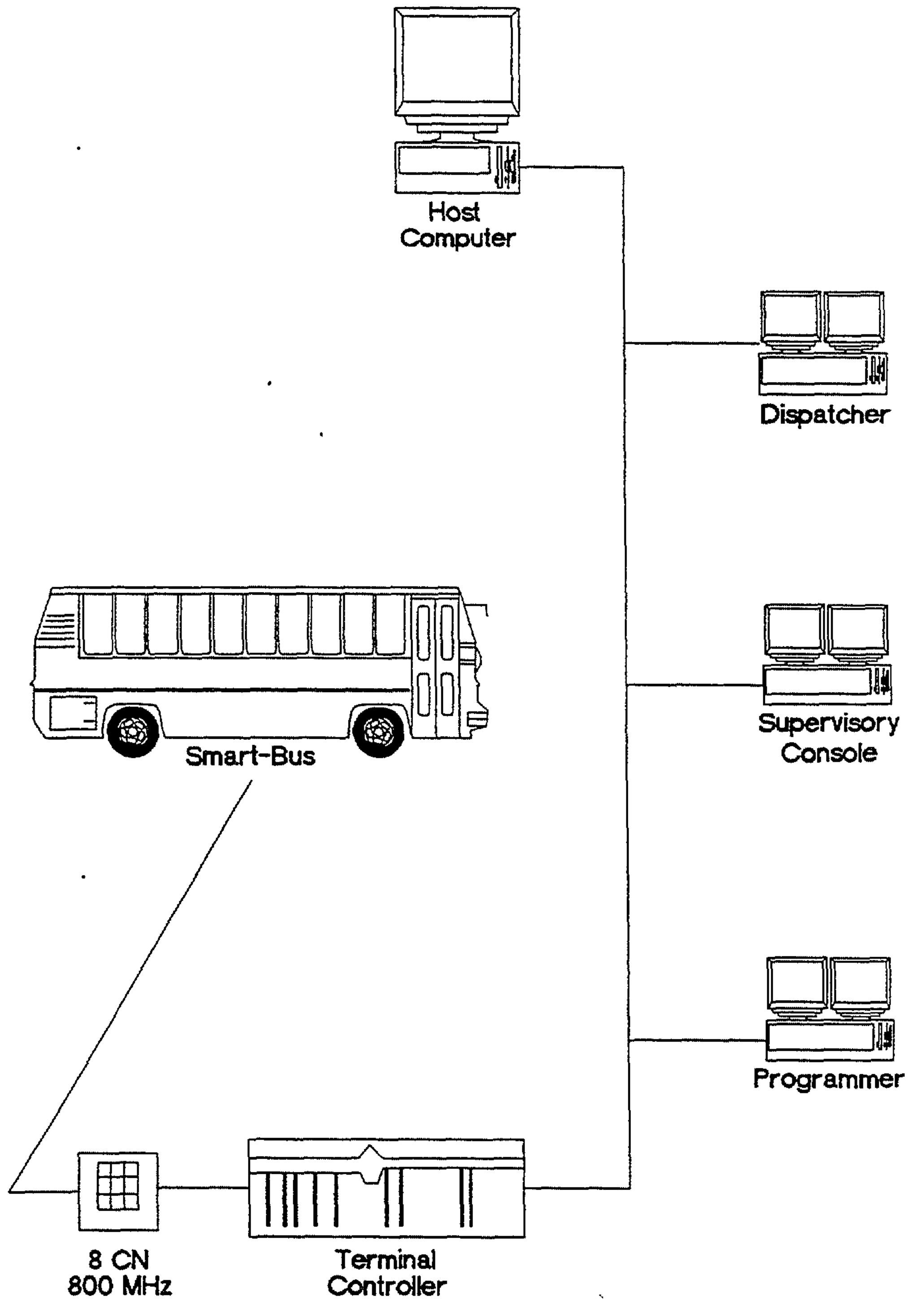
Automatic Vehicle Location System

An AVL system is composed of several sub-systems having specific tasks. In general, an AVL system is formed by a control center, Global Positioning System (GPS), in-vehicle tracking unit, and communications link system. Figure II - 18 shows the components of an intelligent transportation system using AVL. The GPS was developed by the U.S. Department of Defense for the purpose of providing worldwide navigation data. It consists of 21 satellites that transmit navigation data at all times at no cost to the user. The in-vehicle tracking unit gathers the navigation data provided by GPS and sends it through a communication link to the control center. The in-vehicle tracking unit also transmits vehicle identification and other vehicle status data. The communication link is a system of two-way radio (UHF or VHF) and/or cellular transmission that transmits data from the in-vehicle tracking unit to the Control Center. The Control Center is the brain of the AVL system; in that it processes and analyses the data for the purpose of providing a more reliable and efficient transit system. The Control Center is formed by several components which may vary according to the needs of the specific traffic management system The principal components are the main computer, mapping controller, and a database bank that form the computer aided dispatch (CAD). **Figure II - 19** shows the components that form the control center for an AVL/CAD system.

An AVL/CAD system can improve transit service reliability, increase the safety of both passengers and drivers, and reduce operation expenses by providing the following features:



WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Intelligent Transportation System Using AVL Austin Area-Wide ITS Austin, Texas	Figure II-18



WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Automatic Vehicle Locator System Austin Area-Wide ITS Austin, Texas	Figure II-19

- Real-time bus location;
- Difference between scheduled and actual location;
- Location of bus bunching;
- Bus demand information;
- Bus information on current assignment and vehicle status;
- Tracking of off-route busses;
- Recording of incidents, locations, and other data used for management reports and analysis;
- Improving response for emergency and routine situations;
- Improving communication between bus drivers and the control center,
- Providing an alarm system for security of operators and passengers;
- Providing information for planning, scheduling, and information management;
- Providing location of bus stops, time point and land marks; and,
- Providing address matching and temporary detours.

Agency Survey

Five transit agencies located in different geographic regions of the country responded to a survey during August and September, 1995 to gather information regarding current activities in AVL. The principal agencies and/or systems which provided information are:

- Maryland Department of Transportation Mass Transit System in Baltimore, Maryland;
- Minnesota Guidestar Program Travlink Minneapolis-St. Paul, Minnesota;
- Denver Rapid Transit District, Denver, Colorado;
- Milwaukee County Transit System, Milwaukee, Wisconsin, and,
- Los Angeles Metropolitan Transportation Authority Freeway Service Patrol, Los Angeles, California.

The following other systems were contacted but did not fully respond to the survey: Des Moines METRO Transit System; Orleans Levee District; Scranton’s County of Lackawanna Transit System; Oklahoma City’s KFOR-TV Fleetservice; New York ITS Real-Time Customer Information System; Detroit’s Suburban Mobility Authority for Regional Transportation AVL System; and, Dallas Area Rapid Transit System.

Data obtained from the agency survey of existing AVL systems is summarized in **Table II - 11**. The data identifies that a GPS-based AVL system has been implemented in all five transit/service systems, while data transmission to the control center was conducted using a radio signal varying between 450 and 900~MHZ. The number of dispatch locations varies from one to seven and the number of vehicles equipped with radios, GPS systems, or both vary from 150 to more than 1,000 vehicles.

Milwaukee County Transit System (MCTS)

After the initial survey was complete a more in depth discussion was held with the Milwaukee County Transit System. The Milwaukee County Transit System most closely resembles the City of Austin and Capital Metro of the cities served. The Milwaukee County Transit System in Milwaukee, Wisconsin recently implemented an AVL/radio system with characteristics similar to those desired by Capital Metro and the City of Austin. The MCTS includes an 800 MHz trunked radio system that provides a common voice communications system that willbe shared with many other county entities.

Facilities Summary - The MCTS includes 582 buses, 68 non-revenue vehicles, the communications system, and control center. The AVL system has been installed on approximately 525 vehicles to date. The control center includes an 800 MHz trunked radio system at one site (with a planned expansion to a four-site simulcast system with AVL data capability at two sites), four dispatch workstations, and daily download of schedule data to support route and schedule adherence processing.

Equipment Summary - The radio communications system consists of a trunked 800 MHz radio system which is comprised of 8 channels and 1 repeater site. Eventual expansion of the 800 MHz system will result in a total of 15 channels and 4 repeater sites, of which 2 will be AVL data capable. The system also includes the CFE Microwave System. Four workstations for AVL are provided in the operations center, with an additional workstation for radio only communications. AVL equipment is also installed on all buses and non-revenue vehicles.

Table II-11

Existing AVL Systems Austin Area-Wide ITS
Austin, Texas

	MARYLAND MTA	MILWAUKEE CTS	DENVER RTD	MINNESOTA TRAVLINK	LOS ANGELES MTA - ESP
System Type	CAD/AVL	CAD/AVL	CAD/AVL	CAD/AVL (ATIS)	CAD/AVL
Equipment:					
Buses with radios	305+	643	1167		
Buses with GPS	200+	582	899	80	
Light Rail Veh. w/ GPS	70		22		
OEM Buses	45		244		
Other vehicles	28	61	80		
ATIS Kiosks				3	
Bus stop monitors				2	
CMS at Transit Station				4	
Tow truck with radios					153
Dispatch Locations	4	4	7	1	3
Radio System	490 MHz 4 voice channels 5 frequencies 3 antenna sites 1 database station per site 4 microwave radios 3 microwave hops	800 MHz 8 channels 1 repeater site CFE microwave system	450 MHz 22 base stations 7 voice channels 2 data channels 3 antenna sites 5 microwave hops	450 MHz 1 data channel 1 database station	900 MHz 14 base stations 5 voice channels 2 data channels
Service Area	Baltimore City and surrounding Cities	Milwaukee County	6 counties	Hennedin County	Los Angeles County

Maintenance Summary - Maintenance of the AVL system is currently the responsibility of Westinghouse, because the system has not been officially accepted by the MCTS. Maintenance operations are handled by one Westinghouse maintenance employee and an associate who is occasionally needed to help makes repairs to the system. The one year maintenance contract between Westinghouse and MCTS cost approximately $300,000.

Personnel Summary - The MCTS AVL system is controlled by a small team of dispatchers who operate the workstations in the control center, in addition to the numerous bus drivers required to drive the buses. During heavy time periods, two to three dispatchers are required to operate the system, with an additional employee supervising the operation. All four workstations in the operations center are not operated at one time.

Funding Summary - Funding for the MCTS AVL system totaled approximately $8.3 million dollars. This included approximately $5.2 million for an 800 MHz trunked radio network (including all hardware) and ***$2.6*** million for the AVL system for a total of $7.8 million. In addition to the $7.8 million., approximately $300,000 was allocated for maintenance and $200,000 for change orders for a grand total of approximately $8.3 million.

The 800 MHz trunked radio network includes the infrastructure to operate up to 15 channels, with 6 channels reserved for the transit system. The cost also includes the installation of radios and other hardware for 600+ buses and other vehicles operated by the MCTS. The remaining 9 channels will be available for use by other agencies, such as the police department, fire department, and emergency medical services, with those agencies finding their own radios and other hardware. Each radio/hardware system for each vehicle cost approximately $1,800.

The implementation costs for the AVL system totaled approximately $2.6 million and included equipment and installation for approximately 600 vehicles. The AVL equipment was estimated at approximately $3,500 per bus. The software system designed for both the AVL and 800 MHz systems cost approximately $1.6 million, but it is unknown how much of this cost was attributed to each system. The software cost is included in the total cost of $7.88 million.

Implementation/Phasing Summary - The system was initially implemented beginning in 1992 with Phase 1 including a test of all hardware and prototype software on 15 buses. Phase 1 was completed in June 1994. By the spring of 1995, installation was complete on approximately 602 total vehicles, including both buses and other non-revenue vehicles. The control center and workstations began operations in January 1995 under the direction of the contractor. The contractor must complete an extensive testing and evaluation phase before the MCTS will accept the system and provide payment for services. Final acceptance testing is anticipated in February, 1996 at which time the MCTS will assume responsibility for the entire system.

Cost Estimate for AVL Systems

There are four components used to determine the cost of implementing an AVL system. These components are as follows:

- Number of buses and support vehicles using AVL, and radio systems;
- Type of radio system, number of channels and capabilities of data processing;
- Number of dispatch locations required and number of remote dispatch locations; and,
- Type of software implemented in the scheduling of buses.

The cost of the control center is rather small on a per bus system for a transit system as large as Capital Metro (375 buses). The central office cost portion of the system is generally covered by the installation of a new radio system. If a new system is added to an existing system that has the capabilities of accommodating an AVL system, the central office portion is only several hundred thousand dollars. A general guideline used by the systems surveyed in determining the cost of installing an AVL system is an estimate of $10,000 per bus. The maintenance and operating costs were covered in the Cities' general dispatch systems. Systems have been installed using a combination of federal, state, and local funds. The Capital Metro is in the process of upgrading their radio system as part of their SMART BUS Program.

ROADWAY INCIDENT MANAGEMENT
SCOPE OF WORK

Task - Identify resources to share traffic control with emergency vehicle management

Task Description and Milestone

The work generally consists of recommending data that should be shared between traffic control and emergency management services. A centralized emergency computer-aided dispatch (CAD) system is housed at the Austin Police Department. There is no direct link to traffic control services, though one is desired.

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

Summaries of the facilities, equipment, maintenance, personnel, funding, and implementation needed to share the recommended data should be provided.

Facilities include structures or enclosures necessary to house and operate equipment and personnel and its cost. Equipment includes hardware, software, and communications items and their cost. Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs, Personnel includes persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing. Documentation of a phased implementation strategy should be included.

Roadway Incident Management

It is estimated that the population of Austin will increase from 510,637 in 1995 to 672,700 by 2005 which is a 32% increase. It is also estimated that the Austin Metropolitan area will increase from 657,136 people in 1995 to at least 876,289 people during 2005 which is a 33% increase. This anticipated increase in population will significantly add to the number of vehicles on city freeways and streets over the next 10 to 15 years as well as develop a demand for increased use of public transportation.(1)

In addition, the number of trucks are expected to increase -- especially along IH 35 as a result of the North American Free Trade Agreement (NAFTA) as discussed in The Commercial Fleet Management Section of this task. Unless steps are taken to improve traffic management along IH 35 and Loop I (MOPAC), an increased number of incidents with increasingly significant delays can be expected over time. This applies both to delays during peak periods caused by normal congestion recurring each week day and to delays caused by incidents. Because of this, measures must be taken to locate incidents and to overcome the effects of these incidents as quickly as possible.

"An incident is any non-recurrent event which causes reduction of roadway capacity or abnormal increase in demand.(2) Roadway incidents can include:

- accidents;
- vehicle breakdowns;
- roadwork activities;
- special events;
- inclement weather (snow, ice, flood); and,
- disruptive activities adjacent to the roadway.

Roadway incidents have been found to constitute an average delay of 55 to 60% on freeways.(5) This can be explained to a certain degree by noting the results of a study conducted along IH 45, Gulf Freeway, in Houston. As is shown in **Table II - 12**, reductions in capacity from 26% to 79% were found to occur on the three-lane freeway during an incident.(6) It is important to note that an accident or other incident on a shoulder can reduce the capacity of three lanes by 26%. Also, the blockage of one of three lanes reduces the capacity of three lanes by 48 to 50% whereas one lane normally carries

Table II – 12

Typical Capacity Reduction
Austin Area-Wide ITS
Austin, Texas

ROADWAY INCIDENT TYPE	CAPACITY REDUCTION (PERCENT)
Normal Flow (three lanes)	-----
Stall (one lane blocked)	48
Non-injury accident (one lane blocked)	50
Accident (two lanes blocked)	79
Accident on shoulder	26

33% of the traffic. The same phenomenon applies to the blockage of two lanes. The blockage of two of three lanes, which normally carry 67% of three lanes, reduces the total capacity by 79%.

In addition, roadway incident caused congestion can lead to secondary accidents. A study on one freeway in Minneapolis, Minnesota showed that 13% of all peak period accidents occurred as a result of a preceding roadway incident.(3) The effects of roadway incidents on pedestrians must also be considered. Studies have shown that 20 to 30 percent of pedestrian fatalities on freeways involved disabled vehicles.[(4)]

Roadway incident management is an important factor in reducing delay and, as a result, secondary accidents. A study in Los Angeles showed that for each minute of delay due to an incident, the delay to each motorist would be four to five minutes.[(5)] This finding is supported by a separate study on IH 45 (Gulf Freeway) in Houston. It was estimated in the IH 45 study that a one-lane blockage on the Gulf Freeway lasting 18 minutes would cause 800 vehicle-hours of delay. If roadway incident management cut this in half (9 minutes), only 200 vehicle hours of delay would result.[(6)]

The same hardware and software systems needed for Traffic Management identified in Chapter 3 and 4 are also needed for incident management. These include:

- Traffic responsive traffic signal system;
- Freeway Control (e.g., ramp meter control, CMS, LCS);

In addition, traveler information provided to motorists approaching the city and to commuters leaving their home and office apply to both traffic management and incident management.

The proposed Traffic Management Center (TMC) plays a vital part in both traffic management and incident management in that it provides for:

- Integrated Traffic Management between the City and the State traffic control systems;
- Close coordination of personnel within the agencies;
- Sharing of information between agencies;
- Coordination with multi-modal transportation (buses, trucks, HOV); and
- Rapid information dissemination to the news media.

The integrated City-State traffic management system and proposed TMC are only one part of roadway incident management. Roadway incident management involves much more and involves additional agencies. These are the police, 91 I, fire, emergency medical services, motorist aid patrols or courtesy patrols, sheriff, constables and volunteer fire (collectively known as Public Safety Agencies). Transit agencies are also involved.

Roadway Incident Management System Concepts

A Roadway Incident Management (RIM) system can be applied to all roadways. This system would include both the arterial and freeway network if desired. The following discussion is oriented towards the freeway system since TxDOT has already programmed the implementation a RIM system. However the same concepts could be applied to the Austin Area arterial street network. There are several elements of roadway incident management. All parts must fit and work together if:

- roadway incidents are to be detected and verified quickly;
- roadway incident management vehicles are to be dispatched without delay;
- vehicles involved in an incident are to be rapidly removed;
- motorists are to be advised of hazardous conditions and congestion (or slow speeds) ahead;
- traffic is to flow smoothly to and from a special event; and,
- traffic is advised of roadwork ahead.

The overall concept must be to improve communications, cooperation and coordination. This can be achieved through the addition of each of the following applications.

Preplanning - There is a need for agencies to work together in preplanning so as to assure that each agency will know what to do in the event of a specific incident. This is especially important for handling major incidents.

For accidents, each agency's responsibilities needs to be known. Also, it is important to know who is in charge. For example, in a hazardous spill and fire (or potential fire) situation, the fire department would appear to be in charge with the other agencies providing support as agreed upon in prior discussions. The poke would be in charge at major accidents involving several agencies and special events. PSA would be in charge where injuries are involved until those injured are cared for (e.g., removed from the scene). For roadwork, vehicle breakdowns, and inclement weather, the city or state traffic management personnel could be best suited (depending on conditions). An understanding needs to be developed as to which agency will be in charge. In unusual circumstances not covered by normal conditions, it would appear that the police would be in charge.

Preplanning for alternate routes, traffic signal changes, CMS/LCS messages, frontage road priority use, special event coordination, as examples, eliminate the chance of making an incorrect decision and/or confusion during an incident.

It would also be desirable to develop a Roadway Incident Management Team consisting of trained personnel from the different agencies. Personnel from each agency will not be required in each type of incident. When called upon to participate, each team member called upon to work as part of the team for a particular incident will need to know ahead of time his or her responsibilities and what steps need to be taken and who will do them. The team should have back-up members who can either substitute for or be called up when additional personnel are needed. The team members would be drawn from city/county/state personnel who have other till time jobs but can be made available as necessary. This approach is carried out effectively in California. The Roadway Incident Management Team should have vehicles equipped for incident management, which could include a command vehicle used in major incidents.

Preplanning could also be carried out through the existing Austin Traffic Management Team (TMT) concept with joint meetings at the proposed TMC. The TMT consists of second level supervisors from city, county, public transportation, state and federal offices including some or all of the following:

- Manager of the proposed TMC;
- Police lieutenants in charge of traffic;
- Public transportation operations coordinator;
- Fire department supervisor;
- EMS supervisor;
- Department of Public Safety lieutenant;
- County engineer; and,
- MPO representative.

The TMT members discuss traffic and transportation problems involving mobility and safety – usually at monthly meetings. The TMT would discuss roadway incident management problems and provide support to a Roadway Incident Management Team as part of a preplanning process. The TMT would also provide an approach for overcoming institutional issues which might occur regarding support for the Roadway Incident Management Team. Examples include:

- Smoothing the way for acceptance between all agencies where incidents might involve several organizations (e.g., more than one city or cityand county);

- Help in developing procedures which involve others not normally involved;
  - Contractors in construction areas;
  - Utility companies in construction areas;
  - Maintenance personnel not normally involved;

- Assist in obtaining necessary personnel and materials from agencies by being a "spokesperson"; and,

- Assuring that proper commercial wrecker services are provided.

The TMT could be the supporting arm of the Roadway Incident Management Team in providing the necessary assistance.

<u>Incident Detection/Reporting</u> - There are several modes of roadway incident detection typically used in urban areas throughout the country. These include:

- 911 and/or a separate number of reporting incidents;
- Electronic detection (detectors), vehicle transponders (toll tags);
- Motorist Aid Patrol (Courtesy Patrol);
- Other Public Vehicles (Maintenance, Police, Bus) through use of proposed 800
- Mhz frequency;
- Commercial traffic information services;
- Aerial surveillance;
- Call boxes;
- Fixed observers; and,
- CCTV.

These modes of detection, when brought together in one location such as a TMC, can each provide traffic information which can be effectively used to provide the operator of the proposed TMC with an effective picture of what the problem is and how the problem can be overcome.

Dispatching and Information Dissemination - When an accident or vehicle breakdown is detected, verified, and required action determined, the traffic management operator together with personnel from other agencies at the proposed TMC will call for the agency(ies) or the Roadway Incident Management Team to take care of the problem During the preplanning activity, coordinated activity can be determined (e.g., who will be needed to do what) under different levels of incident severity. For instance, where a vehicle is stopped on the shoulder or adjacent lane, the courtesy patrol called to provide for the vehicle needs. If necessary, the vehicle(s) will be removed from the freeway by the courtesy patrol vehicle or wrecker. If necessary, the courtesy patrol can ask for police assistance in convincing the motorist that the vehicle needs to be moved.

At this stage, as well as Levels I-V discussed below, it is essential to remove vehicles from the freeway main lanes and shoulder as quickly as possible. In fact, Chapter 4, Uniform Act, Section 39 of the Texas Traffic Laws, issued by the Texas Department of Public Safety requires that motorists involved in an accident must move their vehicles from the freeway if all vehicles involved in the accident can be driven. Also courtesy patrol assistance should be provided free of charge (e.g., gallon of gas, water in the radiator, tire inflator kit, radiator stick) sufficient to get a stalled vehicles off the freeway as quickly as possible. Courtesy patrol vehicles should be provided with bumpers designed to push vehicles from the main lanes of the freeway. If a vehicle cannot be started, it should be pushed from the freeway for the protection of the driver and his vehicle, the courtesy patrol vehicle and all motorists on the freeway. Removing vehicles eliminates “rubber necking” by motorists in opposing lanes of traffic.

In addition, vehicles should be towed or pushed to Accident Investigation Sites (AIS), where available, or to a location out of the main lanes. Moving vehicles so they cannot be seen by motorists on the freeway main lanes is essential in eliminating“rubber necking” by freeway motorists. Accident investigation should be made at the AIS or at a location off the freeway and out of sight of freeway motorists. The use of AIS has been found to have a 28 to 1 benefit to cost ratio.

There are five levels of response which are required when the incident problem is beyond the stage noted above. These levels are determined during the preplanning activity and reviewed periodically to assure that everyone understands and agrees to the action required. The following is based on the incident management procedures developed for the IH 287 New York State Freeway in Rockland County, New York. The complete procedure is provided in **Appendix II - B**.[2]

1. **<u>Level I</u>** - When a roadway incident occurs that has serious implications, initial preparation should be taken to handle a more serious event if it occurs.

   - Police/fire/wrecker(s) are dispatched;
   - The commercial radio stations are advised;
   - CMS, LCS and HAR are placed in service;
   - Preplanned alternate routes are inspected and the best route chosen for possible use. Each alternate route has permanent fold out signs; and,
   - Detours may be required (e.g., use of shoulder and/or frontage road).

2. **<u>Level II</u>** - Traffic is light and expected to be cleared before heavy traffic demand occurs.

   - Level I action is taken;
   - The Primary Alternate Route is to be used for local traffic. This may be the frontage road. Traffic signal timing patterns are changed along the route;
   - Commuters are advised to carpool or take transit by radio and television;
   - The Alternate Route signs are opened; and,
   - Agencies prepare to provide added personnel.

3. **<u>Level XII</u>** - Congestion has occurred and it is timely for motorists to take the Alternate Route.

   - Levels I and II actions must be taken;
   - Motorists are advised to use the Alternate Route; and,

- Personnel Tom agencies assign personnel to emergency points to prevent grid lock along the Alternate Route.

4. **Level IV** - At this level, congestion is affecting congestion on the surrounding roadway network. Motorists should take the extra time to divert.

    - Levels, I, XI, and III actions must be taken and,

    - Motorists are advised by radio which entrance ramps are closed and possible alternate routes to be taken.

5. **Level V** - At this level, the roadway will be closed for a long period of time -- for as long as one or more days.

    - Levels I-IV are implemented,
    - Special signing is installed for long term diversion; and,
    - Work with the Emergency Management Center.

An approach for alternate plan development is given in **Appendix II - C**.[2] For Type III-V accidents, a command post should be established at the scene of the accident. The command post provides a location for all involved in management of the incidentto report to initially and throughout the incident. Roadway incident management personnel finalize the preplanned incident management procedure at the command post. The command post is also the communication center for reaching the TMC control center and field personnel.

The command post can be a designated car or truck, a tent, or a specifically designated command vehicle (van or mobile home type vehicle). Specially designed command vehicles are used for major sites in California.

Roadwork - Generally, construction and maintenance roadwork can be scheduled in time to let agencies know. The maintenance work can be coordinated between the maintenance foreman and the manager at the proposed TMC. Affected agencies can be advised and appropriate action scheduled as needed.

Construction work should be reviewed by the design/project engineer and TMT members and the design/project engineer. Since roadway construction affects the surrounding areas for a long period of time, all agencies should know ahead of time about the sequence of work and how it will affect them The manager of the TMC will coordinate operations with the project engineer and other agencies during construction and as detours are made.

Special Events - Special events are scheduled ahead of time which gives the TMT and those scheduling the event time to develop plans for handling traffic, locating park and ride lots to encourage bus ridership and developing special bus routes to and from the event. The various agencies affected will be able to coordinate with the TMC manager prior to, during and after the event. It has been found that preplanning pays big dividends in traffic handling and utilization of buses at the special event.

Inclement Weather - Inclement weather comes in many forms. It may consist of rain or ice which could cause accidents requiring various levels (Levels I-IV) of roadway incident management depending on severity and length of time. Normally, people stay home if the weather persists for more than one day and night. However, preplanning is needed to determine action to be taken by each agency.

Review of Actions Taken - A review needs to be made of the actions taken during the incident once the incident is cleared. This action permits the agencies to know what went well - or bad – and what can be improved the next time. The conclusion should be entered into a log and the plan changed as necessary.

Existing Emergency Operations Center

The Travis County/City of Austin E911 Communications Center, referred to in this report as the Emergency Operations Center (EOC), located within the City of Austin Police station houses personnel from:

- Police Department;
- 911;
- Fire Department; and,
- Emergency Medical Services (EMS).

The personnel are located together on one floor and have communications with each other by telephone and voice. The organization works well because of the personnel's desire to work together and the support provided by the city administration.

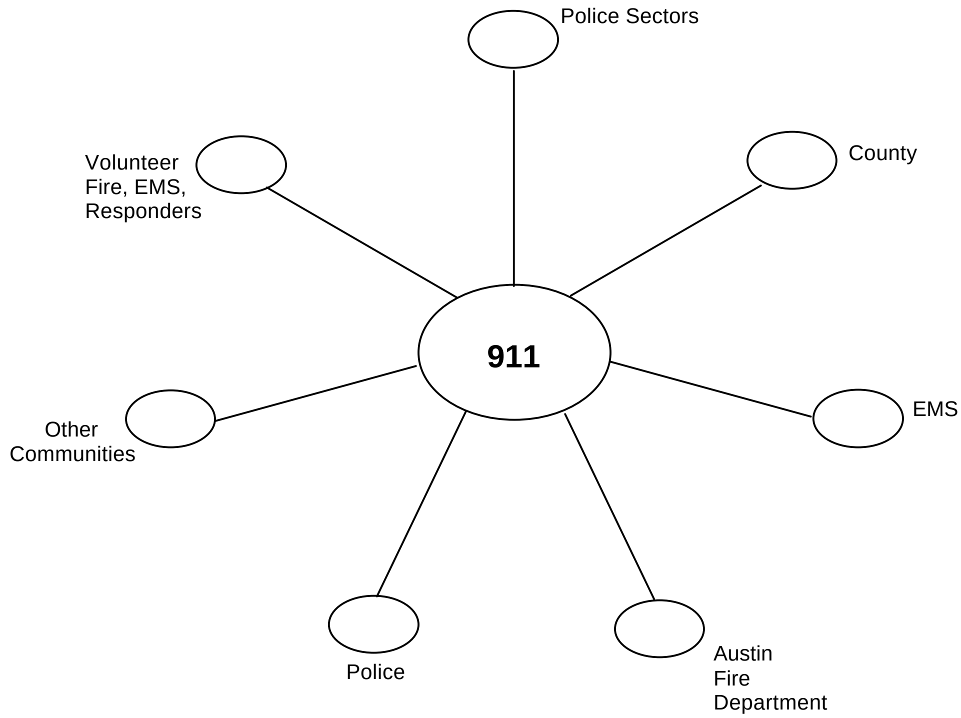
Basically, 911 is the main communications used for the Emergency Operations Center. As is shown in **Figure II - 20**, calls are received and distributed by the 911 operators. The Computer Aided Dispatch (CAD) system is also used as a communications mediumby 911 operators as well as by the other public safety agencies. Public safety agencies have recently begun rerouting non-emergency 911 calls to a non-emergency 911 center. Police, Fire and Emergency Medical Services (EMS) share a common CAD system. The police utilize a computer aided dispatch system in managing calls. The Police Department handles enforcement and accident cabs received by 911 operators, All injury reports go to the police and then are routed to EMS. The Police Department works with TxDOT in the operation of the Changeable Message Signs (CMS) and Lane Control Signals (LCS). This function will increase as more CMS and LCS are installed within the city.

The Fire Department and EMS handle calls involving their services. The Fire Departmentoften sends one of its units to a 91 I call first and the EMS unit takes over when its unit reaches the scene. The Fire Department also uses an additional personal computer based radio dispatch system to alarm fire stations. A flow chart of the management of calls is given in**Figure II - 21,** and **Appendix II -D.** The CAD system includes a software package that gives the length of travel time for each link which can be of help in routing vehicles. Travel times are determined by driving the links.

System Expansion - Several studies are underway for the development of an updated emergency services system which will provide improved service response and the development of an improved communication system. The studies include an analysis of the:

- 911 System and Operations;
- Computer Aided Dispatch (CAD);
- Geographic Information System (GIS);
- 800 Mhz Radio Trunking System;
- Mobile Data Terminals (MDT); and,
- Global Positioning System (GPS).

These studies are being carried out in three phases:



(Public Safety Agencies)

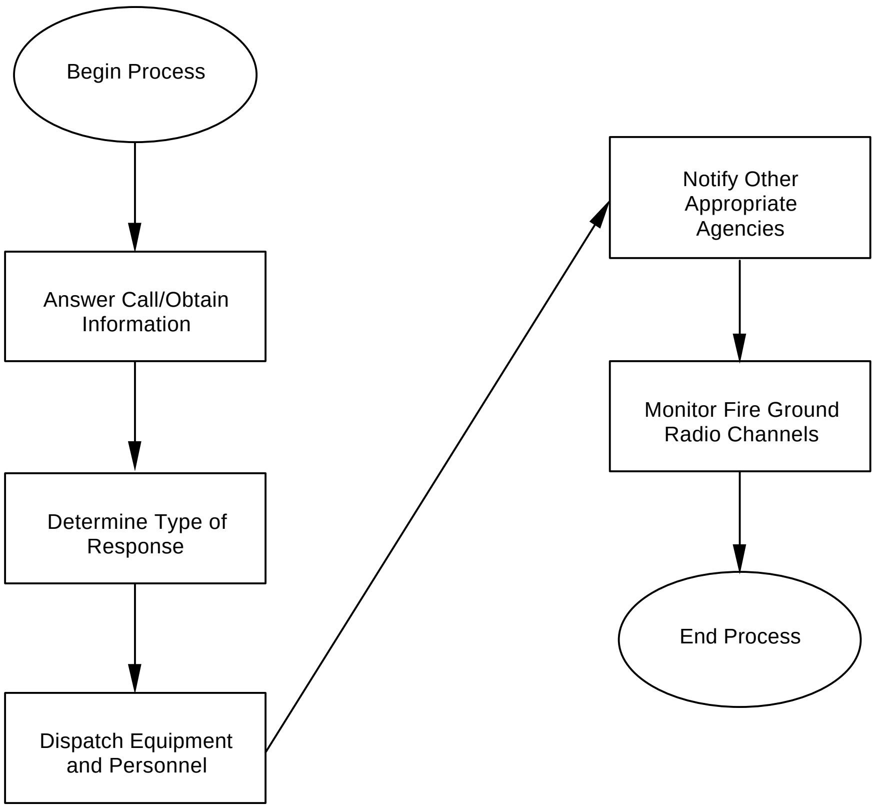
Source: City of Austin, 1995.

WILBUR SMITH ASSOCIATES
CONSULTING ENGINEERS AND PLANNERS
HOUSTON, TEXAS

NORTH AMERICAN CONTROLS CORPORATION
ADVANCED TRAFFIC ENGINEERING
KESSMAN & ASSOCIATES

Existing 911 Operations
Emergency Operations Center
Austin Area-Wide ITS
Austin, Texas

Figure II-20



Source: City of Austin Fire Department, 1995.

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Austin Fire Department Dispatch Process

Austin Area-Wide ITS

Austin, Texas

Figure II-21

- Phase 1 - Needs Assessment, Conceptual Design and Cost Estimates;
- Phase 2 - Licensing, Specifications, Evaluation and Funding; and,
- Phase 3 - Contract Award and Implementation.

It is planned for the system to have improved land line and radio communications, and to have a GIS system which will provide more accurate information. Cost estimates and conceptual design information for the proposed system expansion are undetermined at this time.

One of the studies involves finding a more desirable location for the EOC or Emergency Safety Center (ESC) and building. The building will be approximately twice the size of the present center. It would be desirable for the Center to be located:

- Away from a major public building;
- Away from a freeway;
- Where there are two access routes;
- At a site where high water due to floods is not a factor; and,
- In a secure site with restricted access to visitors.

Sharing Traffic Control Data

A primary objective of the Public Safety Agencies is to operate more efficiently and achieve a more rapid response in providing their services. The agencies also mentioned a desire to develop a joint TMC but they also have the need to meet the location requirements mentioned above. They agree that a joint center will permit a closer coordination with state and other city transportation agencies in traffic handling and reaching the scene of an accident or other emergency. All agencies involved have expressed a strong desire to work together in sharing information and data.

There is also a need to maintain close contact with the proposed Emergency Safety Center (ESC) or Emergency Operation Center (EOC). The proposed (ESC) is being designed to bring agency administrators together in case of a disaster. This could include a Type V accident discussed previously. The proposed TMC will also need to maintain close contact with the proposed ESC. It would be desirable to coordinate information to the proposed ESC from a TMC.

Information of Benefit to the Public Safety Agency - The integrated city/state Advanced Traffic Management System (ATMS) should be designed to make available all traffic data and CCTV to the PSA personnel. This would include EMS work stations located at the TMC traffic control room. Information which the Emergency Management System personnel do not initially consider useful may be found to be useful in the future. Also, since the ATMS will be flexible and modular in design it should be possible to modify software so as to provide desired information which would be of benefit to the PSA personnel at a later date.

Selected information which could be of benefit to each PSA agency is given in **Table II - 13.** This information can be used as desired. Other information given in Table II - 5, shown previously, can also be made available.

Information of Benefit to the Proposed Traffic Management Center - It would be of considerable value to know traffic conditions and problems being experienced by the PSA personnel. The information needed is given in **Table II - 14**. The information received will be of benefit in carrying out traffic management during incidents as well as during normal periods of congestion.

The sharing of information and coordination between agencies will be of significant benefit. In addition, person-to-person contact and knowing who to contact in case of an emergency will be of primary importance in managing an incident.

Locating one or more police officers in the TMC control room will permit the police to have direct police contact with the officer at the scene of an incident. The officer at the TMC can monitor the CCTV at the same time as the traffic management personnel and agree on action that needs to be taken. The officer at the TMC can then recommend actions to the officer in the field. The same approach could apply for the management of traffic around fires through direct communications between the fire, police and traffic management personnel in the TMC control room.

Table II – 13

Traffic Information Provided to Public Safety Agencies by the City and State Traffic Management Agencies

Austin Area-Wide ITS
Austin, Texas

Information
Incidents located by TMC
Wall Map Display of Level of Service in Color or Arterials (red for Congestion, Yellow for Crowded Lane Conditions, Green for Free Flow). Also available on PC monitor for Operator use in conjunction with GIS System.
Incident Location Shown on PC and/or Wall Map
Travel Time Along Links on Major Arterials
Status of Queue Lengths Due to Incidents
Estimated Delay Caused by Incident Along or Adjacent to Freeway, Major Streets and Major County Roads
Location of Courtesy Patrol Vehicles
CMS and HAR Messages and LCS Displays*
Location of Water Across Highways and Streets and Icy Road Conditions
Maintenance and Construction Activities Underway on Freeways, Major Streets and County Roads
CCTV Pictures as Requested
Additional Information Can be Provided Upon Request
Request for Support by City, State or Capital Metro
*Utilized as need by each agency

Table II- 14

Information Provided to the Traffic Management and Capital Metro from the Public Safety Agencies
Austin Area-Wide ITS
Austin Texas

Information
Location of Emergencies Reported to 911 Which Could Affect Traffic Conditions (Accidents, Fires, Public Disturbances)
Reports on Locations with Congestion Which Need Traffic Improvements and High Accident Experience Locations Which Need Enforcement
Location of Water Across the Street or Highway and Icy Road Conditions
Emergency Vehicles Dispatched which Affect Vehicle Preemption of the Traffic Management System
CMS and HAR Messages and LCS Displays in Effect*
Request for Support by TxDOT or City
* Recommend Coordination with TMC Before Implementing Messages and Displays

Recommended Roadway Incident Management Program

The recommended Roadway Incident Management Program for the Greater Austin area involves closer coordination between various service providers and an areawide operations center. The following paragraphs identify facilities, equipment and personnel needed for the program, as well as summaries of maintenance activities, funding, and implementation.

Facilities - Based on the above discussion, it is recommended that a closer coordination be obtained between the Traffic Management and Public Service Agencies. This can best be handled through a joint Austin Regional Operations Center (herein called the TMC). The proposed TMC would locate the Traffic Management Control Room and the Public Service Agencies Control Room contiguous to each other on the same floor. The police officer stationed in the Traffic Management Control Room during the peak periods could be available to work with the traffic management personnel as needed during peak periods while working 111 time in the Public Service Agencies Control Room during off peak periods. The Traffic Management Center Control Room will have work stations available for TxDOT, City and County traffic management personnel and for Public Service Agencies and Capital metro personnel. An "Operations Room" should be available next to the TMC Control Room for traffic management and emergency services personnel to develop strategies prior to and during incidents. Information would be available in a Work Station format for the personnel in the Operations Room to analyze and telephones available to personnel in each agency. In addition, communications, including video, should be provided for video conferences and data sharing between the Operations Room and the Emergency Operations Center. Radio communications should also be provided as a back up when land line communication is not available. The video conference communications should be provided through the GAATN system.

It is estimated that the joint Traffic Management and Emergency Management Control Area (Operations Control Area), including the Operations Room or Rooms, will be 16,000 sq. ft. Two Operations Rooms may be desired - one for Public Safety Agencies and one for Traffic Operations. This would provide 11,000 sq. ft. for the Public Safety Agencies and 5,000 sq. ft. for traffic management. The 16,000 sq. ft. would provide for up to 100 Public Safety personnel and 40 personnel from Traffic Management and Transportation Information related organizations (e.g., Capitol Metro, Texas Department of Public Safety, Courtesy Patrol) listed later in Table II - 21. It is recommended that the Operations Control Area be located so that it could be expanded in some manner in the future (e.g., locating offices adjacent to the Operations Control Area which could be removed to make way for expansion of the Operations Control Area, when needed).

Since the Emergency Management Services Control room will be in operation for 24 hours a day, consideration should be given to allowing pre-agreed upon traffic management strategies to be carried out by the Police Department.

Equipment Summary - The hardware previously recommended for the Traffic Signal System (TSS) and the Freeway Traffic Management System (FTMS) is also capable of supporting Incident Management/Verification/Response simultaneously with Traffic Signal and Freeway Traffic Management control. The hardware includes:

- TSS Local Intersection Controller/FTMS Local Control Unit:
  - 2070/ATC
  - 170/AIB
- Vehicle Detectors:
  - Inductive Loops
  - Video Image Processing
  - Microwave Detectors - Infrared Detectors
- Roadway Surveillance Equipment
  - CCTV
- TSS Central System/FTMS Computer Unit
  - Networked Pentium-type PC workstations with bi-directional links to Police/Fire/EMS CAD System

Additional hardware would need to be provided on the Police/Fire/EMS CAD System to allow for this bi-directional link.

Software that provides roadway incident detection capabilities and data sharing capabilities should be added to the software recommended in Chapters 3 and 4. Roadway Incident Detection

Software for the Local Controller should provide incident alarms to the TSS/FTMS Central/Computer Unit. These alarms are calculated by measuring parameters i.e. volume, speed, and occupancy at each vehicle detector location (upstream and downstream). A roadway incident is detected based upon any of these parameters exceeding threshold limits.

When an alarm occurs, CCTV could be used at the TSS/FTMS to verify the incident. A computer message would then be sent from TSS/FTMS to the Police/Fire/EMS CAD system once verification is complete. The software referenced previously in the City of Austin Traffic Signal System Section and in the TxDOT FTM Section (i.e. ramp metering, signal coordination, emergency vehicle pre-emption, changeable message signs with diversionary route information, routing alternatives, etc) would be initiated by the TSS/FTMS system.

Linkage Software for Bi-Directional Communications between the TSS, FTMS, and Police/Fire/EMS CAD System to allow messages to be sent between the TSS, FTMS and Police/Fire/EMS CAD System should also be implemented so that all agencies are notified of incidents. The TSS and FTMS should be notified of all incidents that might have an effect on task flow. The TSS and FTMS could be utilized to improve response to the incident and increase safety.

Maintenance Summary - Since the electronic equipment used within the total system is basically the same as that used in the FTM and Traffic Signal Systems, it is anticipated that the maintenance costs percentage will be about the same. This could amount to between five and seven percent per year of the cost of the equipment and software, depending on the complexity of the E911 Communications System and whether maintenance personne1 are available or if a maintenance contract is used. The maintenance cost noted does not include operations costs which are included in the operational costs of the Traffic Management Center.

Personnel Summary - The Emergency Safety Center staff expected to double (which should require at least twice as much space as is available at present) in the future. The staffing inthe TMC Control Room for the TSS and FTM system will also double from three personnel each for TSS and FTM (six total) to six personnel each for TSS and FTM (twelve total) over the next 10 year period. The remaining personnel shown in Table II - 21 should remain unchanged during this period.

Funding Summary - It is concluded that the additional funding for data sharing should be negligible and absorbed in the traffic management system costs previously discussed if the system is designed initially to accommodate the traffic and incident information requirements.

Implementation/Phasing Summary - It is important for the Traffic Management and Public Safety Agencies personnel to work together in incorporating data sharing needs into their systems at this time so as to assure that it will be available when the new systems are implemented. This will reduce overall costs and improve efficiency in operation.

The Integrated Emergency Safety Center/Traffic Management system should be designed so that they can be operated at separate locations if necessary until a permanent Austin Regional Operations Center is built. Communications can be carried out over GAATN, a fiber optic loop along the freeway system, radio and telephone. It would be desirable, however, to initially provide for all services in one Austin Regional Operations Center.

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2. Freeway Incident Management Handbook, July 1991, U.S. Department of Transportation, Federal Highway Administration, Washington, DC.
3. Lari, Adeel, et al, "IH 35 Incident Management and the Impact of Incidents on Freeway Operations", Minnesota Department of Transportation, January, 1982.
4. Ulmer, Robert, et al, " Analysis of the Dismounted Motorist and Road Worker, Model Pedestrian Regulations", DOT-HS-806-445, NHTS, August, 1982.
5. Traffic Engineering: Handbook, Fourth Edition, 1992, Chapter 12, Institute of Transportation Engineers, Washington, DC.
6. Dudek, Conrad L., Freeway Incidents and Special Events: Scope of the Problem, Circular 326, December 1987, Transportation Research Board, Washington, DC

EMERGENCY VEHICLE MANAGEMENT
SCOPE OF WORK

Task - Identify resources to monitor 800 Mhz radio network transmissions

Task Description and Milestone

The work generally consists of identifying methods to use an 800 Mhz radio network to detect and vehicle incidents.

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary 0 Personnel Summary 0 Funding Summary
- Implementation/Phasing Summary

Summaries of the facilities, equipment, maintenance, personnel, funding, and implementation needed to share the recommended data should be provided.

Facilities include structures or enclosures necessary to house and operate equipment and personnel and its cost. Equipment includes hardware, software, and communications items and their cost. Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing. Documentation of a phased implementation strategy should be included.

Emergency Vehicle Management

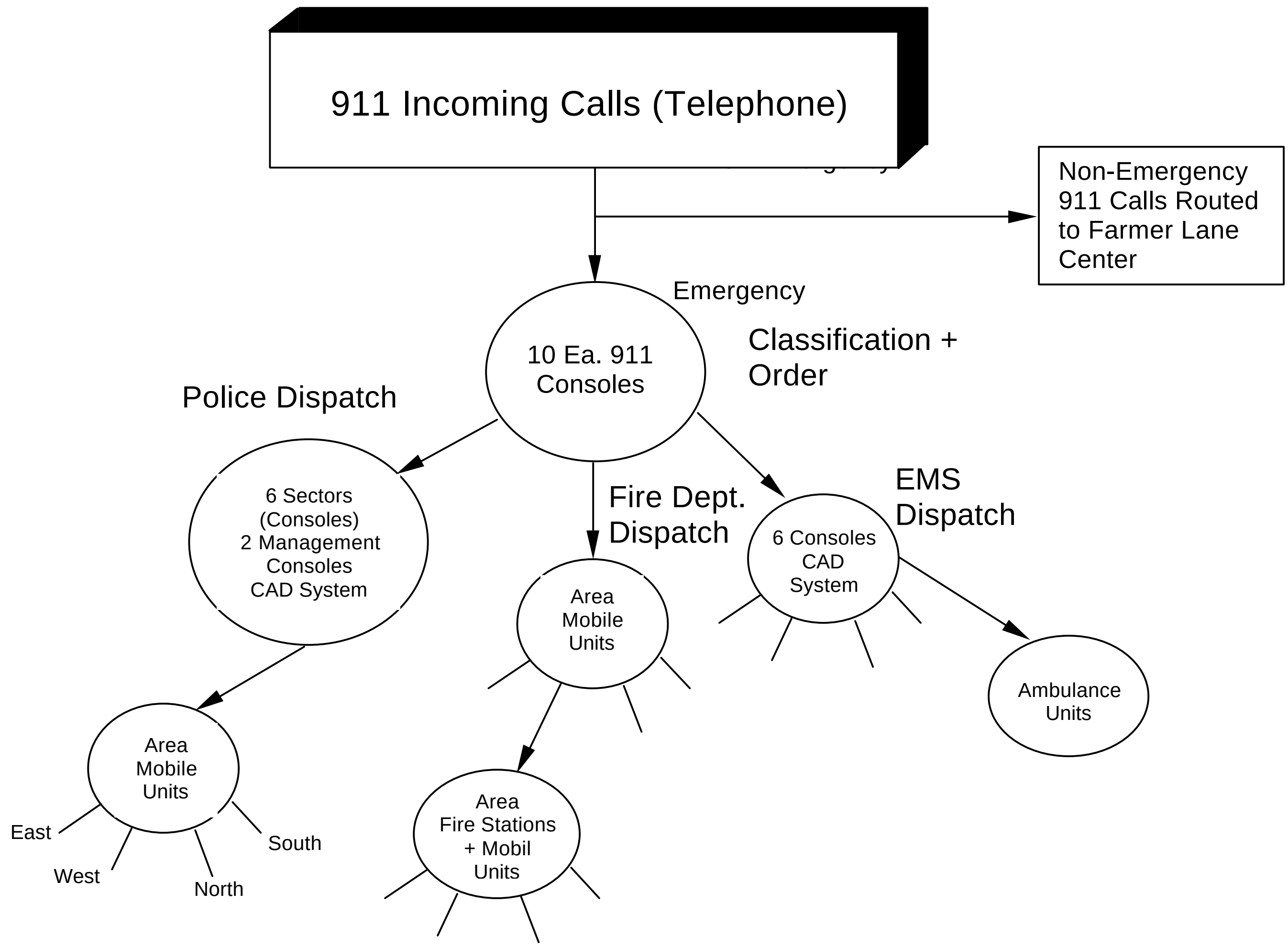
It is important for agencies to communicate with each other in carryingout traffic and incident management. This is especially true when several agencies exist within a regional area. Part of this communication includes the utilization of radio communications between the agencies. Rapid communication can be achieved when traffic and management emergency vehicles have access to the same radio frequency.

Emergency Vehicle Management Concepts

Radio communication has proven itself over the years through communications between maintenance vehicles and between emergency vehicles within the same agency and the communications of these vehicles with the agency base station. The radio is used to report incidents, advise on conditions in the field and to ask for additional support and/or material (e.g., traffic control signs, maintenance equipment, wreckers, sand). The utilization of a common frequency becomes important as a region becomes more urbanized and begins to involve several agencies.

It is the management of communications that predicates the successfu1 integration of multiagency operations to form a unified operational Emergency Vehicle Management System. The key factor is the coordination of Police Department, Fire Department, Ambulance, Hazardous Materials (HAZMAT) and other responsive agencies at the lowest level of mobile communications in order to respond, process and closeout the Emergency Incident (or a major disaster).

Figure II - 22, Present Public Safety Agency System Communication, illustrates how the present system communicates to the lowest level of the responsive unit. Incoming calls are being processed from the 9 11 all the way to the mobile response units. However, the Police Department, Fire Department and EMS Dispatch radio communications are on more than three different frequencies with no field intercommunication between mobile units. Some coordination exists between the Dispatch operators that operate common partitioned floor space area at the Austin Police Department. A figure illustrating an alarm dispatch of a multi-company response by the Austin Fire Department is included in **Appendix II - D.**



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Present Public Safety Agency System Communications Infrastructure
Austin Area-Wide ITS
Austin, Texas

Figure II-22

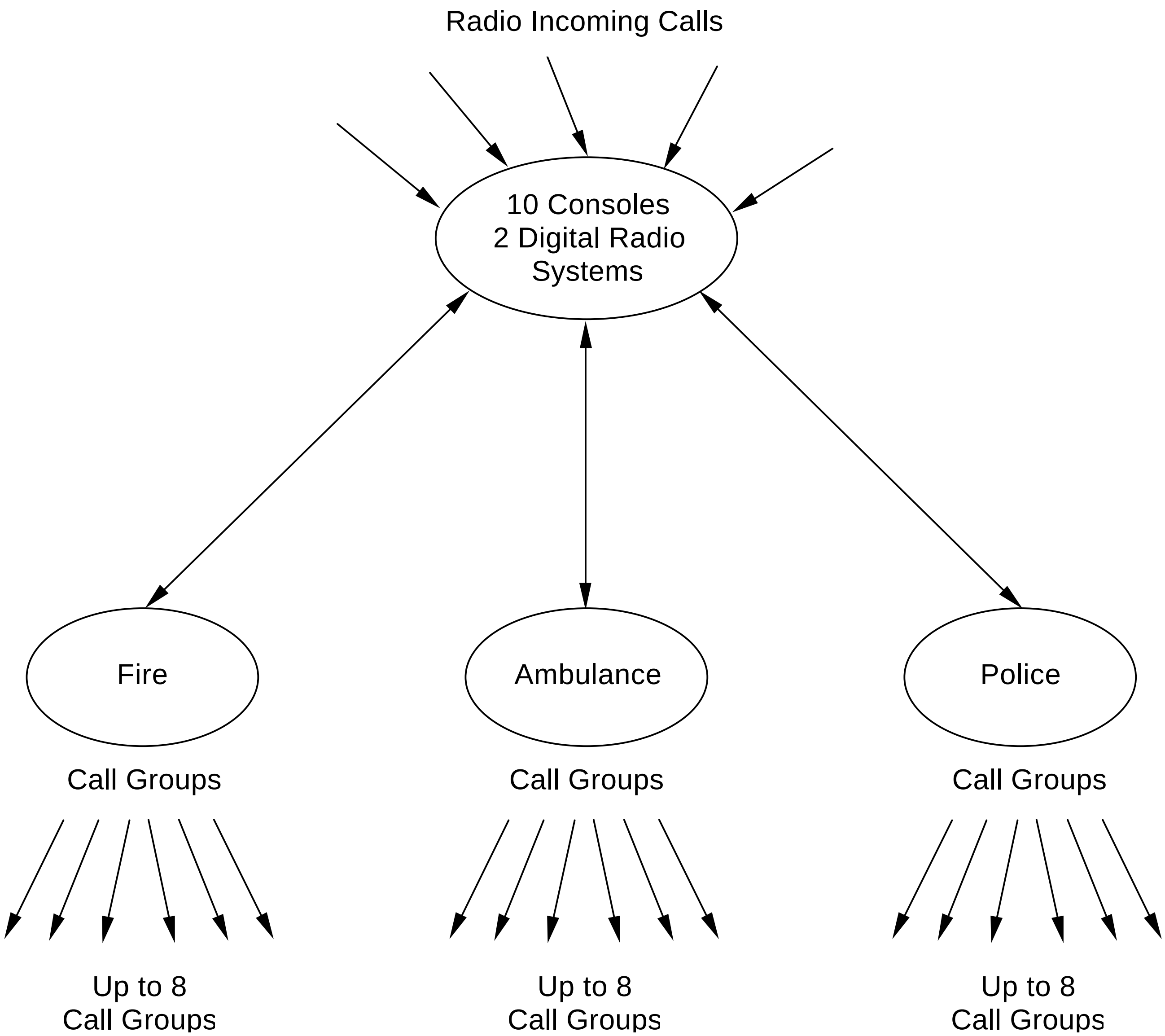
Marked improvements can be achieved in coordination and communications by utilizing an 800 MHz radio trunking system in order to let the responsive mobile units, with dispatch supervision, to communicate, coordinate, and closeout the incident at the lowest level. A conceptual diagram of the proposed 800 MHz communications system for the Austin area is shown in **Figure II - 23.**

Detecting and Verifying Incidents with 800 MHz Radio Network

Identifying, verifying, and managing incidents becomes complicated in an urban region where freeways and streets pass in and out of two or more jurisdictions. Some streets can only be reached by first traveling into another agency. When an accident is noted by a police officer or highway maintenance employee in an area outside his/her jurisdiction, it would be desirable at times to initially ask for assistance of a vehicle from another city and to quickly advise of an accident noted in an outlying area of another city. Similarly, if a vehicle from one jurisdiction is close at hand to an accident, it may be desirable for that vehicle to be the first on the scene, to verify the accident, advise on the severity, and provide initial support. A 800 MHz system will permit rapid reporting of an incident and rapid communicating between agencies in such instances. A conceptual plan for such a system is shown in **Figure II - 24.**

The 800 MHz system will also allow the agencies involved in incident management to communicate over the same frequency during incident management (e.g., accidents, inclement weather conditions, special events, vehicle breakdown debris on the highway). This will permit the rapid deployment of personnel and equipment. A 800 MHz system will also permit an agency to contact another in reporting debris on the street or highway and a traffic management equipment malfunction (CMS, traffic signal).

The lower tier call groups will be able to call in to their dispatch console the report of incident (detection), The dispatch will notify the manager console for consideration with other lower tier call groups, i.e., fire, police. The call groups frequency management as well as channel allocation is dynamic at all times for coordination efficiency.



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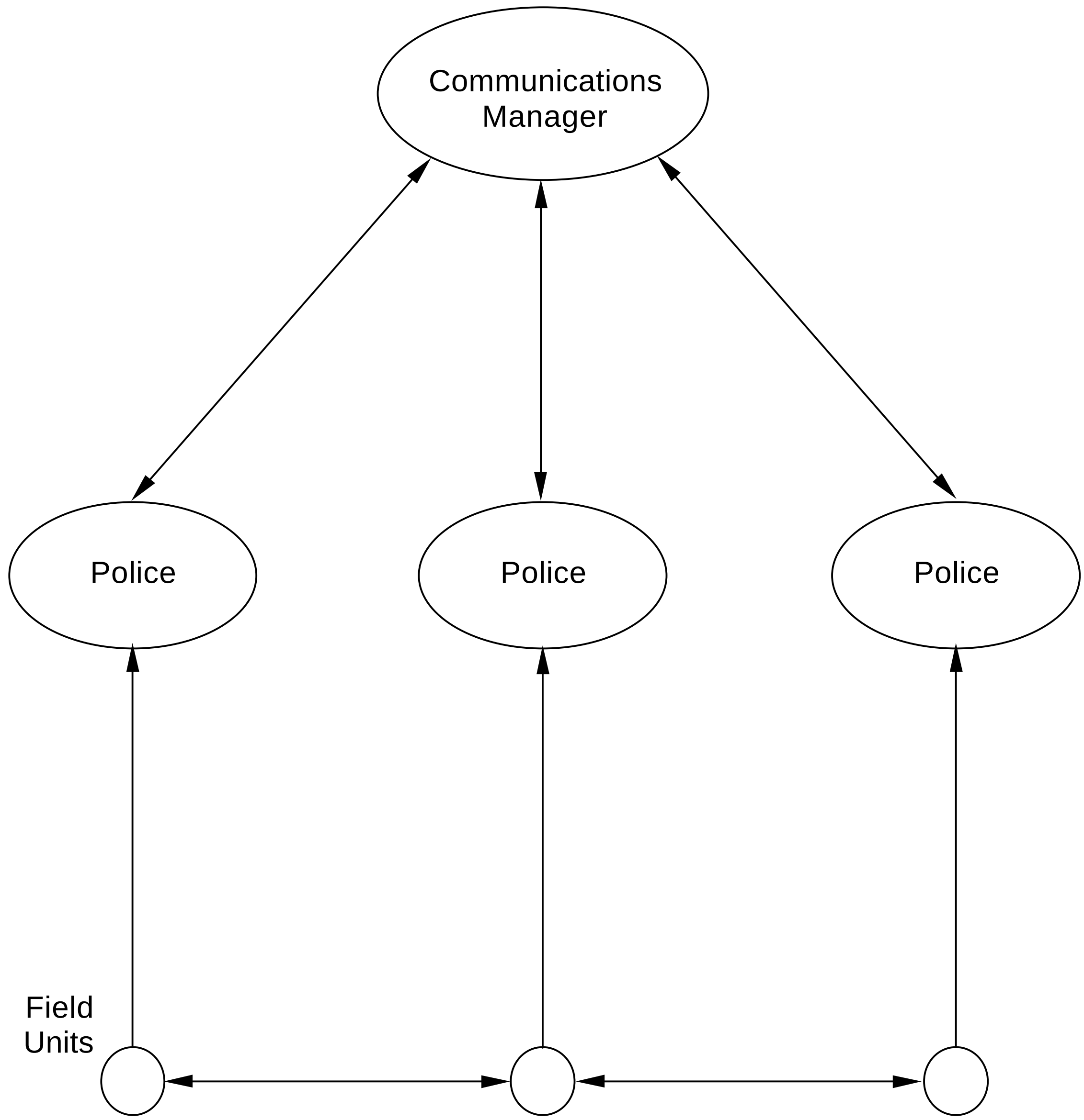
Conceptual Diagram of
800 MHz Communications System
Austin Area-Wide ITS
Austin, Texas

Figure
II-23



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Incident Detection/Verification System

Austin Area-Wide ITS

Austin, Texas

Figure II-24

In addition, the TMC can contact a vehicle in the field (e.g., courtesy patrol, maintenance vehicle and police vehicle) to confirm a reported incident and advise on the assistance needed. This will be of particular benefit where CCTV is not available. There are also times when an incident is first noted by a vehicle in the field (e.g., courtesy patrol, police) and the 800 MHz radio can be used in reporting the incident and requesting assistance in personnel and equipment.

Interagency radio communications as described above is not possible at present. The City of Austin Police Department operates on a 462 MHz frequency whereas adjacent cities (e.g., Georgetown, Round Rock and Williamson County) operate at an 800 MHz frequency. Public Safety Agencies in the Austin area utilize 450 - 470 MHz on UHF, while West Lake Hills and Rollingwood operate on VHF. Most agencies appear to have cellular phones and pagers which operate at a 900 MHz band, which is helpful as long as all vehicles have cellular phones or pagers. Since all vehicles have portable radios, it would be most desirable for each jurisdiction to operate on an 800 MHz frequency.

By utilizing a 800 MHz frequency, it will be possible for vehicles to communicate on one frequency. Portable radios could be used to communicate with officers and other personnel that are away from their vehicles.

The existing area 800 MHz trunking systems are being utilized by Williamson County, Georgetown and the City of San Antonio. In San Antonio, the agencies that are using the 800 MHz trunking system are listed as follows:

- Police Department
- Fire Department
- Water and Wastewater Departments

Since the intent of the 800 MHz trunking system is to facilitate the integration of the mobile units and interagency coordination between the Fire Department, Police Department, and EMS, it is clear that a seamless implementation can be achievedfor an Austin area wide communications as well as for the surrounding community.

Facilities Summary - The facilities and building size neededby the Public Safety Agencies to operate an 800 Mhz trunking system are currently being addressed in several other ongoing studies.

Preliminary indications are that the existing facility will need to be expanded to accommodate a new 800 MHz system.

Equipment Summary - The existing communications equipment of the 800 MHz trunking system currently being programmed by the City of Austin consists of the following list:

- Police Department Dispatch:
  - 3 Radio systems (including VHF, UHF, and 800 MHz) for 8 Dispatchers and 8 data interfaces;
  - Voice Switcher;
  - 3 Prime Repeaters;
  - 20 Secondary Repeaters for Metroplex wide coverage (for Mobile Data Terminal (MDT) use only);
  - 300 Mobile units with data interface (6 Sector x 50 units/sector); and,
  - 300 Portable radio (talkies).

- Fire Department:
  - 2 Dispatch Radio Systems for 5 Dispatchers and 5 data interfaces;
  - 2 Prime Repeaters use the Police Departments secondary repeaters for metroplex wide coverage;
  - 125 Mobile radios with mobile data terminal interface;
  - 101 Emergency vehicle radios; and,
  - 59 Portable radios.

- EMS Department:
  - 3 radio interfaces and 5 phone interfaces; 4 Dispatchers and 6 computer aided dispatch (CAD); and,
  - 28 Mobile radio units (with any 17 operational at one time)
  - 80 portable radios on UHF and VHF frequencies.

- Traffic Management Center Radios-(permanent mounts) will be needed as follows:
  - 2 for City of Austin Police Department;
  - 1 for Capital Metro Police;
  - 1 for Courtesy Patrol;
  - 1 for Travis County Sheriff, and,
  - 1 for Department of Public Safety,

The 125 mobile radios require a data interface such as the police radios do. These are the fire engine type radios. The secondary type radios (101) are for support vehicle with no digital data interfaces.

It will also be important for TxDOT to be part of the 800 Mhz radio network in order to make personnel and equipment available to assist the Public Safety Agencies. Radio equipment needs will initially include

- 4 for District Road Maintenance;
- 3 for Emergency/TMC Operations;
- 4 for Traffic Management Maintenance; and,
- 3 for Courtesy Patrol.

The radios located within vehicles could either be permanently mounted within the vehicle or portable. In addition, two 800 MHz scanners should be provided at the District office.

Maintenance Summary - The maintenance requirements for an 800 MHz Trunking System must provide for a minimum of 10% of the equipment budget per year; or an ongoing maintenance agreement (on site) would be highly recommended as opposed to having the agency maintain the radio system.

Sophisticated spread spectrum, coupled with a digital radio system carrier, and subcarrier switching and voice/data compression requires expensive and costly maintenance test equipment, as well as a facility with floor space and several technicians for maintainingthe radio system. The digital radio system provides dynamic channel allocation as well as management for lower tier intercommunications. This function increases the interagency coordination. This technology was commonly being used in Vietnam and more currently in the Gulf War. The Battlefield coordination and troop deployment was based on the same functionally as the 800 MHz.

Personnel Summary - The operations personnel required for 800 MHz trunking are more than the existing operations. Personnel requirements are currently being identified as part of other ongoing studies. Preliminary indications are that additional personnel will be needed to operate and maintain the proposed 800 MHz system.

Funding Summary - Funding for the equipment has been programmed to be incorporated into a future Communication Center. The funds for the Communication Center will be provided by the agencies operating budgets and future bond programs. Detailed cost estimates are currently being prepared by the City of Austin implementing agencies. An approximate estimated cost for equipment needed for an 800 MHz trunking system are identified in**Table II - 15.**

Implementation/Phasing Summary- The implementation and phasing of the 800 MHz Radio Trunking System is currently being developed as part of other ongoing studies.

Table II – 15

Budget Estimate for Two Site 800 MHz Trunk Radio System Equipment

Austin Area-Wide ITS

Austin, Texas

#	Item	Unit Costs	Total Cost	
20	Repeaters	$12,000 ea	$240,000	
4	5 channel antenna systems	$35,000	$140,000	
2	Central Trunking Controllers	$55,000	$110,000	(-55,000)
2	Equipment Shelters with fence	$35,000	$70,000	(-35,000)
1	System Manager	$50,000	$50,000	
1	Engineering & Installation	$100,000	$100,000	(-25,000)
3	Consoles	$25,000	$75,000	
1	Console Common Electronics	$75,000	$75,000	
28	800 Mhz Control Stations	$ 4,700	$131,600	
	Grand total fixed equipment for all 3 agencies		$991,600	
	To share the Water & Waste Water system deduct			($115,000)

Mobiles and Portables by agency:

Police	300 mobiles	$2,400ea	$720,000
	300 portables	$2,200	$660,000
Fire	125 mobiles/interface	$2,800	$350,000
	101 mobiles	$2,400	$242,400
	59 portables	$2,200	$129,800
E.M.S.	17 mobiles	$2,400	$40,800
TxDOT	14 mobiles	$2,400	$33,600
	25 scanners	$400	$800
TMC	6 radios at work stations	$5,000	$30,000
Grand Total Mobile/Portables with no accessories or installation cost.			$2,207,400

NOTE: All prices may change depending on exact application and requirements

COMMERCIAL FLEET MANAGEMENT
SCOPE OF WORK

Task - Identify resources to share information with other services

Task Description and Milestone

The work generally consists of identifying and dissemination information useful for commercial vehicle operations.

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

Summaries of the facilities, equipment, maintenance, personnel, finding, and implementation needed to identify and disseminate this information should be presented.

Facilities include structures or enclosures necessary to house and operate equipment and personnel and its cost. Equipment includes hardware, software, and communications items and their cost. Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing. Documentation of a phased implementation strategy should be included.

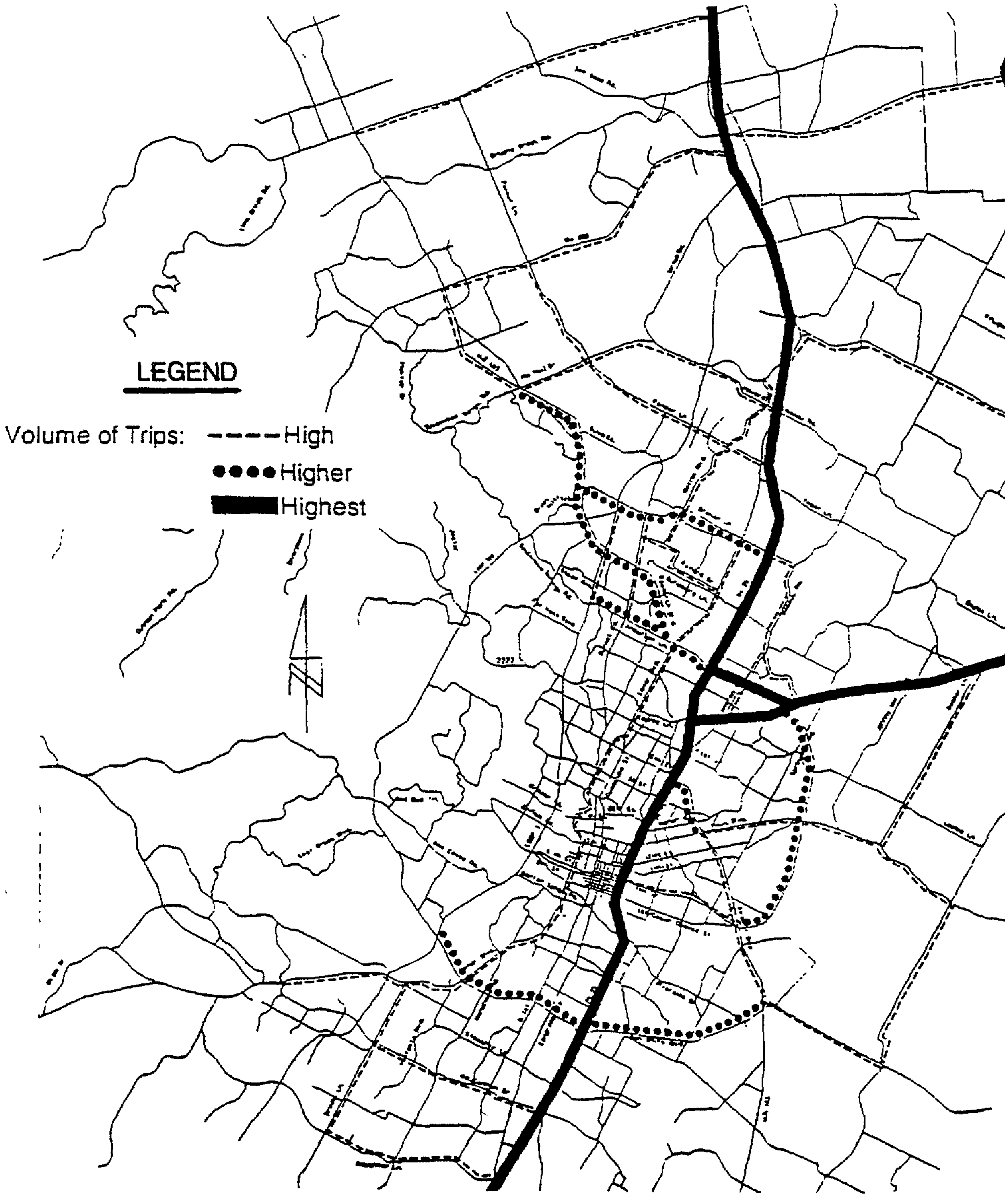
Commercial Fleet Management

Commercial vehicles are becoming an increasingly important factor in the operation of highways within Austin. It is anticipated that there will be a significant increase in truck traffic along IH 35 after December 18,1995 when the North American Free Trade Agreement (NAFTA) begins to allow trucks from Mexico to travel throughout the state and after 2000 when Mexican trucks can travel throughout the United States.

Between October 1991 and December 1993, Austin experienced a 40% increase in southbound cross-border truckloads and 30% increase in northbound truckloads. This amounted to an increase of 5,000 truckloads southbound per month and 1,900 truckloads northbound per month. It has been estimated that truck traffic will continue to increase at a rate of 20% per year through 1998 and begin leveling off after 1998 to 10% per year.(1) Assuming this projected rate is accurate, the number of trucks involved with NAFTA along IH35 in 1995 can be expected to more than double by 2000. In addition, trucks not involved with NAFTA trade will also increase, possibly as much as 10% per year (or as much as 60% by 2000).

The increase in truck traffic will place a greater burden on an already overloaded highway facility. **Figure II - 25** and **Figure II - 26**, from the Austin Metropolitan Area Transportation Plan(1), show that truck activity exists on major routes in addition to IH 35. This includes US 183 and SH 71 to the east of IH 35. US 183 and SH 71 are already crowded, if not congested, and increased problems can be expected until they are developed into freeways and SH 130 is constructed around the east side of Austin. The "Freight Element Section" (Section 4.6) of the Austin Metropolitan Area Transportation Plan provides further effects of truck traffic and recommended solutions and is included in **Appendix II - E** of this report.

The effects of trucks on the freeway and major thoroughfares necessitate the application of traffic and incident management at an early date along all freeways and major highways, especially IH 35. It may also be desirable to lit heavy truck traffic to off peak periods and preferably at night. Various ITS User Services apply to Commercial Vehicle Operations. As noted in **Table II - 16,** four are discussed in this section.



Source: Austin Metropolitan Area Transportation Plan, Austin Transportation Study, Adopted December 12, 1994.

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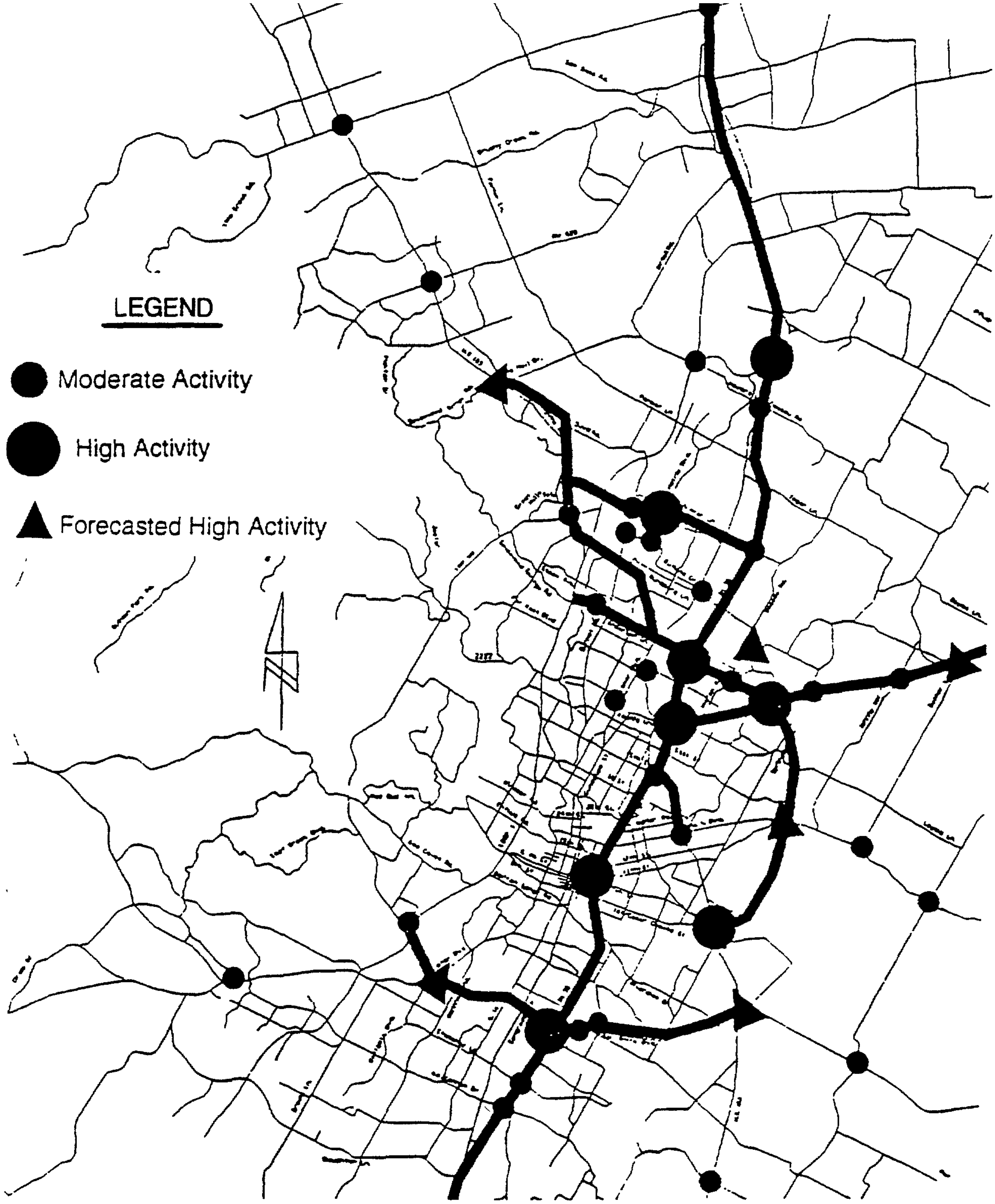
Austin Area Roadway Freight Corridors by Volume of Trips

Austin Area-Wide ITS
Austin, Texas

Figure II-25



Source: Austin Metropolitan Area Transportation Plan, Austin Transportation Study, Adopted December 12, 1994.

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Areas of Concentrated Roadway Freight Activity
Austin Area-Wide ITS
Austin, Texas

Figure II-26

Table II – 16

ITS User Services Which Would Benefit Commercial Vehicle Operators
Austin Area-Wide ITS
Austin, Texas

Enroute Driver Information*	• Specific Information for Trucks provided from TMC to Dispatcher • General Information for all Motorists via Radio available to al1 Truckers
Route Guidance*	• Available through possible use of TEMPO or other information from TMC to Dispatchers
Electronic Payment *	• Could be utilized if Toll Roads are built in Austin
Commercial Vehicle Automated Roadside Safety Inspection (and Enforcement)*	• Available through advanced enforcement system central computer and use of WIM, AVI and AVC roadside equipment
Commercial Fleet Management*	• Use of GPS on trucks assists dispatching in locating commercial vehicles in conjunction with Enroute Driver Information and Route Guidance

Commercial Fleet Management Technologies

There are basically two types of commercial trucking fleets which must be managed on a day to day basis: 1) single unit delivery vehicles and heavy trucks which originate or enter the city to deliver goods but do not pass through; and, 2) heavy trucks which pass through the city.

- *Local Roadway Freight* - The delivery vehicles and heavy trucks which deliver goods are generally required to meet delivery deadlines to businesses within the city. If deliveries are made on a routine basis, the company dispatchers and truck drivers are generally aware of normal traffic conditions along their routes. Of primary interest to the company dispatchers and truck drivers is the location of an unusual delay (e.g., in excess of 20 minutes) on a freeway or major arterial. With this information, the dispatcher and/or truck driver can select an alternate route.

- *Through Roadway Freight* - Trucks traveling through a city also have delivery deadlines outside of the area. Short haul through trucks have the same problem as the delivery vehicles in this regard, but long haul trucks may have some time built into their schedule.

Improved communications systems to provide critical transportation information to drivers and dispatchers and to receive weight and location information from vehicles are currently under development and testing using various Intelligent Transportation System (ITS) applications. Commercial vehicle operations (CVO) systems are systems that apply various ITS technologies to improve the operations, safety and efficiency of commercial vehicles. CVO systems are targeted to provide a variety of benefits, including safety, productivity, and mobility. Safety benefits include advanced screening, targeted inspections, correction verification, roadside monitoring, on-board monitoring, and emergency response. Productivity benefits include reduced delays, reduced paperwork, enhanced auditing, shipper needs, and driver/vehicle monitoring, while mobility benefits include increased intermodalism and international competitiveness and opportunities.

Implementation of CVO systems are being driven by three national CVO goals:[(2)]

- *Transparent Borders* - An electronic network that would allow commercial vehicles to travel from one state to another as easily and smoothly as passenger cars. Compliance with registrations, licenses, and permits would be verified electronically through mainline monitoring and mileage reported automatically;

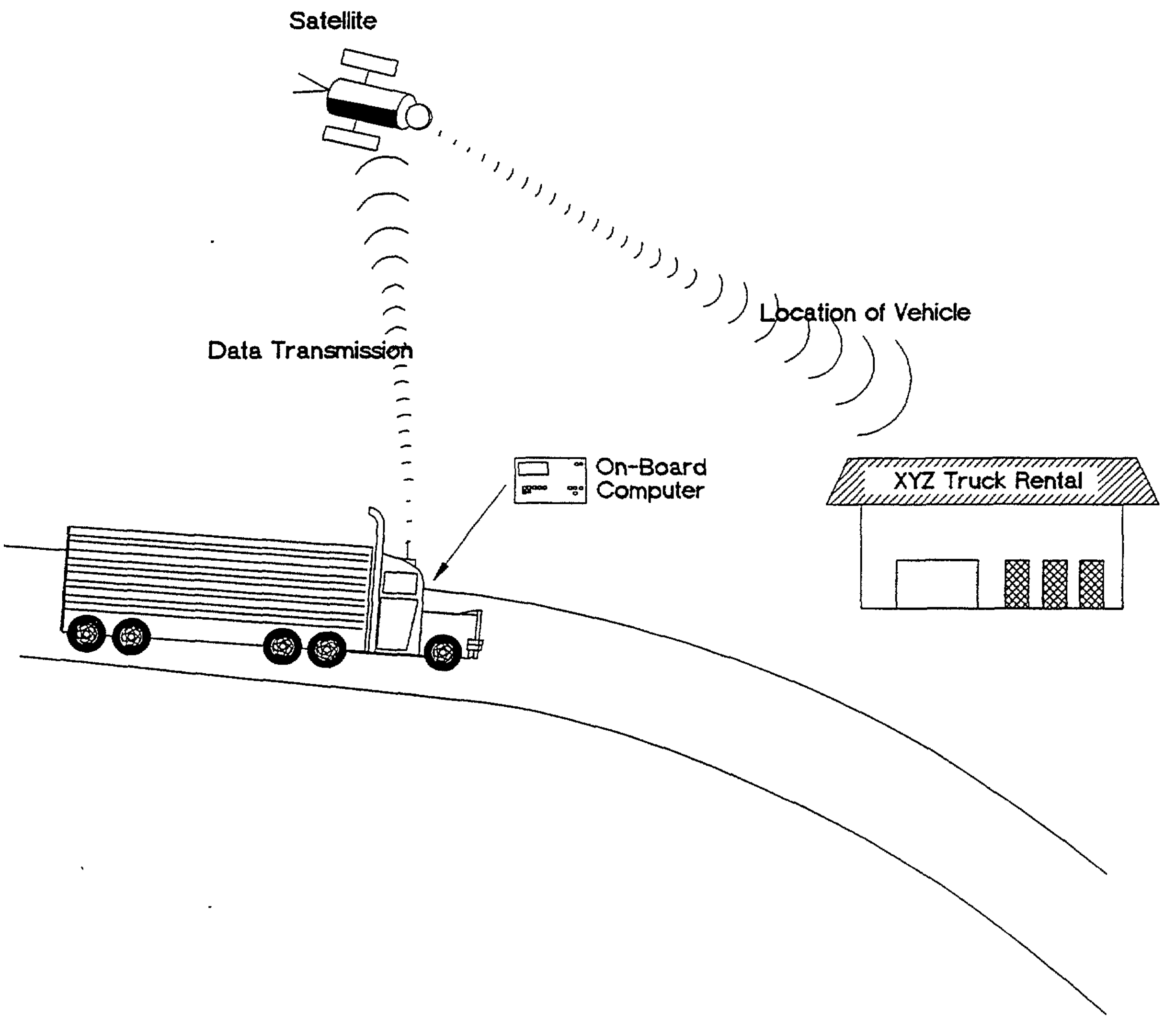
- *Electronic Commercial Driver/Vehicle Safety Inspections* - An electronic network that verified information such as a vehicle's current Commercial Vehicle Safety Alliance (CVSA) inspection decal and a driver's Commercial Drivers License (CDL); and,
- *One-Stop Shopping* - A concept allowing carriers to comply with all trucking regulations at one geographic location. All states would be computerized and linked together for issuance and collection of taxes, permits, authorities, insurance, and other items.

Provided with information far enough ahead of time, the trucking company dispatcher may be able to route the truck so as to bypass Austin *or* determine if another alternate route within the city (e.g., US 183 or MOPAC/SH 71KJS 290 or an alternate route to IH 35) can be used. It may be determined to stay in the stream of traffic if the estimated delay time is short or have the trucks stop at a truck stop until the cause of the incident has been overcome and traffic is beginning to flow normally again.

Real-time traffic information provides numerous benefits to commercial truck fleets, including an increase in fleet productivity, an improvement in customer service, improvement to the truck driver's environment, and a reduction in costs. For example, when the upper level of the George Washington Bridge in New York was closed on a weekday morning at 2:44 AM, an overnight package delivery service was able to inform its drivers to use an alternate route and allow them to meet critical aircraft departure schedules at Newark International Airport[(3)]. The traveler information provided permitted packages to arrive on time, which reduced service costs, increased customer service, and increased productivity of the vehicles.

Truckers traveling through Austin are often not familiar with the highway system. Increased information and guidance are usually needed. Without adequate information on conditions ahead and available alternate routes, a heavy truck driver can become a real problem as he tries to take an alternate route on his own volition within unfamiliar territory.

Technologies used to provide or obtain travel information from commercial vehicles include Automatic Vehicle Location (AVL) and On-Board Computer (OBC) systems. **Figure II – 27** illustrates AVL and OBC concepts, which provide dispatchers with vehicle location information and truck drivers with route and travel information. AVL and OBC technologies are the technologies



Source: <u>Commercial Vehicle Operations and Institutional Barriers (COVE) Study: Texas Working Group Kick-off Meeting Presentation</u>, Booz-Allen + Hamilton, Inc., September 1, 1993.

WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Automatic Vehicle Location (AVL) and On-Board Computer (OBC) Concepts Austin Area-Wide ITS Austin, Texas	Figure II-27

which can provide the greatest solution to managing commercial truck traffic in the greater Austin area. A Discussion of AVL systems is provided in the Public Transportation section.

The Control Center is the brain of the AVL system; in that it processes and analyses the data for the purpose of providing a more reliable and efficient transportation system. The Control Center is formed by several components which may vary according to the needs of the specific traffic management system. The principal components are the main computer, mapping controller, and a database bank that form the computer aided dispatch (CAD).

An AVL/CAD system can improve commercial fleet service reliability, increase the safety of both commercial truck drivers and other drivers on the road, and reduce operation expenses by providing the following features:

- Providing real-time commercial vehicle location;
- Providing alternate routes to avoid known traffic delays;
- Improving communication between commercial truck drivers and the control center;
- Providing information for planning, scheduling, and information management;
- Recording of incidents, locations, and other data used for management reports and analysis; and,
- Providing address matching and temporary detours.

Several companies exist that track commercial truck traffic and provide traveler information to truckers and/or dispatchers on a subscriber basis. One of these is QualComm which is a nationwide service with a nationwide marketshare of approximately ninety percent (90%). They charge a fee of approximately $150.00 per month per vehicle regardless of the amount of information transmitted or connect times. QualComm monitors the location of trucks through GPS and provides two-way communication between the dispatcher and the truck as a service. Knowing the location of the truck, the QualComm operator could provide information on delay and possible alternate routes to take. However, they would not be interested in providing this service on a city by city basis. If transportation data was available on a nationwide basis from a series of TMC's, they would be interested in providing traveler information to their client's dispatchers and/or individual vehicles. Other companies use cellular based systems with lower upfront costs but higher operating fees.

Commercial Vehicle Enforcement - An area of interest to the public sector is the weight, registration and safety of vehicles and drivers. Vehicles can now be checked through use of Weigh-In-Motion (WIM) and Automatic Vehicle Classification (AVC) equipment for registering and monitoring vehicles traveling along the highway system. There will be means in the future also to check the condition of the vehicle and to a certain extent the condition of the driver.

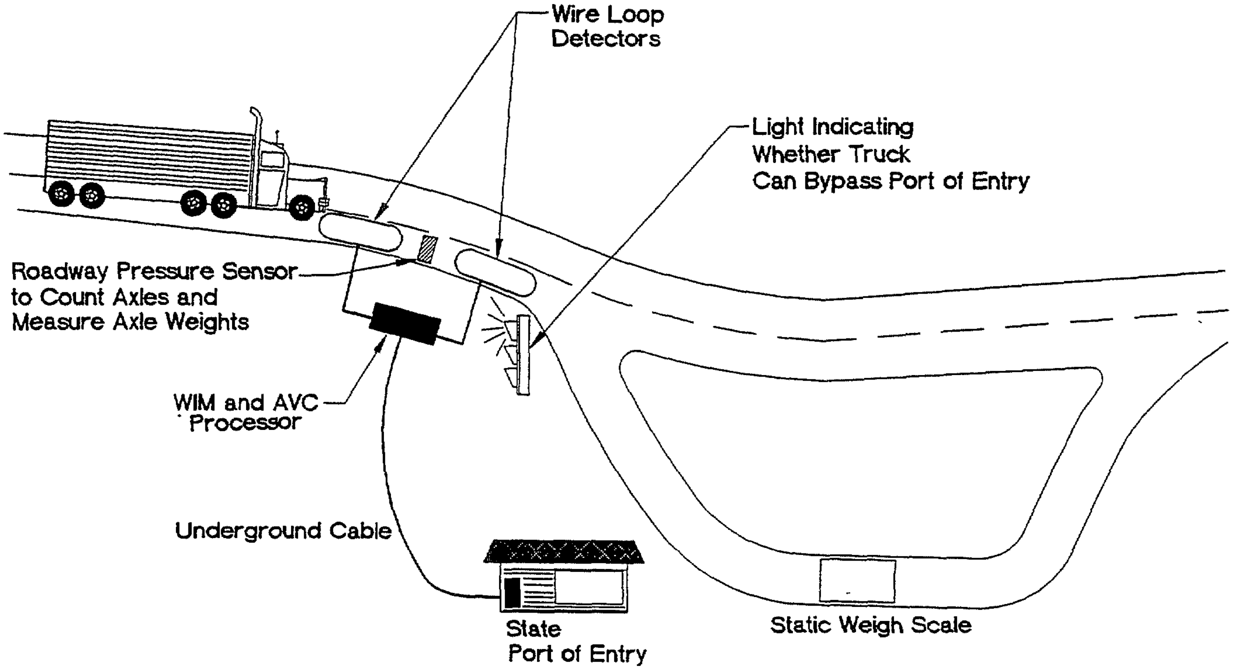
Figure II - 28 illustrates AVC and WIM concepts, which permit commercial vehicles to pass weigh stations without stopping if weight and vehicle classifications comply with State laws. WIM and AVC will provide information to governmental agencies about whether a commercial vehicle is complying with regulations, but will not help a great deal in providing real-time traffic information.

Provisions can be made for monitoring the above referenced equipment at the TMC for the purpose of locating trucks that are over weight and/or not properly registered for the cargo they carry. When a vehicle is noted that does not meet the necessary requirements, the Department of Public Safety would be notified by an operator at the TMC.

Identifying and Disseminating Information

As previously stated, the primary concern of trucking companies and truck drivers is the location of unexpected delays along their route, along with additional information on the condition of possible alternate routes. This basic traveler information should be made available to trucking companies or commercial information services (e.g., QualComm) at the TMC, The trucking company or commercial information service could then carry out its own analysis and dissemination of traveler information to its subscribers.

The basic information should include speeds, travel times and level of service (LOS) along segments of a freeway and major highway or street such as those shown in Figures II-25 and II-26 which carry a heavy amount of truck traffic. Information should also be included on normal recurring delay and delay caused by incidents. The information should also be included on the Internet for the



Source: Commercial Vehicle Operations and Institutional Barriers (COVE) Study: Texas Working Group Kick-off Meeting Presentation, Booz-Allen + Hamilton, Inc., September 1, 1993.

WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Automatic Vehicle Classification (AVC) and Weigh-In-Motion (WIM) Concepts Austin Area-Wide ITS Austin, Texas	Figure II-28

benefit of all motorists and commuters as they prepare to leave their homes, and should be provided to the public media for distribution via cable companies, radio, and television.

Other information such as travel time and speed along various highways and streets could be utilized to determine travel time along possible alternate routes for trucks. A PC version of travel time analysis along routes has been developed at the University of Texas at Arlington. The computer model, known as TEMPO. It would be desirable to apply this model in real time for rerouting commercial vehicles when delays occur along a given route normal due for congestion or an incident. Real time information on speed and travel time for each available route would be fed into the PC from the computer. The TEMPO model would determine the available capacity and travel time for the route along which a delay exists and along each possible alternate route. The model would then advise the trucking agency on the travel time for each route and/or provide recommended routing instruction. Information from the PC for TEMPO would be made available at an interface point in the TIC at the TMC for use as a computer link with the trucking company dispatcher(s). Communications would involve a modem provided by the trucking company at each end of the transmission and a print out at the dispatchers office. The same approach could be applied in providing information to Metro Traffic and other media companies which in turn would provide information to the trucking company dispatchers.

An alternative approach to the dissemination of information to trucking companies would involve the joint funding of an outside agency such as HELP, Inc., to distribute information to subscribe trucking companies. HELP, Inc. is organized to work with states and trucking companies in developing and implementing services which help motor companies. Application of the TEMPO model for Austin could be one such service.

By providing information for routing trucks, TEMPO would also be of value to the public by reducing overall delay to all motorists. If designed on a public/private partnership basis, it is suggested that the TEMPO output not be placed on the Internet. Doing so would defeat the purpose of providing information only to trucking companies.

Communications between the TMC and the trucking companies or services could be via a variety of sources, including a computer network, telephone, fax or pager. The TRANSCOM program in the New Jersey/New York City area uses an 80 character alphanumeric pager to communicate with trucking companies. The pager is typically installed in the trucking company or service's office, and the dispatcher is trained to read the coded message and then relay the information to drivers. It is the company's responsibility to read the messages and relay the information to their drivers, not the responsibility of the governmental agencies[3]. In addition, the same approach could be provided as discussed above for TEMPO in providing traffic information to trucking companies and Metro Traffic. The use of an interface point where commercial companies can obtain information has been successful in the Chicago TMC. The commercial company provides the equipment and communications it needs for obtaining desired information.

Regardless of the communications media used in the Austin area, the responsibility of disseminating traffic information to commercial fleets should belong to the trucking companies or service providers. Traffic information should be provided to commercial fleets or service providers through the TMC, but relaying that information to appropriate commercial vehicles should be up to the trucking company's dispatcher. Providing specific information to each truck would be difficult. Direct communications with the truck driver could also create confusion for the dispatcher and the truck driver. Providing information to the dispatcher which is specifically for use by commercial vehicle operators rather than directly to the truck driver would also place liability for a resulting incident on the commercial operator.

Facilities Summary - Additional facilities should not be required for providinginformation to truckers if the computer hardware and software at the Traffic Management Center or Operations Center includes the information for use by all motorists. This includes the Austin Home Page and Internet which would include information on highway conditions for Austin. As previously discussed in the previous paragraph , a communications interface point should be provided for commercial companies to tie their hardware and communications to. These companies would also be responsible to provide the equipment which might be needed attheir dispatch/information facilities (e.g., modems, P.C.).

Equipment Summary - Except for information provided by TEMPO and the advanced ITS type enforcement equipment such as AVL and OBC, the information provided by the FTM system can be a part of the software development for the central computer and should not require additional equipment. The AVL, OBC, or pager equipment should be provided by commercial vehicle companies or other agencies with connections at interface points in the TMC.

The TEMPO model should be provided as a separate stand alone PC with output through the central computer to the trucking agencies. The estimated cost for the hardware/software and interface between the PC and computer should be less than $100,000 which, as previously stated, could be shared 50-50 through a public/private partnership. The output of the PC would be provided to the Commercial Vehicle Operators as previously discussed. The equipment beyond the interface point would be the cost of the commercial companies.

The advanced enforcement system central computer equipment could either be housed in the TMC or at a Department of Public Safety (or other) office. The cost of the equipment (hardware and software) should be paid for by the enforcement agency and would not be a part of this project. The TMC system operator could be alerted, however, when a non-registered truck passes the enforcement station on the field and CCTV information sent to the DPS or other enforcement agency for their use in tracking the vehicle along the freeway system. If the enforcement agency provides this service from the TMC, it should provide for the costs of the needed interconnect between the advanced enforcement system computer equipment and the TMC work stations(s). As with the implementation of the TEMPO model, the cost for interconnection to the enforcement agency should be less than $100,000.

Maintenance Summary - Since most of the information provided to truckers and their dispatchers can be handled through the central computer, the maintenance costs (except for TEMPO) could be included as part of the overall TMC maintenance costs. Maintenance costs for TEMPO would be approximately $1000 per year which could be paid for by TxDOT as part of its maintenance for the TMC. The information for the trucking companies would benefit all motorists and as such should be paid for through the public sector. The maintenance for the advanced enforcement system equipment could be paid for by another agency if located within the TMC.

Personnel Summary - Additional personnel should not be needed to provide information to the truckers and trucking companies. The information would be provided as part of the overall operation of the TMC.

Funding Summary - As previously stated, added funding will not be required except for the TEMPO software and any advanced enforcement system equipment housed in the Center (see equipment summary).

Implementation/Planning Summary - The overall information provided to travelers and trucking companies should be included in the initial design of the proposed TxDOT FTM system. If TEMPO is not included, provisions should be made for adding this type of system at a later date. The possible addition of TEMPO should be included as a planned part of the system.

References

(1) Austin Metropolitan Area Transportation Plan, Austin Transportation Study, Adopted December 12, 1994.

(2) Commercial Vehicle Operations and Institutional Barriers (COVE) Study: Texas Working Group Kick-off Meeting Presentation, Booz-Allen & Hamilton, Inc., September 1, 1993.

(3) "The Utilization of Real-Time Traffic Information by the Trucking Industry," IEEE Transactions on Vehicular Technology, Vol. 40, No. 1, February, 1991.

DISSEMINATING TRAVELER INFORMATION SCOPE OF WORK

Task - Identify resources to disseminate en-route and pm-trip travel information from other services to travelers.

Task Description and Milestone

En-route and pre-trip travel information provides information used in making informed trip decisions, Travel information is largely provided by traffic control, incident management, and public transportation management services. This information has the following desirable characteristics:

- Useable
- Timely
- Reliable
- Accurate

Trip decisions include:

- Departure times
- Transportation modes 0 Routes

The work generally consists of recommending methods to disseminate information from other services meeting the above criteria to travelers.

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

Summaries of the facilities, equipment, maintenance, personnel, funding, and a phased implementation plan to disseminate en-route and pre-trip travel information methodologies should be presented.

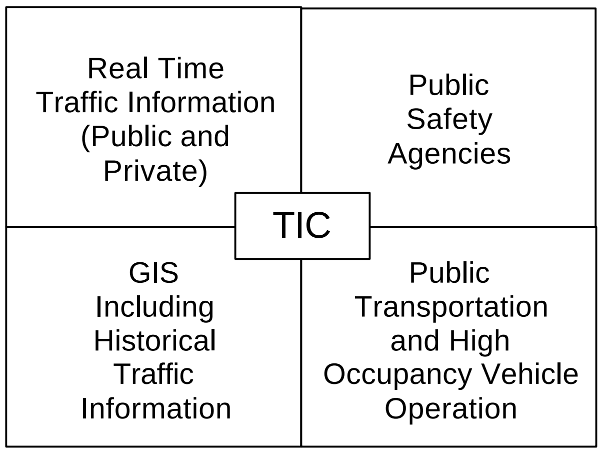
Disseminating Traveler Information

The Austin metropolitan area is the second fastest growing region in the United States[1]. Highway and street networks are becoming more congested which increases the potential for accidents. Assuming that the existing growth rate continues (or increases even more), congestion will continue to increase. Austin is on the borderline of becoming a non-attainment area. Vehicle emissions will increase as traffic increases. The increase in congestion and vehicle emissions increases the need for intermodal integration. For instance, the development and implementation of a multimodal plan which would reduce single occupant vehicles (SOV) by 10% could reduce vehicle congestion by as much as 48%.[2] Reducing the number of SOV and improving mobility necessitates increased information to commuters and public transportation operators as well as to commercial vehicle operators and other motorists.

The dissemination of accurate and timely information to motorists is dependent on available information from many sources and on how this information is analyzed. The best means for obtaining and analyzing traffic information is through the development of a Transportation Information Center (TIC). The TIC provides a platform to build on for improved movement of people, goods, and services. The TIC is an integral part of the TMC as is shown in **Figure II – 29** and Figure IX - 30, the TIC interfaces with the TMC work stations and the transportation and enforcement agencies within the region and in turn disseminates information in a manner useable by these agencies and the traveler. The TIC should be located in a room adjacent to the TMC Control Room if and/or when one TMC is provided and adjacent to the FTM Control Room when separate City/State Control Centers are provided,

Transportation Information Center

The TIC should serve as the hub for current operations and for the future ITS user services within the Austin metropolitan area and region. The focal point of metropolitan ITS rests with collection and use of information. Without adequate and timely information, all aspects of ITS suffer, and this will make the application of advanced systems unpopular with the user. In order to achieve accurate and timely information and apply it properly to all areas of ITS, there is a need for a central



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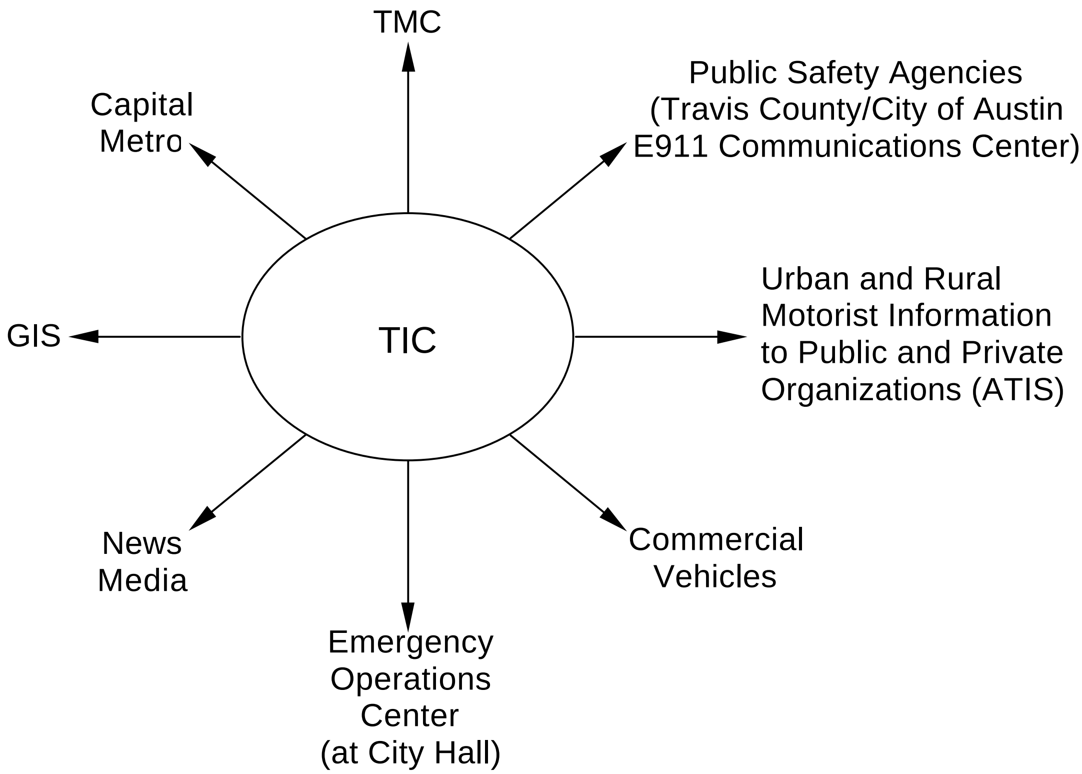
Relationship of Transportation Information Center (TIC) With Other Operations
Austin Area-Wide ITS
Austin, Texas

Figure II-29



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collection and distribution point. This applies regardless of whether the traffic management approach is centralized or decentralized. The TIC provides this capability.

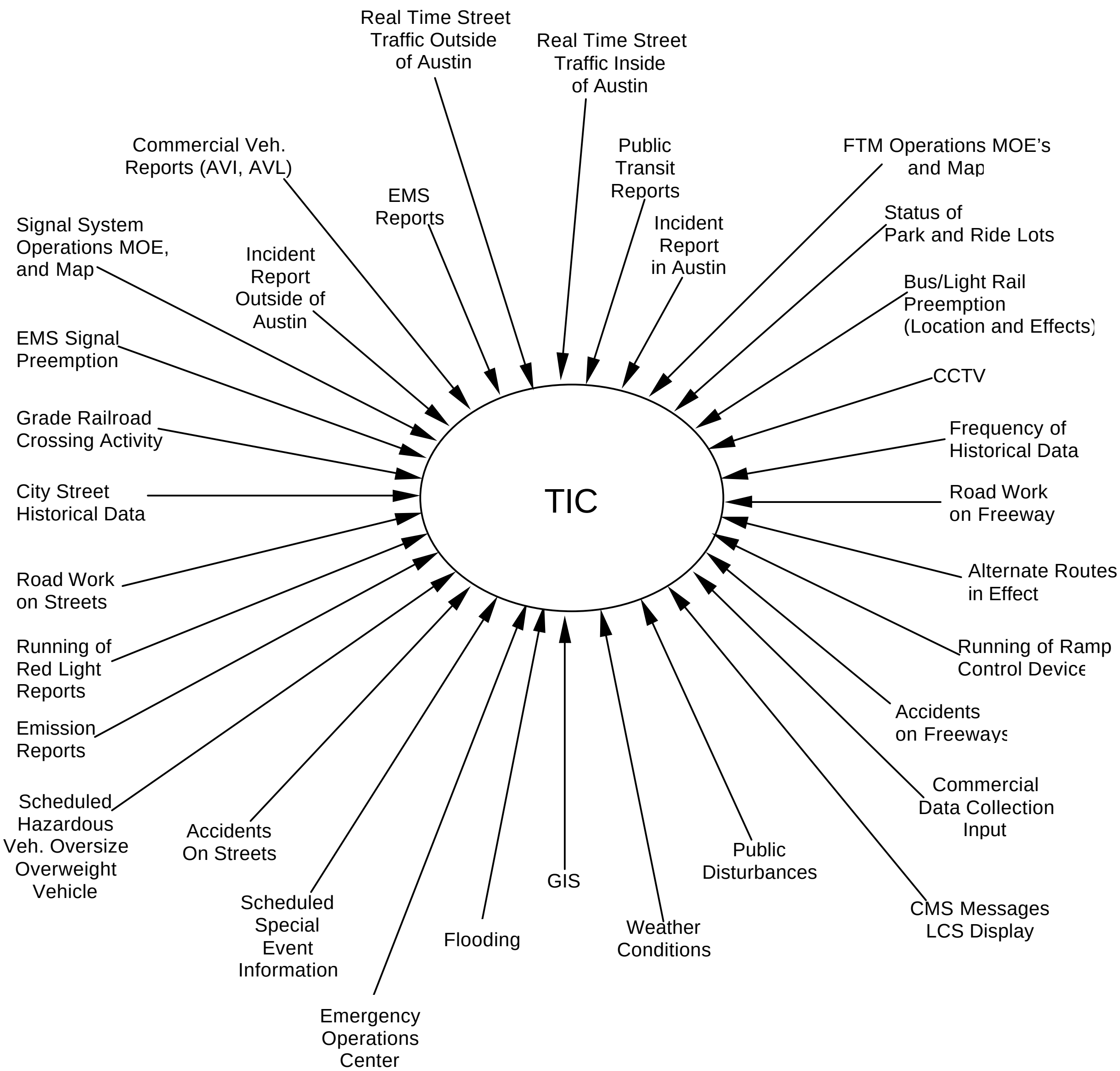
As is shown in **Figures II - 31, II - 32,** and **II - 33**, the TIC provides for data gathering from many sources, sorting and analysis of data and distribution to various users. Traffic information must be timely and accurate. This can best be achieved through one TIC. It is important to note that information can be prepared at the TIC and sent to the news media as shown in Figure II - 33. The news media can provide important support for the overall concept of intermodal integration and traffic management.

The collection, analysis and distribution of informationshould be carried out as a separate but integral part of the TMC. That is, the TIC should have its own personnel who receive, analyze and provide information to the transit, TMC and Public Safety Agency personne1 in a centralized traffic management approach and to the traffic control centers in a decentralized approach. The TIC should be operated and maintained jointly by the city, transit, and state traffic management personnel.

The TIC data base should be part of a regional Geographic Information System (GIS). The TIC will not need to be at the same location as the GIS, which would probably be maintained by the city or county public works department. The GIS will, among other things, provide the following information:

- freeway and street geometric information (e.g. lane width, street width) and capacity;
- traffic control locations and traffic signal timings;
- historical traffic, accident and enforcement data;
- speed zones;
- fire station and PSA locations;
- designated fire runs and fire plug locations;
- bus routes and bus stops;
- railroad crossings and train schedules;
- low water crossings and areas subject to flooding; and,
- school locations and school zones.

This information will permit the TIC operators to combine real time and historical traffic information with information provided by the Public Safety Agencies Center to assist in overall mobility and safety.



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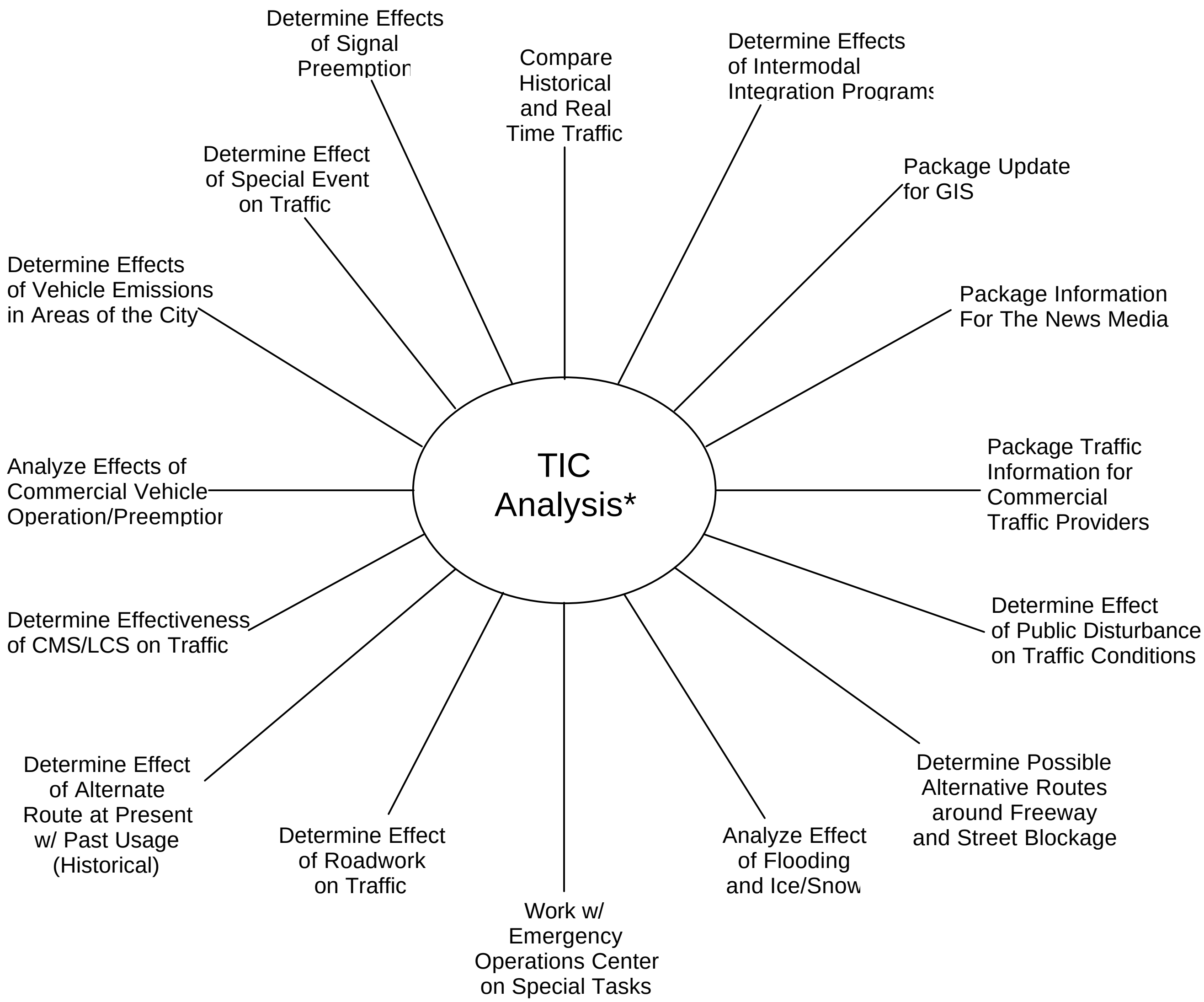
Examples of Data Input

Austin Area-Wide ITS

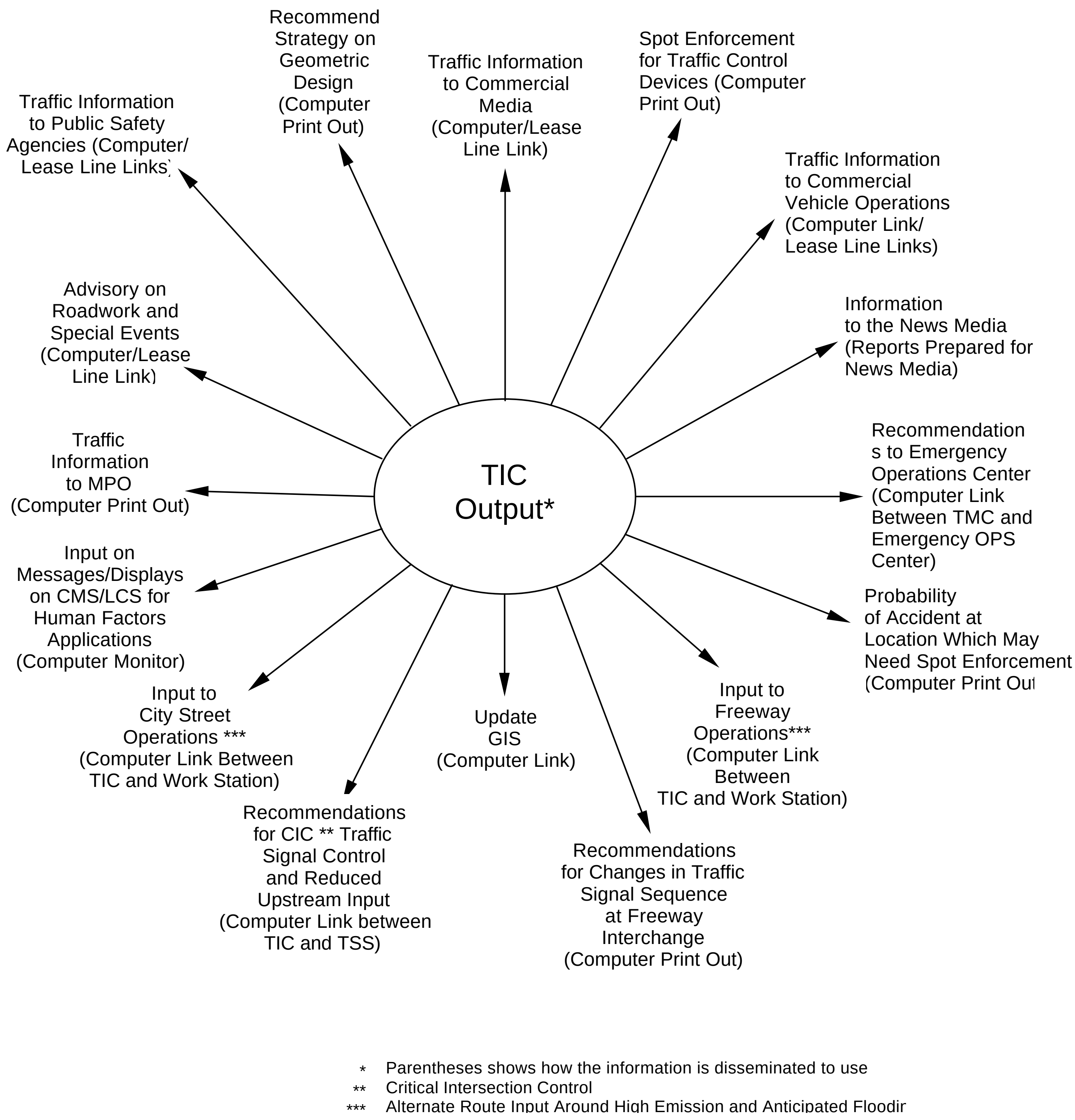
Austin, Texas

Figure II-31



* Information Determined Based on Input from Figure 33

WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	Examples of Traffic Analysis (Data Fusion) at TIC Austin Area-Wide ITS Austin, Texas	Figure II-32



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Examples of Information Dissemination

Austin Area-Wide ITS

Austin, Texas

Figure II-33

In a centralized traffic management approach, the TIC will be an integral part of the TMC. Traffic data provided from vehicle detectors used in selecting traffic contro1 plans (timing plans) is supplemented by the other information which the traffic control operators need to know to manage traffic during periods of recurring and non-recurring (e.g. incidents, special events) congestion. In the decentralized traffic management approach, the TIC should be located at one of the traffic control centers and information transmitted to the other centers.

One TIC is needed for providing information to travelers, be they commuters or motorists entering or passing through the metropolitan area. Information also needs to be provided to Public Safety Agencies operators, public transportation operators, commercial vehicle operators and the commercial news and traveler information media. The TIC will also be the center in the future for providing route guidance to all motorists. Traveler information needs to be:

- Useable;
- Timely;
- Reliable; and,
- Accurate.

This applies to all persons involved in using the street and highway system within the region. All aspects of Traveler information must be applied with these characteristics in mind.

Although there is a need to provide accurate information to travelers within the city, there is also a need to provide information to those who are entering the region. This information needs to be provided far enough in advance to permit the traveler to take an alternate route if desired. The same applies to the commuter who may decide to take an alternate mode of transportation or alternate route, leave at a different time than usual, or stay at home (e.g. ice, snow, disaster). Good information and analysis will provide information which meets the above requirements.

Data Resources

Various forms of traffic related information should be made available at the TIC. Bringing this information and making it available in a useable form is known as data fusion. The information includes:

Traffic Control Data - Traffic control data includes the traf5c volume, lane occupancy, speed, and motorist delay information which is obtained from vehicle detectors and CCTV. Traffic control data also includes traffic control patterns (timing patterns) in effect. Traffic signal timing plans can provide information to technicians in the TIC such as the progression band for a particular arterial and the capacity of that arterial.

Vehicle detectors used for traffic management provide invaluable information which is used to provide accurate and timely information to the news media and to the traveler selecting the best mode of travel or travel route.

In addition, information obtained from the commercial media (e.g. helicopters, airplanes, mobile, and stationary observers) and courtesy patrol vehicles are also part of the traffic data. As with CCTV, this information can provide added information and serve as the “eyes” of the TIC to confirm information received from vehicle detectors.

Since weather affects traffic conditions, it also needs to be considered part of the traffic data. A partnership should be developed with the conventional news providers in obtaining this information (flooding, icing conditions, high winds, etc).

Incident Management Data - Incident management data includes the traffic control data noted above plus information from the Public Safety Agencies. This includes information received from 911 operators and from EMS and traffic management vehicles on the scene of an incident. This information permits the TIC operators to recommend a change in the traffic control patterns and provide motorists with needed traveler information.

Traffic information obtained from vehicle detection can provide valuable information for the PSA Computer Aided Dispatch (CAD) operations by providing real time information along major arterials. This can be used in determining travel times on intersection to intersection links. This same vehicle detector information is used in 1.5 generation traffic responsive and traffic adaptive traffic signal control during incidents.

The San Antonio Traffic Management Center has access to Channel 54 on general T.V. The channel allows instantaneous viewing of incident location by key personnel with access to a T.V. on a 24 hour a day basis. The director of maintenance can ascertain the equipment needs of an incident from his home in the middle of the night and call out the appropriate machines and personnel. At non critical times the T.V. channel can provide traffic information to the general populous. The display can be provided by the public or a private company.

As with recurring congestion and conditions, commercial data collection agencies (such as Shadow Traffic and other helicopter services which collect traffic data) provide valuable information during incidents that occur during the peak hours of travel. A partnership between TxDOT, the City of Austin, and commercial data collection agencies for obtaining traffic data similar to that used for obtaining weather information should be utilized.

Public Transportation Management Data - Capital Metro is determining which type of Advanced Vehicle Location (AVL) system it will install in its buses in the future. This system will provide information on the location buses and estimated time of arrival at bus stops. This information will permit the development of a non-preemption priority type operation at traffic signals to service buses when they are behind in their schedules.

The estimated arrival at bus stops can also provide an estimate of travel time and speed between signalized intersections along a route. This information can be used in conjunction with the average vehicle speed obtained from the vehicle detector mentioned previously and from ongoing recorded travel time runs by other vehicles to determine real time changes in link speed and travel times.

Using the 800 Mhz frequency radio, bus operators will be able to report incidents and special conditions along their route which might not be known otherwise. CCTV cameras can then be used to analyze the problem reported by the bus driver.

“Smart“ kiosks could transmit this information to regular riders and potential riders at bus stops and other locations such as employment, retail, and entertainment centers. The kiosks could provide an audio message to people with special disabilities with the use of special receiver devices that would minimize the possibility of noise pollution.

Anticipating Accidents

Information gathered by the TIC can be used to help "predict" accidents. Information on existing high accident/high traffic volume locations when combined with demographics involving the make up of drivers involved in accidents (high school and college students) within the area (e.g. school campuses, office complexes) can be combined to point out locations which need a rapid response program, added enforcement and/or added traveler information. The accident, demographic information, rate of growth in traffic and vehicle speed is part of the information which can be used in analyzing traffic conditions. For instance, a rapid increase in traffic within an area which has either congestion or is on the border line of congestion can be an area to flag for a potential increase in accidents.

Types of Travelers

Travelers can be divided into two general groups - home/business based and out of city based travelers. The home/business travelers are generally familiar with the city and its major thoroughfares. They reach their work, shopping, school or recreation destination without difficulty. They can maintain their sense of direction and be familiar with an alternate route streets and freeways. Even with their familiarity of the area, information and directions on streets and freeways to use in avoiding congestion are still helpful and reassuring. Sometimes, just knowing the location of congestion is of help.

Some out of town travelers may know about routes from past experience and be able to obtain information from travel maps (e.g. "Texas Official Travel Map") which show the freeways and most of the major streets, but many others are not familiar with the city. Additional real time information provides a much needed means for avoiding congestion and keeping from getting lost. The following discusses the needs of each of these travelers.

Home/Business Traveler - The home/business traveler should be able to obtain the following information from the TIC:

- *Pretrip Information* - Real time information can be obtained from television, radio, internet and telephone. This includes locations of incidents, travel time and delay, possible alternate routes, travel time by bus, bus route schedules and car pool parking lot locations. Also, the best bus route schedule can be obtained on a request basis where bus transfers are necessary. The simplest approach is to receive information by radio, telephone, and television broadcasts. This can include a public service television channel and public owned radio and periodic reports on commercial radio/television stations. The best bus route to take where transfers are involved could be obtained by telephone.

The Internet can be used to provide information on specific auto/commercial vehicle routes as will interactive television and computers in the future when fiber optic cable is provided to homes and businesses. Travel time information on predesignated routes and advisory alternates can also be obtained through a commercial information service when suitable information is provided by the TIC. These services should also be able to provide predictions on anticipated traffic conditions over the next five, ten and fifteen minute periods based on a combination of current and historical information. In addition, a public television station, such as the television station approval obtained by the San Antonio TxDOT district, could be provided for to continuously broadcast current traffic conditions by voice and map.

The newspaper provides information on roadway work which should also be part of the real time report. These are approaches which should be planned for over the next five years by the city, state, and Capital Metro. Some approaches can be provided initially as the city and state traffic management systems are implemented. These involve providing real time reports on traffic conditions (including a map), bus schedules, and park and ride lot locations.

- *Information Kiosks* - Information kiosks located at shopping centers, office complexes, and other major traffic generators can provide information on traffic conditions to individuals traveling to their next location. Kiosks can also be provided at bus stops to advise on arrival time for the next bus.

  Information kiosks can also show the person at a bus stop which is the best route to take in reaching his/her destination, and the closest bus stop to the desired destination. The kiosks would best be provided as a public service either by a public agency or by a private information service with time provided for advertising (advertising time sold by the private operator). Specific route information could be sold on a pay for information basis (insert your money and select a route). The same could apply for selection of the best bus route to get home. In addition, a map and/or route vending machine could be available for the individual to further plan a route, if necessary. Information kiosks are available and could be implemented as soon as adequate traveler information is available through the TIC.

- *Enroute Information* - Motorists enroute to their destination can be provided with information through:

  - AM and FM commercial radio station broadcasts*;

- Traveler Information Stations (TIS) formerly known as Highway Advisory Radio (HAR) located at a preselected location on the AM band;
- Changeable Message Signs (CMS) and Lane Control Signals (KS);
- CMS on buses to advise on current location and on the next bus stop*;
- Visual display of major routes and conditions (green, yellow, red color code) on an in-vehicle display*;
- Vehicle locator (GPS, towers or beacons) with cellular phone, pager or private radio route information; and,*
- Vehicle locator with visual and voice in-vehicle route guidance (in-vehicle map)*.
- Information for Commercial Vehicle Dispatchers.

* Commercial or Vehicle Owner costs not part of the TMC costs.

The first four of these are in use today within the nation. Commercial radio stations provide valuable information to motorists. Information obtained from a TIC and from subscriber services provide relatively up to date information on a periodic broadcasting basis. The development of a TIC could improve the accuracy and timeliness of the broadcast information. The Illinois DOT allows the broadcasting stations in Chicago to receive freeway traffic data for analysis purposes.(3) One commercial radio station, for instance, utilized the freeway speed data to determine current travel times to various points along each freeway during the peak hours.

TIS equipment has been approved along with higher wattage transmitters (up to 10 watts) and selectable AM broadcasting radioband locations. The higher wattage provides for wide area transmission. Lower wattage transmission provides for a specific area or section of highway along with the ability to synchronize TIS units and permits the use of two or more units in tandem in order to broadcast a longer message.(4)

The Minnesota Department of Transportation (MnDOT) utilizes a public service station to broadcast messages related to incidents. Signs with flashers are located along each freeway. The motorist is instructed by the sign to tune to a designated frequency when a message applies to traffic on that freeway.(5)

CMS and LCS are scheduled for installation as part of the Austin FTM system being designed by TxDOT. Supplementing CMS could be installed along city streets in advance of the freeways which would advise on freeway and corridor street conditions. Automatic fold out signs could be used in addition to the CMS could be used to direct motorists along an alternate route around an incident.

In-vehicle visual display of roadway conditions has been installed as a private venture in the United Kingdom. A public/private effort could be carried out as a public/private venture through data gathering and dissemination at the TIC with private sector in-vehicle displays.

The same public/private partnership approach could be applied to the combined use of GPS and/or towers and cellular phone and/or pager information -- both initially for: (1) more current route information than commercial radio broadcasting can provide, and (2) route guidance information. An alternate to route guidance by cellular phone involves the use of two-way beacon to locate the vehicle and in turn broadcast route guidance information through use of beacons located throughout the city. The approach is being used in Oakland County Michigan.(6)

Each of the approaches discussed are in use or are viable for use in Austin either now or in the future provided a TIC is constructed as part of the city/state/Capital Metro traffic management system. As noted, most of the motorist information can be provided through a public/private partnership. The use of TIS, CMS, and radio broadcasting will be available to those who cannot or do not desire to use the private subscriber services. The traffic information provided free of charge to the public should be as accurate and up to date as that provided to in-vehicle subscriber services.

Out-of-City Travelers - Travelers from out of town who are either delivering goods within the metropolitan area, stopping for a period of time or traveling straight through are not often familiar with the city. These travelers are generally not familiar enough with recurring traffic conditions along their route to know what to expect. In addition, these travelers are not familiar enough with the city to take an alternate route on their own. It would be beneficial for them to know what problems exist in time to either divert or be prepared to stop for a time, if necessary. For instance, if a major incident occurs blocking southbound IH 35 in Austin, a southbound IH 35 motorist hearing of the incident in Temple could take SH 95 and SH 21 around Austin provided motorists know about the problem as they approach Temple. Closer in to Austin, a southbound motorist on IH 35 could take US 183 and SH 71 east of town or FM 1325/MOPAC and US 290 west of IH 35.

Because of the existing traffic conditions and potential for major accidents along IH 35, it would be desirable to provide advance traveler information both north and south of the metropolitan area along IH 35.

The “Texas Official Travel Map” is excellent in showing state highways available for travel around Austin and major arteries within the city (and other major cities in Texas). Each vehicle in Texas should have a copy of this map in its vehicle glove compartment. A wider distribution of the travel map would be beneficial. In addition, vending machines provided at Rest Stops along the Interstate Highways where motorists could purchase the map. These maps can, and should, be used for pre-trip planning and be available for reference along the trip. Approaches for motorist information include:

- Communications with commercial vehicle operations dispatchers via computer telephone links;

- Coordination with other radio stations (e.g. Waco, Temple/Killeen, San Antonio) by TIC personnel to provide announcements on major incidents in Austin and along IH 35 in rural areas;

- Installation of short range and long range Traveler Information Stations (TIS) with signs and flashing beacons advising motorists that there is a message on an incident ahead. The TIS stations could be located at points where motorists can decide whether to take an alternate route or stop for lunch, dinner or the night to avoid the congestion;

- TIS can also be used to provide information on how to reach park and ride lots for bus service to special events (e.g. football games, Aqua Fest) as they enter the city; and,

- Commercially available computer stored “yellow pages” located within the vehicle provide information on services and addresses for these services. In the future, the yellow pages could be integrated with route guidance systems to help the motorist locate the desired business.

The same approach noted above could be carried out on other major highways routed through Austin (e.g. US 183, US 290, SH 71). In addition, the TIC could work with the EMS Center in handling “May Day” calls when accidents occur within the metropolitan area and region.

Recommended TIC Approach

The collection, analysis and dissemination of information within *one* location provides an organized process for providing information to travelers. This can be provided through the Traffic Information Center (TIC) with personnel dedicated to the process.

In addition, field equipment such as Traveler Information Stations (TIS), Changeable Message Signs (CMS) and Lane Control Signals (LCS) are part of the public owned traveler information system. Information is provided for pretrip planning, such as the use of a public television channel, Internet, and radio broadcasts. This would also apply to coordinating information with radio stations within Austin and in other cities. It would be desirable to coordinate radio reports in San Antonio with the TxDOT TMC in San Antonio. Information kiosks and travel maps at rest stops would best be provided by the TIC staff or through contract with a private agency.

The TIC staff will also provide information to the TMC operators and to Public Safety Agencies from the personnel. The primary control of the CCTV should rest with the TMC operators but the CCTV use will be coordinated with TIC and other agencies when they need to use it.

The remaining traveler information shown below in this chapter will be the joint function of the public/private sectors:

- "Yellow Pages";
- Subscriber network information for route information and route guidance;
- Information to commercial vehicle dispatchers;
- Information kiosks at shopping centers, offices, airport, truck stops, and bus stops.

Information will be provided by the TIC personnel in these instances and disseminated further by the private sector.

Facilities Summary - The TIC functions can be carried out through the use of same type computer system as that being installed in the trai3ic management system within the TMC or one of the traffic control centers (preferably the TxDOT center). It would be desirable to provide for the TIC hardware and software facilities as part of the city or state traffic management system. As an integral system with the traffic management system, the TIC facilities will be included as part of the traffic management control facilities.

Equipment Summary - It is estimated that $1,600,000 will be required for hardware and software to adequately carry out the TIC functions previously described. Since the traveler information system will be of benefit to travelers using city streets, freeways, public transportation and enforcement activities, the cost of the TIC system should be shared between the various agencies involved. As the need/response for additional service develops, new and/or expanded services could be added on an incremental basis. The TIC function cost include $200,000 to provide access to a general T.V. channel. These channel costs might increase if some of the costs cannot be deferred to the private sector.

There are additional costs, which will involve the Traveler Information Stations (TIS). The cost for a central 10-watt TIS located in Austin and having a 10 to 15 mile broadcasting radius would be approximately $22,000 ($11,000 for the equipment and $11,000 for the installation). A lower wattage unit installed along the freeway in rural areas would cost approximately $15,000 ($7,000 for the equipment). A second unit tied in tandem with the first and spaced approximately 10 miles apart would cost an additional $10,000 ($1,500 for the equipment) plus lease line costs for interconnecting the two units. If broadcast range is not a problem, a central TIS could cost less and still achieve the same broadcast radius.[7] Various Home/Business Traveler Services would best be handled by Commercial development or through vehicle owner purchase.

Maintenance Summary - Maintenance for the TIC should be part of the maintenance for the TMC or agency traffic control center. As with the TMC, maintenance at the TIC could be carried out through a maintenance contract. Since the TIC is for the benefit of both the city and the state, the maintenance costs for the TIC should be shared by the city, state and Capital Metro. The estimated yearly costs for maintenance of the TIS would also be approximately 10% of the equipment costs (plus telephone lease line costs).

Personnel Summary - In order to properly carry out the TIC functions, two personnel should be utilize on a till time basis. During peak periods and incidents, these personnel will help analyze conditions and support the traffic management personnel. During other periods, they will obtain information (e.g. roadwork, special event, historical, GIS, weather) analyze the information and work with others (TMC, EMS, commercial media) in providing the needed information. As with installation and maintenance costs, it is recommended the salaries be a shared cost.

Funding Summary - Funding for installation of the TIC and the TIS should be available through the same bond funds and/or Federal funds as for the traffic management system funds.

Implementation/Phasing Summary - The TIC functions should be included as an integral part of the TMC or traffic control center (preferably the TxDOT control center). The initial information should be disseminated to traffic management system operators, public safety agencies, public transportation personnel, commercial radio stations, commercial vehicle operators, and to a central TIS for the city. It is also important to incorporate the traffic data into the city GIS.

Additional TIC functions can be carried out by working with the private sector and installing additional TIS in rural areas. It is anticipated that the total TIC functions will be implemented in full within five years with the exception of route guidance. Plans should be made to implement the program over five years and expand it as the city traffic signal system comes on line.

References

(1) Austin American Statesman, October 7, 1995.

(2) Presentation by Michael Bolton, General Manager for Capital Metro at ITS Conference on October 13, 1995.

(3) McDermott, Joseph, Chief Bureau of Traffic, Illinois Department of Transportation, Schaumberg, Illinois.

(4) National Travelers Information Radio Exchange News, Volume 5, Issue 1, Spring 1995, Zeeland Mi.

(5) Carlson, Glen, Manager of Traffic Control Center, Minnesota Department of Transportation, Minneapolis, Minnesota.

(6) Jim Barbaresso, Oakland County Department of Transportation, Oakland County, Michigan.

(7) Bill Baker, Travelers Information Systems, Zeeland Mi.

MULTI-AGENCY TRAFFIC MANAGEMENT CENTERS
SCOPE OF WORK

Task 1 -Identify metropolitan areas with traffic control centers capable of desired functions

Task Description and Milestone

The City of Austin desires a computer controlled signal system which is capable of the following functions in the order of importance:

- Accommodates existing system characteristics;
- Integrates signal control, preemption, cameras, signs, and flashers;
- Integrates video from a mobile source;
- Utilizes a distributive architecture;
- Supports a variety of communication mediums;
- Perform multiple tasks simultaneously;
- Provide remote access;
- Automatically adjust signal timings to accommodate traffic demand;
- Evaluate operations based on real-time speeds, travel times, and queue lengths;
- Continuously collect operational characteristics;
- Continuously update color coded maps;
- Display the network in different colors based on congestion;
- Recommend streets which can accommodate diversion during an incident;
- Provide emergency/bus preemption;
- Distinguish emergency/non-emergency preemption;
- Maintain signal coordination during preemption;
- Identify time, agency, and impact of preemption; and,
- Share data with other agencies.

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

The work generally consists of compiling summaries of the facilities and equipment, maintenance, personnel, funding, and implementation of a system capable of the above functions by other metropolitan areas. Two metropolitan areas should be considered.

Task 2 - Identify factors influencing the location of a multi-agency traffic control center

Task Description and Milestone

The work generally consists of identifying the advantages and limitations of both a centralized traffic management center and a distributed traffic management approach. A centralized center houses a variety of transportation stakeholders. A distributed approach enables each stakeholder to operate from their own facility while in direct communication with other stakeholders.

The Engineer shall provide the following services:

- Facilities Summary
- Equipment Summary
- Maintenance Summary
- Personnel Summary
- Funding Summary
- Implementation/Phasing Summary

Summaries of the facilities, equipment, maintenance, personnel, funding, and implementation needed to share the recommended data should be provided.

Facilities include structures or enclosures necessary to house and operate equipment and personnel and its cost. Equipment includes hardware, software, and communications items and their cost. Equipment costs should be identified as capital, operations, and maintenance. Maintenance includes routine and preventative actions, as well as, life-cycle costs. Personnel includes persons needed to design, operate, and maintain facilities and equipment. Funding includes both public and private sources of innovative financing. Documentation of a phased implementation strategy should be included.

Multi-Agency Traffic Management Centers

Traffic Management Centers (TMC) currently play an important role in helping to increase efficiency along roadway systems in cities nationwide. The most valuable services provided by TMCs to the public include real-time traveler information, incident detection and response management, motorist assistance, monitoring and surveillance of highway systems, and real-time traffic signal control.

Existing Traffic Management Centers

A survey recently conducted by The Urban Transportation Monitor identified 33 TMCs located in cities across the country. Twenty-four of the cities responded to the survey with information regarding their current operation and future plans. Summary tables from the September 15, 1995 and September 29, 1995 issues of The Urban Transportation Monitor are shown in **Table II - 17** and **Table II - 18** on the following pages.

Table II - 17 identifies summary characteristics about all facilities surveyed. The average number of personnel working at TMCs includes three traffic engineers, five traffic technicians, eleven dispatchers, and seven other personnel (computer scientists, supervisors, computer programmers, and system operators). Annual operating and maintenance budgets averaged $2.1 million per year, with 12 TMCs operating 24-hours per day, 7 days/week. Ten of the TMCs surveyed have a till-time police officer assigned to the center.

During October 1995, six TMCs were contacted by Wilbur Smith Associates to gather more detailed information regarding each TMCs facilities, equipment, maintenance, personnel, funding, and implementation/phasing schedule. Five of the TMCs (San Antonio, Texas; Montgomery County, Maryland; Houston, Texas; Los Angeles, California; and Minneapolis, Minnesota) responded to the survey by the date of this report, with one other location (Seattle, Washington) not responding at this time. Available information gathered from each location is summarized in the following sections.

Table II – 17

Summary of TMC Characteristics
Austin Area-Wide ITS
Austin, Texas

	% TMCs that have this presently installed	% TMCs that will install this in future
PRESENT, FUTURE EQUIPMENT/TECHNOLOGIES		
For collecting traffic information:		
Inductive loops/loop detectors	79	36
Closed-circuit television	86	46
Video surveillance cameras	71	39
Ramp meters	57	39
Vehicles as probes	18	36
Surveillance aircraft	18	11
Roadside mounted radar detectors	21	14
Satellites	4	4
Cell phone lines	54	25
Radio communication (CB, agency radio)	86	29
Telephone	79	29
Video imaging detection system	36	39
For distributing traffic information:		
Variable message signs	89	46
Highway advisory radio	50	54
Radio broadcast	64	25
Radio-CD, agency radio	57	18
Cable television	43	43
Personal computer/modem	64	39
Information kiosk	25	71
Telephone	68	36
Telephone-auto dialing	39	32
Displays at activity centers	29	61
For display:		
CRT displays	71	36
Map graphics display	79	46
PRESENT, FUTURE CAPABILITIES/FUNCTIONS OF TMC		
Incident management coordination	89	39
Special event coordination	96	36
Data backup	71	29
Media coordination and cooperation	96	39
System software support and maintenance	75	29
Traveler information services	54	61
Video surveillance	75	43
Traffic responsive signal control	50	50
Variable message sign control	89	43
Integrated transit and traffic operations	25	50
Integrated police/fire dispatching	29	43
HOV system coordination and cooperation	39	54
Emergency response vehicle management	32	25

Source: The Urban Transportation Monitor, September 29, 1995, p. 7.

Table II – 18

Transportation Management Centers Survey Results

Austin Area-Wide ITS

Austin, Texas

NAME OF TMC	Monitor Traffic Operations Center Milwaukee County WI		Houston TranStar; Houston, TX		VDOT Suffolk District Traffic Management System Control Center, Virginia Beach, VA		Traffic Systems Management Center Seattle, WA	
NAMES AND ROLES OF ORGANIZATIONS PARTICIPATING IN TMC	Milwaukee Cty Sheriffs Dept Milwaukee Cty Highway Dept		Harris County, City of Houston, Metro Transit Authority TxDOT Traffic Reporting Services		Virginia State Police		Washington State DOT Washington State Patrol	
EQUIPMENT, TECHNOLOGIES INSTALLED	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future
For collecting traffic information:								
Inductive loops/loop detectors	Ö	Ö	Ö	Ö	Ö		Ö	
Closed-circuit television	Ö	Ö	Ö	Ö	Ö		Ö	
Video surveillance cameras			Ö	Ö	Ö		Ö	
Ramp meters	Ö	Ö	Ö	Ö	Ö		Ö	
Vehicles as probes			Ö	Ö				Ö
Surveillance aircraft								
Roadside mounted radar detectors			Ö					Ö
Satellites								
Cell phone lines			Ö	Ö				
Radio communication (CB, agency radio)			Ö	Ö	Ö		Ö	
Telephone			Ö	Ö	Ö		Ö	
Video imaging detection system	Ö	Ö	Ö	Ö		Ö		Ö
For distributing traffic information:								
Variable message signs	Ö	Ö	Ö	Ö	Ö		Ö	
Highway advisory radio		Ö		Ö	Ö		Ö	
Radio broadcast			Ö	Ö	Ö			
Radio-CD, agency radio			Ö	Ö	Ö			
Cable television				Ö	Ö			Ö
Personal computer/modem	Ö	Ö	Ö	Ö	Ö		Ö	
Information kiosk			Ö	Ö		Ö	Ö	
Telephone	Ö	Ö	Ö	Ö	Ö		Ö	
Telephone-auto dialing	Ö	Ö		Ö				
Displays at activity centers			Ö	Ö		Ö	Ö	Ö
For display:								
CRT displays	Ö	Ö	Ö	Ö			Ö	
Map graphics display	Ö	Ö	Ö	Ö	Ö		Ö	
Other (as indicated by respondents):	Large screen projection TV	Large screen projection TV						
PRESENT AND FUTURE CAPABILITIES/FUNCTIONS OF TMC								
Incident management coordination	Ö	Ö	Ö	Ö	Ö		Ö	
Special event coordination	Ö	Ö	Ö	Ö	Ö		Ö	
Data backup	Ö	Ö			Ö		Ö	
Media coordination and cooperation	Ö	Ö	Ö	Ö	Ö		Ö	
System software support and maintenance	Ö	Ö	Ö	Ö	Ö		Ö	
Traveler information services	Ö	Ö	Ö	Ö	Ö		Ö	
Video surveillance	Ö	Ö	Ö	Ö	Ö		Ö	
Traffic responsive signal control		Ö		Ö			Ö	
Variable message sign control	Ö	Ö	Ö	Ö	Ö		Ö	
Integrated transit and traffic operations		Ö	Ö	Ö				
Integrated police/fire dispatching		Ö		Ö				
HOV system coordination and cooperation		Ö	Ö	Ö	Ö		Ö	
Emergency response vehicle management			Ö	Ö			Ö	
Other (as indicated by respondents								
TYOE OF ORGANIZATIONS TO WHICH TRAFFIC INFORMATION IS PROVIDED	Radio traffic reporters; traffic info service; TV station		Traffic reporting services; police		State police; news media; cable television companies; local municipalities		Traffic reporters (radio): TV stations; state patrol; metro transit, large business	
NUMBER OF PERSONNEL AT TMC	4 traffic engineers 1 traffic technician 2 dispatchers 2 electronic/computer engineers 1 office manager		7 traffic engineers 3 traffic technicians 6 dispatchers		2 traffic engineers 12 traffic technicians 1 electrical engineer 1 electronic technician supervisors 6 other		9 traffic engineers 3 traffic technicians 12 dispatchers/systems operations specialists 2 programmer specialists	
ANNUAL OPERATING AND MAINTENANCE BUDGET	$1.0 million		$750,000 not including personnel costs		$3 million		$1.3 million (for center only)	
PROVIDE TOURS FOR TRANSPORTATION PROFESSIONALS?	N.A		YES		YES		YES	
DAYS AND HOURS OF OPERATION	5 am to 7pm, M-F		6am to 10pm, M-F		24 hours/day; 7 days/ week		6 am to 7pm M-F, Sat & Sun 9am to 6 pm. Radio/Tunnel operations 24 hours/day, 7 days/week	
POLICE OFFICER ASSIGNED TO TMC?	NO		YES		YES (am and pm rush hours		NO	

Source: The Urban Transportation Monitor, September 15 and 29, 1995 issues.

Table II – 18 (continued)

Transportation Management Centers Survey Results
Austin Area-Wide ITS
Austin, Texas

NAME OF TMC	Montgomery County Transportation Management Center, Rockville, MD		Bridgeport Operations Center, Bridgeport, CT		Michigan Intelligent Transportation Systems Center, Detroit, MI		I66/I395 TMS, Arlington, VA	
NAMES AND ROLES OF ORGANIZATIONS PARTICIPATING IN TMC	DOT, Montgomery County Police & Fire and Rescue, Maryland State Highway Administration		Parsons Brinkerhoff Smartroutes, Inc.		DOT		State Police, Metro Traffic Safety Service, County Police	
EQUIPMENT, TECHNOLOGIES INSTALLED	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future
For collecting traffic information:								
Inductive loops/loop detectors	Ö	Ö			Ö		Ö	Ö
Closed-circuit television	Ö	Ö	Ö		Ö		Ö	Ö
Video surveillance cameras	Ö	Ö	Ö				Ö	Ö
Ramp meters					Ö		Ö	
Vehicles as probes		Ö						
Surveillance aircraft	Ö						Ö	Ö
Roadside mounted radar detectors		Ö	Ö					Ö
Satellites								
Cell phone lines								Ö
Radio communication (CB, agency radio)	Ö	Ö	Ö				Ö	Ö
Telephone	Ö	Ö	Ö				Ö	Ö
Video imaging detection system	Ö	Ö						
For distributing traffic information:								
Variable message signs		Ö	Ö		Ö		Ö	Ö
Highway advisory radio	Ö			Ö		Ö	Ö	Ö
Radio broadcast	Ö							
Radio-CD, agency radio	Ö		Ö					
Cable television	Ö			Ö			Ö	Ö
Personal computer/modem		Ö	Ö					Ö
Information kiosk		Ö				Ö		Ö
Telephone		Ö	Ö					Ö
Telephone-auto dialing		Ö						Ö
Displays at activity centers		Ö				Ö		Ö
For display:								
CRT displays	Ö	Ö	Ö					
Map graphics display	Ö	Ö	Ö		Ö		Ö	Ö
Other (as indicated by respondents):	Direct connection to broadcast TV							
PRESENT AND FUTURE CAPABILITIES/FUNCTIONS OF TMC								
Incident management coordination	Ö		Ö			Ö	Ö	Ö
Special event coordination	Ö		Ö		Ö		Ö	Ö
Data backup	Ö		Ö				Ö	Ö
Media coordination and cooperation	Ö		Ö		Ö		Ö	Ö
System software support and maintenance	Ö		Ö				Ö	Ö
Traveler information services	Ö	Ö		Ö				Ö
Video surveillance	Ö	Ö	Ö				Ö	Ö
Traffic responsive signal control	Ö			Ö				Ö
Variable message sign control		Ö	Ö		Ö		Ö	Ö
Integrated transit and traffic operations	Ö							Ö
Integrated police/fire dispatching	Ö		Ö					Ö
HOV system coordination and cooperation		Ö					Ö	Ö
Emergency response vehicle management	Ö	Ö						Ö
Other (as indicated by respondents								
TYOE OF ORGANIZATIONS TO WHICH TRAFFIC INFORMATION IS PROVIDED	Maryland State Hwy Admin; police; media (TV & radio)		State police; Newington operations; State of CT Maintenance; Smartroutes		State police; emergency patrol; Metropolitan traffic Center		Media; state police; various traffic operation centers	
NUMBER OF PERSONNEL AT TMC	3 traffic engineers 9 traffic technicians 3 dispatchers		2 traffic engineers 1 project manager 1 operation supervisor 8 full-time operators/3 part-time		3 traffic engineers 6 traffic technicians		1 traffic engineer 4 traffic technicians	
ANNUAL OPERATING AND MAINTENANCE BUDGET	N/A		$1 million		$800,000		$700,000	
PROVIDE TOURS FOR TRANSPORTATION PROFESSIONALS?	YES		YES		YES		YES	
DAYS AND HOURS OF OPERATION	16 hours/day, 7 days/week		24 hours/day, 7 days/week		6am to 7pm, M-F		19 hours/day, 7 days/week	
POLICE OFFICER ASSIGNED TO TMC?	NO		NO		NO		YES	

Source: The Urban Transportation Monitor, September 15 and 29, 1995 issues.

Table II – 18 (continued)

Transportation Management Centers Survey Results
Austin Area-Wide ITS
Austin, Texas

NAME OF TMC	INFORM (Information for Motorists), Hauppauge, NY		COMPASS, Ontario, Canada		Traffic Systems Center, Oak Park, IL		Transportation Management Center, San Diego, CA	
NAMES AND ROLES OF ORGANIZATIONS PARTICIPATING IN TMC	Parsons Brinkerhoff, Johnston Electric Corp. TT Wiley & Assoc. JHK		N/A		IDOT Communications Center and Emergency Traffic Patrol		Caltrans California Hwy Patrol	
EQUIPMENT, TECHNOLOGIES INSTALLED	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future
For collecting traffic information:								
Inductive loops/loop detectors	ö		ö		ö		ö	ö
Closed-circuit television	ö		ö			ö		ö
Video surveillance cameras	ö		ö			ö		ö
Ramp meters	ö		ö		ö		ö	ö
Vehicles as probes				ö				
Surveillance aircraft								
Roadside mounted radar detectors	ö		ö					
Satellites								ö
Cell phone lines				ö			ö	ö
Radio communication (CB, agency radio)	ö		ö		ö		ö	ö
Telephone	ö		ö				ö	ö
Video imaging detection system	ö			ö				
For distributing traffic information:								
Variable message signs	ö		ö		ö		ö	ö
Highway advisory radio		ö		ö	ö		ö	ö
Radio broadcast	ö		ö		ö			
Radio-CD, agency radio	ö						ö	ö
Cable television	ö		ö		ö			ö
Personal computer/modem	ö			ö	ö		ö	ö
Information kiosk		ö	ö					ö
Telephone	ö			ö			ö	ö
Telephone-auto dialing	ö				ö		ö	ö
Displays at activity centers	ö			ö	ö			ö
For display:								
CRT displays	ö		ö		ö		ö	ö
Map graphics display	ö		ö		ö		ö	ö
Other (as indicated by respondents):			Traffic info on paper; auto tau;audio tech-nology detec-tion		Test printers			
PRESENT AND FUTURE CAPABILITIES/FUNCTIONS OF TMC								
Incident management coordination	ö		ö				ö	ö
Special event coordination	ö		ö				ö	ö
Data backup	ö		ö				ö	ö
Media coordination and cooperation	ö		ö				ö	ö
System software support and maintenance	ö		ö		ö		ö	ö
Traveler information services	ö			ö			ö	ö
Video surveillance	ö		ö			ö		ö
Traffic responsive signal control		ö			ö		ö	ö
Variable message sign control	ö		ö		ö		ö	ö
Integrated transit and traffic operations		ö		ö				ö
Integrated police/fire dispatching			ö				ö	ö
HOV system coordination and cooperation	ö			ö			ö	ö
Emergency response vehicle management			ö					ö
Other (as indicated by respondents			Automatic inci-dent detection					
TYOE OF ORGANIZATIONS TO WHICH TRAFFIC INFORMATION IS PROVIDED	Media (TV & radio); state, county, and city police; shadow and metro traffic; government agencies; private enterprise		Media (TV & radio); emergency services (fire & police); newspapers		Media (TV & radio); police; tollway authority; transit agencies; universities' other state agencies		Traffic reporting services; newspapers; radio stations; bulletin boards; internet	
NUMBER OF PERSONNEL AT TMC	2 dispatchers 13 operators 1 programmer 7 state employees		2 traffic engineers 3 traffic technicians 23 dispatchers 15 emergency patrol 12 maintenance		2 traffic engineers 3 traffic technicians 4 electrical technicians 2 electrical engineers 2 computer engineers 1 secretary		3 traffic engineers 3 traffic technicians 3 dispatchers 6 software engineers/systems analysts	
ANNUAL OPERATING AND MAINTENANCE BUDGET	$5.3 million		$4.2 million		$1 million		TBD	
PROVIDE TOURS FOR TRANSPORTATION PROFESSIONALS?	YES		YES		YES		YES	
DAYS AND HOURS OF OPERATION	24 hours/day 7 days/week		1 center operates 24 hours/day 7 days/week; 1 operates 16 hours/day 5 days/week; 1 operates 16 hours/day7days/week		Operates 24 hours daily but only staffed 5am-7pm M-F		5 am to 8 pm, M-F	
POLICE OFFICER ASSIGNED TO TMC?	NO		NO		NO		YES	

Source: The Urban Transportation Monitor, September 15 and 29, 1995 issues.

Table II – 18 (continued)

Transportation Management Centers Survey Results

Austin Area-Wide ITS

Austin, Texas

NAME OF TMC	Central Valley Transportation Management Center, Fresno, CA		Newington Operations Center, Newington, CT		Texas Department of Transportation-Fort Worth, District TMC (Official name not yet determined), Fort Worth, TX		Statewide Operations Center (SOC), Hanover, MD	
NAMES AND ROLES OF ORGANIZATIONS PARTICIPATING IN TMC	Caltrans California Highway Patrol (CHP)		Connecticut State Police		TxDOT Fort Worth/Dallas Cities of Fort Worth, Arlington, Hurst, etc.		Maryland State Police Maryland Transportation Authority	
EQUIPMENT, TECHNOLOGIES INSTALLED	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future
For collecting traffic information:								
Inductive loops/loop detectors	ö				ö	ö	ö	
Closed-circuit television	ö		ö		ö	ö	ö	
Video surveillance cameras	ö		ö				ö	
Ramp meters	ö					ö		
Vehicles as probes				ö				
Surveillance aircraft							ö	
Roadside mounted radar detectors			ö				ö	
Satellites								
Cell phone lines	ö		ö			ö	ö	
Radio communication (CB, agency radio)	ö		ö		ö	ö	ö	
Telephone	ö		ö		ö	ö	ö	
Video imaging detection system			ö			ö		
For distributing traffic information:								
Variable message signs	ö		ö		ö	ö	ö	
Highway advisory radio	ö			ö		ö	ö	
Radio broadcast	ö		ö		ö	ö	ö	
Radio-CD, agency radio					ö	ö	ö	
Cable television				ö				ö
Personal computer/modem	ö		ö			ö	ö	
Information kiosk		ö				ö		ö
Telephone	ö		ö		ö	ö	ö	
Telephone-auto dialing			ö				ö	
Displays at activity centers		ö				ö	ö	
For display:								
CRT displays	ö				ö	ö	ö	
Map graphics display		ö			ö	ö	ö	
Other (as indicated by respondents):							wether, road seners, signal systems maintenance logistics	
PRESENT AND FUTURE CAPABILITIES/FUNCTIONS OF TMC								
Incident management coordination	ö		ö		ö	ö	ö	
Special event coordination	ö		ö		ö	ö	ö	
Data backup	ö		ö		ö	ö	ö	
Media coordination and cooperation	ö		ö	ö	ö	ö	ö	
System software support and maintenance	ö		ö			ö	ö	
Traveler information services	ö			ö		ö	ö	
Video surveillance	ö		ö		ö	ö	ö	
Traffic responsive signal control			ö			ö	ö	
Variable message sign control	ö		ö		ö	ö	ö	
Integrated transit and traffic operations				ö				ö
Integrated police/fire dispatching				ö				
HOV system coordination and cooperation	ö							ö
Emergency response vehicle management							ö	
Other (as indicated by respondents								
TYOE OF ORGANIZATIONS TO WHICH TRAFFIC INFORMATION IS PROVIDED	Media		State police; media' local police; ride share companies		Commercial traffic service		N/A	
NUMBER OF PERSONNEL AT TMC	2 traffic engineers 5 traffic technicians 2 dispatchers 3 CHP officers		4 traffic engineers 3 traffic technicians 2-4 dispatchers (state police) 15 systems operators		N/A		traffic eng. support staff 18 traffic technicians Emergency Response Technicians (ERT)	
ANNUAL OPERATING AND MAINTENANCE BUDGET	N/A		$3 million		N/A		$2.4 million	
PROVIDE TOURS FOR TRANSPORTATION PROFESSIONALS?	YES		YES		YES		YES	
DAYS AND HOURS OF OPERATION	5am to 6pm, M-F; November '95 – 24 hrs/day		24 hrs/day, 7 days/week		13 hours/day, M-F		24 hrs/day, 7 days/week	
POLICE OFFICER ASSIGNED TO TMC?	YES		NO		NO		YES	

Source: The Urban Transportation Monitor, September 15 and 29, 1995 issues.

Table II – 18 (continued)

Transportation Management Centers Survey Results

Austin Area-Wide ITS

Austin, Texas

NAME OF TMC	Anaheim Traffic Management Center; Anaheim, CA		Georgia Department of Transportation TMC, Atlanta, GA		City of Columbus Division of Traffic Engineering TMC, Columbus, OH		Irvine Traffic Research and Control Center (ITRAC), Irvine, CA		ADOT Traffic Operations Center, Phoenix, AZ	
NAMES AND ROLES OF ORGANIZATIONS PARTICIPATING IN TMC	Caltrans City of Irvine Hilton Multivision Cable TV		Georgia State Patrol Georgia Emergency Management Agency		City of Columbus Radio and TV Stations		N/A		Arizona Department of Transportation Federal Highway Administration	
EQUIPMENT, TECHNOLOGIES INSTALLED	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future
For collecting traffic information:										
Inductive loops/loop detectors	ö		ö		ö	ö	ö		ö	
Closed-circuit television	ö			ö	ö	ö	ö		ö	
Video surveillance cameras				ö	ö	ö	ö		ö	
Ramp meters				ö		ö			ö	
Vehicles as probes			ö							
Surveillance aircraft				ö						
Roadside mounted radar detectors									ö	ö
Satellites										
Cell phone lines			ö				ö			ö
Radio communication (CB, agency radio)	ö		ö		ö	ö	ö		ö	
Telephone	ö		ö		ö	ö	ö		ö	
Video imaging detection system				ö			ö		ö	ö
For distributing traffic information:										
Variable message signs	ö			ö		ö		ö	ö	
Highway advisory radio	ö			ö						ö
Radio broadcast				ö	ö	ö				ö
Radio-CD, agency radio			ö		ö	ö			ö	
Cable television	ö		ö			ö		ö	ö	
Personal computer/modem	ö		ö		ö	ö	ö		ö	
Information kiosk	ö			ö		ö		ö		ö
Telephone	ö		ö		ö	ö	ö		ö	
Telephone-auto dialing	ö			ö			ö		ö	
Displays at activity centers	ö			ö		ö		ö		ö
For display:										
CRT displays	ö				ö	ö	ö		ö	
Map graphics display	ö			ö		ö	ö		ö	
Other (as indicated by respondents):									Video/wall Video prepater	Internet
PRESENT AND FUTURE CAPABILITIES/FUNCTIONS OF TMC										
Incident management coordination	ö		ö		ö	ö	ö		ö	
Special event coordination	ö		ö		ö	ö	ö		ö	
Data backup			ö		ö	ö	ö		ö	
Media coordination and cooperation	ö		ö		ö	ö	ö		ö	
System software support and maintenance	ö			ö			ö		ö	
Traveler information services	ö		ö			ö		ö	ö	
Video surveillance				ö	ö	ö	ö		ö	
Traffic responsive signal control		ö	ö		ö	ö	ö		ö	
Variable message sign control	ö		ö			ö	ö		ö	
Integrated transit and traffic operations	ö			ö				ö		ö
Integrated police/fire dispatching	ö			ö				ö		ö
HOV system coordination and cooperation			ö					ö	ö	
Emergency response vehicle management			ö					ö	ö	ö
Other (as indicated by respondents										
TYOE OF ORGANIZATIONS TO WHICH TRAFFIC INFORMATION IS PROVIDED	State; police; media		Traffic reporting stations; police; Georgia Emergency Management Agency		Media; police		N/A		State police; DOT maintenance; DOT construction; news media; personal computer displays	
NUMBER OF PERSONNEL AT TMC	2 traffic engineers 2 interns		9 traffic engineers 6 traffic technicians 12 dispatchers 8 support staff		3 traffic engineers 3 traffic technicians		3 traffic engineers 6 traffic technicians		2 traffic specialists 2 traffic engineers 2 traffic technicians 8 operators 14 support staff	
ANNUAL OPERATING AND MAINTENANCE BUDGET	$1 million (including signal maintenance)		N/A		N/A (not separated from daily operations)		$1.5 million		N/A	
PROVIDE TOURS FOR TRANSPORTATION PROFESSIONALS?	YES		YES		YES		YES		YES	
DAYS AND HOURS OF OPERATION	7 am to 5:30 pm M-F (plus events)		24 hours/day, 7 days/week		6am to 6pm, M-F		7am to 6pm, M-F		24 hours/day, 7 days/week	
POLICE OFFICER ASSIGNED TO TMC?	NO		GDOT enforcement official		NO		NO		YES	

Source: The Urban Transportation Monitor, September 15 and 29, 1995 issues.

Table II – 18 (continued)

Transportation Management Centers Survey Results
Austin Area-Wide ITS
Austin, Texas

NAME OF TMC	Traffic Operations Center; New Brunswick, NJ		TransGuide San Antonio, TC		Traffic Management Center, Minneapolis, MN		Transportation Management Operations Center (TMOC) Portland, OR	
NAMES AND ROLES OF ORGANIZATIONS PARTICIPATING IN TMC	New Jersey Turnpike Authority		San Antonio Police, TxDOT, via Metropolitan Transit, City of San Antonio Traffic Operations, Research Organizations, Police/Fire/ EMS/911/Dispatch		Minnesota DOT/Metro Division		City of Portland, Metro, City of Gresham, Multinomah County, Oregon State Police, Washington DOT, Vancouver	
EQUIPMENT, TECHNOLOGIES INSTALLED	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future
For collecting traffic information:								
Inductive loops/loop detectors	ô		ô		ô	ô	ô	
Closed-circuit television	ô		ô		ô	ô		ô
Video surveillance cameras	ô		ô		ô	ô	ô	ô
Ramp meters				ô	ô	ô	ô	ô
Vehicles as probes				ô		ô		ô
Surveillance aircraft					ô	ô		
Roadside mounted radar detectors								
Satellites								
Cell phone lines	ô						ô	ô
Radio communication (CB, agency radio)			ô		ô	ô	ô	
Telephone	ô				ô	ô		
Video imaging detection system	ô		ô		ô			ô
For distributing traffic information:								
Variable message signs	ô		ô		ô	ô	ô	ô
Highway advisory radio	ô				ô	ô		ô
Radio broadcast			ô		ô	ô	ô	ô
Radio-CD, agency radio					ô	ô	ô	
Cable television			ô		ô	ô		
Personal computer/modem	ô		ô			ô		ô
Information kiosk		ô		ô		ô		ô
Telephone	ô					ô	ô	ô
Telephone-auto dialing	ô					ô		
Displays at activity centers		ô	ô			ô		
For display:								
CRT displays	ô		ô		ô	ô		
Map graphics display	ô		ô		ô	ô		ô
Other (as indicated by respondents):								
PRESENT AND FUTURE CAPABILITIES/FUNCTIONS OF TMC								
Incident management coordination	ô		ô		ô	ô		ô
Special event coordination	ô		ô		ô	ô	ô	ô
Data backup	ô		ô			ô		
Media coordination and cooperation	ô		ô		ô	ô	ô	ô
System software support and maintenance			ô		ô	ô		
Traveler information services	ô		ô		ô	ô		ô
Video surveillance	ô		ô		ô	ô		ô
Traffic responsive signal control	ô		ô		ô	ô		ô
Variable message sign control	ô		ô		ô	ô	ô	ô
Integrated transit and traffic operations	ô		ô		ô	ô		ô
Integrated police/fire dispatching	ô		ô			ô		
HOV system coordination and cooperation		ô		ô	ô	ô		ô
Emergency response vehicle management	ô		ô					
Other (as indicated by respondents								
TYOE OF ORGANIZATIONS TO WHICH TRAFFIC INFORMATION IS PROVIDED	Police; media; TRANSCOM		Media; emergency services (fire & police); transit; private transportation companies; general information services		Commercial radio & TV stations; trucker; transit operators; delivery services; utility companies		Media; police; local authorities	
NUMBER OF PERSONNEL AT TMC	13 dispatchers 5 supervisors 1 manager		4 traffic engineers 20 traffic technicians 60 dispatchers		6 traffic engineers 10 traffic technicians 1 computer engineer 1 programmer 1 R&D engineer 27 other		Center is only now being pulled together-no staff is specifically assigned to TMC.	
ANNUAL OPERATING AND MAINTENANCE BUDGET	N/A		$3 million		$4 million		N/A	
PROVIDE TOURS FOR TRANSPORTATION PROFESSIONALS?	YES		YES		YES		YES	
DAYS AND HOURS OF OPERATION	24 hours/day, 7 days/week		4am to 12am; 7 days/week		6am to 9pm weekdays; 11 am to 7 pm Saturdays & Sundays		Still to be decided-preference is 24 hours/day, 7 days/week	
POLICE OFFICER ASSIGNED TO TMC?	NO		YES		NO		Being considered	

Source: The Urban Transportation Monitor, September 15 and 29, 1995 issues.

Table II – 18 (continued)
Transportation Management Centers Survey Results
Austin Area-Wide ITS
Austin, Texas

NAME OF TMC	TRANSCOM Operations Information Center Jersey City, NJ		San Francisco Bay Area Interim TMC' (California Coastal Region), Oakland, CA		District 7 TMC, Los Angeles, CA		Golden Glades Interchange Control Center, Miami, FL		Colorado Traffic Operations Center, Lakewood, CO	
NAMES AND ROLES OF ORGANIZATIONS PARTICIPATING IN TMC	Over 200 agencies provide and receive information through TRANSCOM		Caltrans, California Highway Patrol (CHP), Metro Transportation Commission, Regional MPO		Caltrans California Highway Patrol Freeway Service Patrol		Florida Department of Transportation Florida Highway Patrol		Colorado State Police Colorado Office of Emergency Management	
EQUIPMENT, TECHNOLOGIES INSTALLED	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future	Presently installed	In Future
For collecting traffic information:										
Inductive loops/loop detectors			ö	ö	ö			ö	ö	
Closed-circuit television	ö		ö	ö	ö		ö	ö	ö	
Video surveillance cameras	ö		ö	ö	ö			ö	ö	
Ramp meters			ö	ö	ö			ö	ö	
Vehicles as probes	ö		ö	ö	ö			ö		ö
Surveillance aircraft					ö				ö	
Roadside mounted radar detectors						ö			ö	
Satellites					ö					ö
Cell phone lines			ö	ö	ö		ö	ö		ö
Radio communication (CB, agency radio)	ö		ö		ö			ö	ö	
Telephone	ö				ö		ö	ö	ö	
Video imaging detection system				ö	ö			ö		ö
For distributing traffic information:										
Variable message signs	ö		ö	ö	ö		ö	ö	ö	
Highway advisory radio	ö		ö	ö	ö			ö	ö	
Radio broadcast	ö		ö		ö		ö	ö	ö	
Radio-CD, agency radio	ö		ö		ö				ö	
Cable television					ö			ö		ö
Personal computer/modem	ö		ö	ö	ö		ö		ö	
Information kiosk		ö		ö		ö		ö		ö
Telephone	ö				ö		ö	ö	ö	
Telephone-auto dialing	ö			ö	ö			ö	ö	
Displays at activity centers		ö			ö			ö		ö
For display:										
CRT displays	ö		ö	ö		ö		ö	ö	
Map graphics display	ö		ö	ö	ö			ö	ö	
Other (as indicated by respondents):	alpha-num-eric pager internet e-mail									
PRESENT AND FUTURE CAPABILITIES/FUNCTIONS OF TMC										
Incident management coordination	ö		ö	ö	ö		ö	ö	ö	
Special event coordination	ö		ö	ö	ö		ö	ö		ö
Data backup	ö			ö	ö			ö	ö	
Media coordination and cooperation	ö		ö	ö	ö		ö	ö	ö	
System software support and maintenance	ö		ö	ö	ö			ö	ö	
Traveler information services	ö			ö		ö		ö	ö	
Video surveillance	ö		ö	ö	ö			ö	ö	
Traffic responsive signal control			ö	ö		ö	ö			ö
Variable message sign control	ö		ö	ö	ö			ö	ö	
Integrated transit and traffic operations	ö			ö		ö		ö		ö
Integrated police/fire dispatching			ö	ö				ö		ö
HOV system coordination and cooperation			ö	ö		ö	ö	ö	ö	
Emergency response vehicle management				ö	ö			ö		ö
Other (as indicated by respondents					lane closure construction, special event construction		traffic adaptive signals			
TYOE OF ORGANIZATIONS TO WHICH TRAFFIC INFORMATION IS PROVIDED	Transp. agencies; local, county and state police; media; employers; TMAs; transit agencies		Media-TV and radio		Media; transportation permits, public		Media; state police; public		Media; local fire/police; truck firms/truck stops/terminals	
NUMBER OF PERSONNEL AT TMC	1 traffic engineer 3 traffic technicians 10 dispatchers 2 operators managers		2 traffic engineers 6 traffic technicians 6 CHP/Media info. officers		8 traffic engineers 4 traffic technicians 8 dispatchers 6 CHP officers		1 traffic engineer 4 support staff		4 traffic engineers 6 traffic technicians 1 support staff	
ANNUAL OPERATING AND MAINTENANCE BUDGET	$1.9 million		$1.4 million		$10 million		$250 K		$2.1 million	
PROVIDE TOURS FOR TRANSPORTATION PROFESSIONALS?	YES		YES		YES		YES		NO	
DAYS AND HOURS OF OPERATION	24 hours/day, 7 days/week		24 hours/day, 7 days/week		24 hours/day, 7 days/week		8 am to 5 pm M-F		6 am to 7 pm; (24 hours/day, 7 days/week as of 11/1/95)	
POLICE OFFICER ASSIGNED TO TMC?	NO		YES		YES		NO		NO	

Source: The Urban Transportation Monitor, September 15 and 29, 1995 issues.

San Antonio TransGuide System

The Texas Department of Transportation implemented the TransGuide system in San Antonio to better manage the heavily congested freeway system. The center is designed to provide transportation officials the opportunity, within two minutes, to react to accidents and incidents on our freeways. At the operations control center, enforcement personnel will determine the type of incident and immediately dispatch emergency medical services and required accident scene clearing services while transportation officials begin a proactive traffic management approach.

Facilities Summary - The TransGuide Operations Center (TOC) was constructed within existing TxDOT right-of-way at the interchange of IH 410 and M 10 West. The TOC serves as the heart of the system and contains the computer system, numerous workstations, and communications equipment. The computer system is composed of a VAXft 810 mainframe computer and monitors and keyboards at each workstation. The software was developed using tailored Commercial-Off-The-Shelf (COTS) products and custom code developed exclusively for the TransGuide system.

Equipment Summary - To gather traffic information, TransGuide uses induction loop detectors buried one inch below the pavement surface. The loop detectors collect lane occupancy and volume information. Additionally, pairs of detectors are used in some locations to collect travel speed information. High resolution CCTV cameras permit the visual confirmation of congested locations reported by the loop detectors. Changeable message signs and lane control signals are used extensively to relay information to the public.

The communication system provides a single network to transmit data, voice, and video information between field equipment and the TOC. The network uses SONET standard communications protocol transmitted over a lily redundant single mode fiber optic system.

Maintenance Summary - Since the TransGuide system has only been operating for about 2 months, operation and maintenance costs have not been realized. The system is still operating under the initial warranty period provided by the contractor. Annual operating and maintenance costs are estimated at approximately $3 million. A concern exists about future maintenance requirements, and consideration is being given to contracting with a private firm.

Personnel Summary - The TransGuide staff includes 4 traffic engineers, 20 traffic technicians, and 60 dispatchers. TransGuide operates from 4:00 AM to Midnight, seven days per week.

Funding Summary - The total cost of the system is estimated at $151 million. Phase one was constructed at a cost of $32 million. The TOC was constructed at a cost of $6 million. Each mile of the system was installed at a cost of approximately $800,000 per mile, including communications and equipment. Hardware and software costs for the TOC totaled approximately $6 million.

Implementation/Phasing Summary - The fist phase of the TransGuide system went online during August 1995, with construction beginning in February 1993. Phase one included 26 miles of the planned 191 mile system, the complete TOC, mainframe computer system, application software, communication switching equipment andall supporting hardware. Additional miles of the system will be added in the near future, with two projects scheduled for construction within the next year.

Montgomery County, Maryland TMC

Montgomery County, Maryland has a population of approximately 800,000 persons and contains about 3,000 miles of roadways. The area is located on the northwestern border of Washington, D.C. and covers an area of approximately 500 square miles. Management of the substantial transportation system has been a priority of the Montgomery County Department of Transportation, with assistance from the Maryland State Highway Administration. The Transportation Management System was developed primarily to control the City's traffic signal system.

The success of Montgomery County's transportation management program is dependent on the coordination and cooperation of multiple agencies. These agencies include police, fire and rescue, environmental, planning, and transportation at the federal, state and local levels. The Transportation Operations and Incident Management Team is composed of representatives from various agencies and meets on a monthly basis to develop and implement transportation management improvements.

Facilities and Equipment Summary - The Advanced Transportation Management System (ATMS) is composed of multiple subsystems that provide real time control. The ATMS features an open architecture that allows for the new technologies to be readily added to the system. The system includes the following capabilities and functions:

- Advanced traffic responsive traffic signal control for over 600 traffic signals. The system is capable of handling up to 1,500 traffic signals;
- CCTV video surveillance. 60 cameras will be operational by the end of 1995 with a total of 200 cameras projected for the future;
- 1,000 loop detectors operational in 1995, with the capability of the system to monitor 3,000 total detectors utilizing various technologies;
- Automated variable message and route guidance sign control under development, and-will be tested during 1995-96;
- Travelers Advisory Radio System (TARS);
- Transportation broadcasts on cable television Channel 55;
- Aerial surveillance program;
- Coordination and information sharing with traffic information services;
- Kiosks and information centers implemented during 1995-96; and,
- Integrated traffic operations and transit management,

Montgomery County has been constructing a several hundred mile communication system to support the development of this system since 1980. The original twisted pair copper based system is being enhanced with a fiber optic system using the SONET standard protocol to support data, video, and voice requirements. The fiber optic system is being implemented with the capacity to connect all government, public school, and college facilities in the County.

Maintenance Summary - Annual operating and maintenance budgets or information are not presently available. The TMC operates 16 hours per day, 7 days per week.

Personnel Summary - The TMC has a staff of 15 persons, including 3 traffic engineers, 9 traffic technicians, and 3 dispatchers. A police officer is not presently assigned to the TMC.

Funding Summary - Funding for the system is not available, because the system has been constructed over a period of 15 years as part of numerous projects and appropriations.

Implementation/Phasing Summary - The first computerized traffic signal system component was constructed in 1980, and has been enhanced several times of the past 15 years to provide incident and traffic management features. The majority of the ATMS has been designed and installed within the last five years, with testing of many new features beginning in February, 1994.

Houston TranStar System

Houston TranStar (acronym for the Greater Houston Transportation and Emergency Management Center) is a joint initiative between the City of Houston, Harris County, Texas Department of Transportation (TxDOT), and Harris County Metropolitan Transit Authority (METRO). These agencies have established a separate legal entity, with a managing director not affiliated with any agency, to design, operate, and maintain the system.

Facilities Summary - A 52,000 square foot TMC is currently being constructed, with completion scheduled for late 1995. The center will be responsible for the Computerized Transportation Management System (CTMS) in freeway corridors, the Regional Computerized Traffic Signal System (RCTSS) on arterial streets, the Motorist Assistance Program (MAP), the Smart Commuter project, the HOV lane network, and emergency and disaster assistance. An interim TMC began operating in late 1993 and currently runs many of these programs.

Equipment Summary - The CTMS will eventually control more than 230 miles of freeway corridors, with 35 miles completed in 1994 and a total of 50 miles operational in 1995. The CTMS system will use vehicle detectors to measure speed, lane occupancy, and flow, changeable message signs, highway advisory radio, CCTV, and ramp metering using a fiber optic communications network. The RCTSS program will computerize more than 1,300 traffic signals throughout the area. Ultimately, about 2,800 traffic signals will be modified and upgraded by participating agencies. The RCTSS system will permit signal preemption for emergency vehicles as well as coordinated priority signal operation for buses that need to maintain schedules.

<u>Maintenance Summary</u> - Maintenance activities are not well defined for Houston's TranStar system, since it is the progress of being implemented. However, maintenance activities are currently averaging about $100,000 per year, with future estimates in the $750,000 range not including personnel and operating costs.

<u>Personnel Summary</u> - Houston TranStar currently has *a* staff of approximately 17 persons, including an executive director, 7 traffic engineers, 3 traffic technicians, and 6 dispatchers. The TMC is operated by a legal entity which is funded by the four major agencies involved in the project.

Funding Summary - A capital budget summary and operating budget for 1995 is shown in **Table II - 19** and **Table II - 20**. Annual operating costs are approximately $1 million, with total capital expenses for the construction of the TMC approximately $13.4 million.

<u>Implementation/Phasing Summary</u> - The TMC is scheduled for completion in late 1995, with functions transferred from the interim center in early 1996. Various components of the system are now operational, with additional segments being added on an annual basis.

Los Angeles TMC

The California Department of Transportation (Caltrans) began implementing an Advanced Transportation Management System in 1971. The system monitors conditions on the areas 400 plus miles of freeways, and provides valuable traffic information to motorists.

<u>Facilities and Equipment Summary</u> - The TMC is housed in a State owned building that is shared with other divisions and departments of Caltrans. The ATMS system is composed of numerous loop detectors (in about 1200 locations) which provide occupancy and speed information, CCTV at 23 locations (400 planned for the future), changeable message signs (CMS) in 73 locations, one dozen highway advisory radio (HAR) transmitters, 798 metered ramps (with 1140 planned for the future), and a service patrol of approximately 200 trucks. Information is distributed to motorists using several media, including FAX, cable television Channel 35, Traffic Vision reports to subscribers, and via the Internet. Communications is currently provided over leased telephone lines, but a fiber trunk line is currently being installed which will replace the need for leased telephone lines.

Table II-19
Houston TranStar Capital Budget Summary
Austin Area-Wide ITS
Austin, Texas

Element	Current Element Cost	Original Budget Transportation	Original Budget Emergency Management	Original Combined Budget Total	Cost – Budget Difference Transportation	Cost – Budget Difference OEM	In Kind Non Reimbursable Services
DESIGN							
Preliminary Engr	244,202	244,202		244,202	0		
Final Design	664,139	528,927	39,788	568,715	95,424		
Const Design Support	140,000	115,000		115,000	25,000		
Subtotal	1,048,341	888,129	39,788	927,917	120,424	0	0
CONST					0		
Building Const	5,849,000	5,411,871	139,049	5,550,920	298,080		
Building Const Change Orders	161,695			0	161,695		
Building Contingency (5% of Bid minus existing change orders)	130,755			0	130,755		
Const Mgt	398,000	350,000		350,000	48,000		
Furniture	416,500	500,000	55,000	555,000	-138,500		
OEM Op' s Rm Work Station Redesign	70,000		43,500	43,500		26,500	
Site Clearing				0	0		13,167
Site Drainage				0	0		15,000

Table II-19
Houston TranStar Capital Budget Summary
Austin Area-Wide ITS
Austin, Texas

Element	Current Element Cost	Original Budget Transportation	Original Budget Emergency Management	Original Combined Budget Total	Cost – Budget Difference Transportation	Cost – Budget Difference OEM	In Kind Non Reimbursable Services
Median Opening				0	0		23,000
Overflow Parking Lot				0	0		7,800
Radio Antenna Cables				0	0		20,000
Parking Lot Striping				0	0		3,000
Subtotal	7,025,950	6,261,871	237,549	6,499,420	500,030	26,500	81,967
PHONE SYSTEM					0		
Phone Switch/Sys Transportation	282,461	250,000		250,000	32,461		
Phone Switch/Sys OEM	107,039		7,600	7,600		99,439	
Phone, Data, CCTV Cables	100,000			0	100,000		
Subtotal	489,500	250,000	7,600	257,600	132,461	99,439	0
Computer Systems					0		
Computer Hardware	2,356,955	2,000,000		2,000,000	356,955		

Table II-19
Houston TranStar Capital Budget Summary
Austin Area-Wide ITS
Austin, Texas

Element	Current Element Cost	Original Budget Transportation	Original Budget Emergency Management	Original Combined Budget Total	Cost – Budget Difference Transportation	Cost – Budget Difference OEM	In Kind Non Reimbursable Services
Systems Integration	1,750,000	1,750,000		1,750,000	0		
Systems Integration Unfunded Delivery 1	224,130			0	224,130		
Systems integration Unfunded CMS	396,000			0	396,000		
Systems integration CMS Satellites	163,000			0	163,000		
Subtotal	4,890,085	3,750,000	0	3,750,000	1,140,085	0	0
GRAND TOTAL FUNDED ELEMENTS	13,453,876	11,150,000	284,937	11,434,937	1,893,000	126,939	81,967

Table II - 20

Houston TranStar Operating Budget
Austin Area-Wide ITS
Austin, Texas

OPERATING BUDGET		
ITEM	FULL YEAR	FY 95/96
SUPPLIES/MATERIALS		
Maintenance Supplies	42,000.00	25,940.00
Office Supplies	32,000.00	19,745.00
Computer Supplies	25,500.00	15,735.00
Postage	4,000.00	2,470.00
Sm Tools/Minor Equip	15,000.00	18,500.00
Printing	30,000.00	39,596.00
Publications	5,000.00	5,000.00
Memberships	2,000.00	2,000.00
Training	1,000.00	1,000.00
Office Equip Rental	21,500.00	13,265.00
Computer Equip Rental	5,500.00	3,395.00
Misc Office Equip	3,000.00	3,000.00
Travel	18,000.00	18,000.00
SUBTOTAL	204,500.00	167,646.00
UTILITIES		
Electric	110,000.00	67,870.00
Gas	20,000.00	12,340.00
Water/Sewage	12,000.00	7,404.00
Communication (Telephone)	44,500.00	50,180.00
SUBTOTAL	186,500.00	137,794.00
MAINTENANCE SERVICES		
Building Cleaning	25,000.00	15,425.00

SOURCE: Houston TranStar, September 1995.

Table II - 20 (continued)

Houston TranStar Operating Budget
Austin Area-Wide ITS
Austin, Texas

OPERATING BUDGET		
ITEM	FULL YEAR	FY 95/96
Landscape Maint	13,200.00	8,804.00
Building Maint	20,200.00	13,375.00
Office Equip Maint	2,000.00	1,340.00
Mechanical Maint	42,000.00	28,140.00
SUBTOTAL	102,400.00	67,084.00
COMPUTER HARDWARE MAINT		
	200,000.00	133,400.00
SUBTOTAL	200,000.00	133,400.00
COMPUTER SOFTWARE MAINT		
	181,000.00	120,727.00
SUBTOTAL	181,000.00	120,727.00
COMMUNICATIONS EQUIP		
Included in Hardware	0.00	
SUBTOTAL	0.00	0.00
VIDEO MAINTENANCE		
Included in Hardware	0.00	
SUBTOTAL	0.00	0.00
PERSONNEL		
Salaries (4 positions)	277,550.00	268,905.00
SUBTOTAL		
GRAND TOTAL	1,151,950.00	895,556.00

SOURCE: Houston TranStar, September 1995.

Maintenance Summary - Operations and maintenance costs average approximately $2.5 to $3 million per year. These costs include salaries for 30 personnel, leased phone line expenses, equipment, and maintenance contracts. The majority of the maintenance of the system is handled through contracts with private companies, In 1991, a service patro1 was initiated between Caltrans and the California Highway Patrol (CHP). Private tow operators are contracted and assigned a beat to patrol. This service costs approximately $14 million per year to operate, including administration.

Personnel Summary - Approximately 30 persons are on the TMC staff, including traffic engineers, system operators, software technicians, and dispatchers. The center is operated 24-hours a day, seven days per week. Personnel are used on a rotating shift basis, with at least three staff members on duty at all times (one CHP officer, one Caltrans operator, and one Caltrans dispatcher).

Funding Summary - Cost and funding information is not well defined because of the "piecemeal" approach used in developing the system. Many system costs, such as the installation of loop detectors, were hidden within freeway reconstruction projects and are not known. However, estimates for the total system range from the hundreds of millions of dollars to one billion dollars, maximum. Current capital outlays for completion of the system are approximately $300 million.

Implementation/Phasing Summary - Caltrans began implementing an Advanced Transportation Management System (ATMS) in the Los Angeles area in 1971 with a relatively small 42 mile freeway loop. Between 1971 and 1990, using a "piecemeal" approach, the system was expanded to its current 400 miles. In 1990, state legislation provided finding for the ATMS, from which a ten year plan was developed for a future 550 mile system.

Minneapolis Traffic Management Center

The Minnesota Department of Transportation's Traffic Management Center (TMC) opened in 1972 and is the operations center for managing freeway traffic in the Twin Cities Metro Area. The TMC is also participating in a number of ITS operational tests, such as the Integrated Corridor Traffic Management (ICTM) project. The ICTM project is being implemented along a 7.9 mile segment of III 494, with the main objective of improving the efficiency of traffic movement throughout the corridor on freeways and arterial streets. The freeway and arterial traffic control devices, such as traffic signals, are being integrated in an adaptive traffic control environment. In addition, the project will develop unified traffic control strategies through interjurisdictional cooperation, implement an incident management plan, and implement a comprehensive motorist information program. The communication media is fiber optic cable. The cable is also connected to transit and EMS users.

An evaluation of the system along III 35W between downtown Minneapolis and Burnsville identified the following highway user benefits, which are typical of other large systems:

- Roadway capacity increased from 1800 to 2200 vehicles per hour per lane;
- Peak period speeds increased 35% from 34 to 46 mph;
- Peak period accidents decreased 27% from 421 to 308 per year;
- Peak period accident rates decreased 41% from 3.40 to 2.02 accidents per million vehicle miles traveled;
- Peak period fuel consumption was reduced by one million gallons per year;
- Peak period air pollutant emissions (carbon monoxide, hydrocarbons, and nitrogen oxides) were reduced by four million pounds per year; and,
- One million dollars a year in road user benefits are attributed to reduced accidents and congestion.

Facilities Summary - The TMC is housed in a building originally constructed in 1972, with a redesign completed in December 1992. The new design includes two independent operator work stations, a radio announcer station, an information officer station, computergraphics terminals, and a large screen map display. Each operator’s workstation consists of 24 17-inch monitors and computer terminals with graphics capabilities to control the ramp meters and changeable message signs. A large computer generated map displays real-time traffic conditions on area freeways. The communication connection to other agencies reduces the urgency desire to move into one facility.

Equipment Summary - The traffic management system currently in operation in the Minneapolis/St. Paul area includes 380 ramp meters, 156 CCTV cameras, and 56 changeable message signs. The CCTV cameras located along IH 94 are mounted on tall buildings and communicate to the TMC via microwave signal. Other CCTV cameras communicate via fiber optic cable or coaxial cable, with the coaxial cable being replace with fiber optic cable within the next five years. Changeable message signs are of the six sided rotating drum type, but the MnDOT is currently evaluating new sign technologies.

Maintenance, Personnel and Funding Summary - Detail information on maintenance activities, personne1, and funding is not generally available at this time. However, information on personnel and funding is being compiled in a TMC Business Plan report, and should be available in the near future. The TMC personnel in peak periods includes 2 operators, 1 public information officer, 1 radio broadcaster, 1 TRILOGY System (Demonstration Project) operator broadcasting to vehicles, and 2 supervisory personnel for a total of 7 people. In off peak periods only 2 people are present. The hours of operation are from 6:00 am to 9:00 pm weekdays and 7:00 am to 8:00 pm on weekends.

Implementation/Phasing Summary- The traffic management system in the Minneapolis/St. Paul area was initiated in 1972 as part of the IH 35W Urban Corridor Demonstration Project, and has evolved into the system described in this section. The system is still being developed as new technologies are discovered, tested, and implemented.

Summary

The five agencies surveyed by Wilbur Smith Associates included two TMCs primarily designed for freeway surveillance (San Antonio TransGuide and Los Angeles TMC), one TMC primarily designed for operating a local traffic signal system (Montgomery County, Maryland), two TMC designed for operating both freeways and traffic signal systems (Houston TranStar) and (Minnesota DOT TMC).

All agencies surveyed stressed that a definite commitment of adequate financial resources, qualified personnel, fully integrated systems, and appropriate technology are available. Funding for operations and maintenance must be allocated from a dedicated source prior to beginning construction of the system. Staffing, training and funding must be available for construction, operations, and maintenance.

For TMC site visits to areas that would possibly be representative to the Austin area it is recommended that the agency staff visit the following cities: San Antonio and Houston, Texas; Los Angeles, Anaheim, and San Diego, California; Montgomery County, Maryland; and Minneapolis, Minnesota. The Las Vegas, Nevada system should be carefully monitored during its expansion phase since Nevada DOT is proposing to utilize 2070's for their system upgrade.

Multi-Agency Traffic Management Center

The Multi Agency Traffic Management Center (TMC) is the core of an integrated traffic control system for multi agency utilization. The primary purpose of the TMC is to gather roadway and traffic data and information for use by numerous local agencies. The TMC should more accurately be called an Information Management Center (IMC) to help encourage the use of the facilities by non-transportation related agencies. The full benefits of a TMC cannot be realized until all of the governmental agencies in the Greater Austin Area become a part of the TMC.

The first step in establishing a multi-agency TMC is the formation of an operations management committee comprised of members of the various agencies most actively involved in its development. This organization should facilitate decision making in regards to the center. The committee should be comprised of, at a minimum, the following members:

- Texas Department of Transportation, Austin District;
- City of Austin (representing traffic, police, fire, and EMS functions);
- Capital Metro; and,
- Travis County.
- Research Enity; and,
- Private Sector Representation

Similar committee structures have provided the catalyst in the development of traffic management centers in cities around the nation, such as Las Vegas, Nevada and Houston, Texas. The committees should be advised by a Board of Directors comprised of one representative from each member agency. A manager or director with no current ties to any member agency manages the committee. This management structure wil1 help to ensure that decisions made will benefit all of Greater Austin and not just one of the member agencies. Funding for the management structure should be provided by the member agencies,

There are two different approaches which could be utilized to develop a TMC for the Greater Austin Area: a centralized approach and a distributed approach. Both of these TMC designs are described in the following sections.

Centralized Traffic Management Center

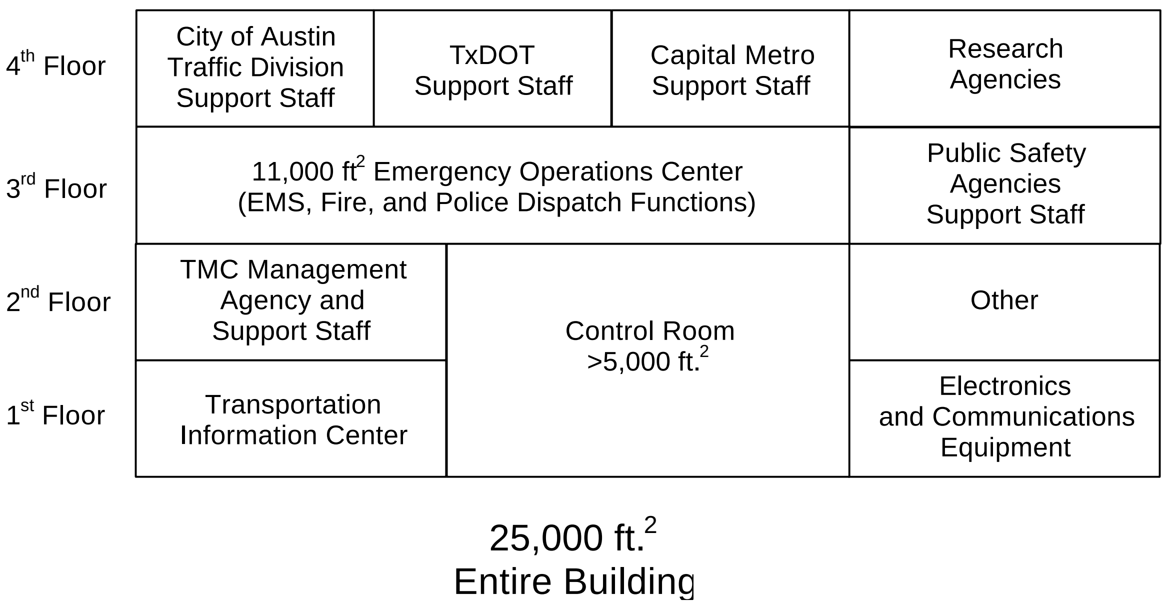
A centralized Traffic Management Center, as shown in **Figure II - 34**, consolidates all operations and dispatching functions of numerous agencies into one building at one location and provides the greatest opportunity for interagency coordination and multi agency cost sharing. The primary areas of coordination are within a few feet of each other and not only lends itself for field coordination but also provides local agency coordination in case of a major disaster. The functions and agencies involved are generally shown on Figure II - 34.

The Texas Department of Transportation, City of Austin, Travis County, Public Safety Agencies (PSA), and Capital Metro are primarily the current end users of a shared Multi Agency Traffic Control Center. This type of deployment enables the total coordination and immediate inter agency coordination within the building as well as the field. In the future, numerous other agencies or organizations, as identified in **Table II - 21**, may be involved in the TMC and may have a desire or need for one or more workstations within the center.

The news media will pray a very important role in the development of the Centralized Traffic Management Center in that the news media will educate the public and help to disseminate traffic conditions throughout the Greater Austin Area. This function will also improve public relations and improve the likelihood of bond elections for sources of funding.

The 800 MHz radio frequency trunking system, which should be a part of the Centralized Traffic Management Center, plays an extremely important role in the interagency coordination of the wider Greater Austin Area. This type of communication system facilitates coordination, especially during major disasters, and will preclude the coordination of a non-centralized traffic management system.

In this case, since the entire head end of the 800 MHz system is located at the Centralized TMC (where a11 of the coordination emanates), it is easy for ah of the agencies to communicate via an 800 MHz radio frequency trunking system during major disasters. Major disasters may interrupt power or preclude the remote outlying areas from communicating over the standard fiber optics or standard telephone system. The 800 MHz trunking system can be highly effective in providing a communications system in times of disaster when electrical power is typically unavailable.



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ADVANCED TRAFFIC ENGINEERING
KESSMAN & ASSOCIATES

Possible Centralized TMC
Building Arrangement
Austin Area-Wide ITS
Austin, Texas

Figure II-34

Table II – 21

Agencies and Organizations to be
Potentially Involved in the Austin TMC
Austin Area-Wide ITS
Austin, Texas

Texas Department of Transportation	NAFTA Weigh-in-Motion Monitoring
City of Austin Traffic Division	HAZMAT Monitoring
City of Austin EMS	News Media
City of Austin Police Department	Commercial Traffic Reporting Services
City of Austin Fire Department	Commercial Vehicle Operations
Capital Metro	City of Round Rock
Texas Department of Public Safety	City of Pflugerville
University of Texas Police Department	City of West Lake Hills
Travis County Sheriffs Office	City of Del Valle
Metro Police	City of Rollingwood
Courtesy Patrol	City of Sunset Valley
National Weather Service	City of Cedar Park
Federal Highway Administration	City of Oak Hill
Federal Transit Administration	City of Jollyville
Federal Aviation Administration	

Advantages - A Centralized Traffic Management Center (TMC) will provide unified traffic management and traveler information for the metropolitan area. This type of deployment will provide the following advantages:

- A centralized TMC will bring together traffic management and public transportation personnel from the City of Austin, TxDOT, Capital Metro, and other agencies. This includes the freeway traffic management and traffic signal system personnel who will be able to work together in developing corridor and area wide traffic management plans for recurring and non-recurring events. This is especially important as traffic volumes grow due to increasing population and freight movement Communications between all agencies/entities will become much easier with the ability to "walk across the room" and discuss an incident or procedure resulting in faster resolution;

- Only one large "hub" communication node will be necessary with a central TMC, thereby minimizing initial construction and later expansion costs. A communication component will be necessary for each major connection into the primary fiberoptic network.

- A central TMC will provide facilities consolidation, with only one physical site needed to operate and maintain;

- A heightened sense of a "TEAM" is formed when all agencies/entities are in one location. Efforts are focused upon providing a unified response Obstacles produced by the "them vs. us" syndrome are decreased as members become better acquainted with each entities' capabilities, resources, procedures, and personnel;

- A central TMC will also permit inter-modal integration through the coordination of traffic management and public transportation. Transit operations could be carried out through a separate computer which would be interconnected with the other traffic management and freeway HOV computers. Being in one location, however, personnel can work more closely in developing strategies for encouraging transit operations (e.g. bus and rail priority operations, improved communications with the public and the media);

- A centralized TMC will permit the Public Safety Agencies, Public Transportation and Traffic Management personnel to work together and to provide one focal point for working with surrounding cities and other agencies (public works, maintenance, Metropolitan Planning Organization);

- A centralized TMC will improve efficiency in overall traffic management and implementation of Intelligent Transportation Systems (ITS). This includes applications for reducing vehicle emissions and increasing HOV and public transit ridership;

- A centralized TMC will also provide one focal point for gathering, analyzing, and disseminating information to the public and commercial media stations. This will permit more accurate and timely information than if information must come from many agencies within the region;

- The development of a central TMC will reduce overall costs to each agency by combining space and communication utilization and by reducing overall operation maintenance costs; and,

- A central TMC will permit the traffic management agencies to have one manager or director (as is being done in Las Vegas and Houston) to coordinate operations and work with the administrators of various agencies.

Disadvantages - Despite the numerous advantages, the Centralized TMC deployment approach provides the following disadvantages:

- The primary disadvantage of the Centralized Traffic Management Center is the possibility of failure in a major disaster. Acts of terrorism and major disasters may interrupt the primary functions of the Centralized Traffic Management Center. Good security measures would include a screening reception area fairly well isolated from the operations and controls areas of the Centralized Traffic Management Center. Finding a location that meets the security needs of all participants as well as operating needs of all participants may be very difficult, costly, and not easily accessible to communications medium.

- A large amount of land will be required in one location for the TMC building and parking areas. Also, each agency has desired needs which makes it more difficult to find a suitable site.

- Initial Facilities Start-up Costs - the initial building costs of constructing a facility to house all agencies/entities would exceed the costs of implementing a Distributed Traffic Management Center that utilizes some or most of the existing facilities.

Facilities Summary - A centralized TMC would require all agencies participating in the center to relocate operational functions and possibly additional support staff to one location. A possible building arrangement was previously shown. The two-story control room would eventually contain approximately 40 workstations to accommodate all of the potential agencies and organizations and large rear-projection screens and/or a video wall at the front of the room. The workstations are the primary operations consoles that are used to verify, detect and provide verification of the type of incident that occurs throughout any part of the Greater Austin Area.

The control room can provide the video verification as well as traffic load conditions, for the Emergency Safety Center located on the third floor. All dispatching functions for Police, Fire, and EMS would be located on the third floor, with a facility of approximately twice the size of the current City of Austin EOC or ESC. The location of the ESC in the same building as the management center is extremely useful during major incidents involving hazardous materials, fire, or terrorism activity. Travis County and other PSA's would also be located in the facility.

The Transportation Information Center (TIC) would also be located *on* the first floor, with large windows overlooking the control room. The TIC is a gathering room for the media, commercial vehicle operators, and other groups desiring real-time traffic information.

The electronics and communications equipment room contains racks of equipment which can support the intent of the Operations Center but also includes spares for future growth. Equipment contained in the electronics and communications equipment room is identified in **Table II - 22**. A common area for all electronics racks which provides communications, video switch gear controller, controller electronics for the traffic signal control systems, as well as TxDOT computer controls, and PSA electronics racks for all 800 MHz trunking and all support console electronics would be concentrated in this area.

This area should be sized for a 100% spare growth for the next 20 years. The type of equipment that can be utilized by the control Center as well as all of the PSA and 911 call outs can be listed under the Equipment Room Equipment Racks as indicated in Table II - 22.

The control center would be overlooked by a planning coordination room. A good design should include windows for the planning coordination room, as well as windows for the hall, Director's room, and the halls adjacent to the control room areas. The typical second floor configuration would provide office space for the Director, secretary, and support personnel, including break room, and storage room.

Even with one TMC, there could be two operations control rooms adjacent to each other, if desired. One control room would provide for the PSA personnel and the second for the Traffic Management, Capital Metro and Traffic Information Center personnel. The two control rooms could be separated by a glass partition.

Table II – 22

Electronics and Communications Equipment Room
Austin Area-Wide ITS
Austin, Texas

	Rack Number	Description
Communications	1 -6	T1, DS3 Equipment
	7 - 8	Fiber Optic Termination
	9- 10	800 MHz Trunking
Video Switchgear	1 - 4	Video Switching & workstation controls
	4 - 8	Termination & Test Equipment
	9- 10	Spare
Traffic Management Computers	l - 3	City Traffic Computers
	4 - 8	TxDOT Freeway Traffic Computers
	9- 10	Interface Cabinet *
	11	CMS Computers*
PSA Equipment**	1-3	Police Department
	4 - 6	Fire Department
	7 - 9	Other PSA Departments
	10	800 MHz Trunking

* The CMS Cabinet is the network server for all CMS field controllers as well as the clients in the TMC.

** The generic equipment for each PSA would include 800 Mhz I/F's , dispatch connects, T1 interfaces, fiber optic interface, telephone PBX connects, 800 Mhz call, did group manager unit.

It may be desirable to locate the TMCYPSA control room and computers below ground for purposes of security. Discussions to date have involved the construction of a new facility, but it may be possible to lease, lease to buy or buy a building that will meet the central TMC/PSA needs in lieu of constructing a new building.

Equipment Summary - A centralized TMC approach consolidates all equipment into one facility, including hardware, software, and communication needs. The equipment needed for a centralized TMC is summarized in the following sections:

- *Hardware* - Hardware used in the operation of a centralized TMC is identical to the hardware recommended in previous chapters for the Traffic Signal System (TSS), the Freeway Traffic Management System (FTMS) and Incident Management, Verification, and Response. The required hardware is summarized as follows:

  - TSS Local Intersection Controller/FTMS Local Control Unit (2070/ATC)
  - Vehicle Detectors (Inductive Loops, Video Image Processing, Microwave Detectors, and Infrared Detectors)
  - Surveillance Equipment (CCTV)
  - TSS Central System/FTMS Computer Unit (Networked Pentium-type PC workstations with bi-directional links to Police/Fire/EMS CAD System)

- *Software* - Software used in the operation of a centralized TMC is similar to the software recommended in previous sections for the Traffic Signal System (TSS), the Freeway Traffic Management System (FTMS) and Incident Management, Verification, and Response. There is a need to have separate software operating in a windows or similar environment such that the entire package will not have to be rewritten if changes or made to one package. Each type of operating package has a unique task to perform and can be tailored to perform that task efficiently while operating under the primary operating system. Updates can be made to each individual package as needed or as available without upgrading the entire system. The required software is summarized as follows:

  - Traffic Signal System Controller Software
  - Central Traffic Signal Software
  - Freeway Management System Controller Software
  - Freeway Management System Central Software
  - Incident Detection Software - Incident Detection Software for the Local Controller that provides incident alarms to the TSS/FTMS Central/Computer Unit. These alarms are calculated by measuring parameters, i.e. volume, speed, and occupancy at each vehicle detector location (upstream and downstream). An incident is detected based upon any of these parameters exceeding threshold limits. When an alarm occurs, CCTV could be used at the TSS/FTMS to verify the incident. A message could then be sent to the Police/Fire/EMS CAD system once verification is complete. The other software previously referenced (i.e. ramp metering, signal coordination, emergency vehicle pre-emption, changeable message signs with

diversionary route information, routing alternatives, etc.) could then be initiated by the TSSEIMS system.

- Linkage Software for Bi-Directional Communications between the TSS. FTMS. and Police/Fire/EMS CAD System - The linkage software allows the field equipment to notify the TMC of an incident or pre-emption and the PSA know the location of their vehicles in the field. The TMC could then communicate to their field units. Software that will allow messages to be sent between the TSS, FTMS and Police/Fire/EMS CAD System should be implemented so that all agencies are notified of incidents. The TSS and FTMS should be notified of all incidents that might have an effect on traffic flow. The TSS and FTMS could be utilized to improve response to the incident and increase safety.

- *Communications* - The primary communications equipment can consist of standard Public Exchange (PBX) telephone communications system as well as the primary fiber optics Freeway Traffic Management System, GAATN Fiber Optic Ring Telecommunications System, and the 800 MHz radio frequency common carrier trunking system, as well as the cellular telephone service area. These types of communications systems are all related in one way or another to the common shared objectives of the Centralized Traffic Management Center.

  In the case of a major disaster where power is unavailable in different areas throughout the Austin Area, the 800 MHz system can be a tremendous asset for the operations of the Centralized Traffic Management Center. Vice versa, when the 800 MHz system does not function well in a rather hidden area in a certain point of the Greater Austin Area, either a cellular phone or a fiber optic communications drop can be made accessible by utilizing the GAATN, or the common Freeway Traffic Management System fiber optics major communications trunkline. The communications equipment summary and estimated cost is shown in **Table II - 23.**

The communications concerns for the centralized TMC approach (which carry all data, voice and video communications) offer the best alternative to a multi-agency cost sharing system for TxDOT, City of Austin, Travis County, and PSA. In addition, Capital Metro, news media, courtesy patrols, and signal shop maintenance can utilize this common multi-agency communications system.

A centralized TMC would provide a common communications system with a multi-agency cost sharing which will in the end provide the most cost effective communications system. This would be true for the onset of the initial projects cost and long term operations and maintenance of the system. The commonality of the communications system throughout the entire area enhances the common electronics packages that are available for the different agencies.

Table II – 23

Communications Equipment Needs and Cost for Centralized Traffic Management Center
Austin Area-Wide ITS
Austin, Texas

Item	**Estimated Cost**
DS3 Carrier - 4 Shelves	$ 120,000
T1 Carrier - 20 Shelves	240,000
Fiber Optic Termination - 2 cabinets	30,000
Interface Drivers - 1 Cabinet*	50,000
800 MHz Trunking System**	991,600
TMC Building Communications	
Control Room - 40 Workstations	40,000
PSA Room - 50 Workstations	50,000
PBX interconnects - 80 Lines	5,600
Total	$ 1,527,200

* Interface drives include the following:
- Video equipment
- Data equipment/management system
- Voice equipment

** A detail study to determine this cost is currently being conducted by PSA.

Maintenance Summary - Operating and maintenance costs for TMCs operating in other cities average approximately $2.1 million per year. Average maintenance costs can be estimated during the planning stages at approximately 10 percent of the construction cost of a TMC. Annual maintenance costs typically range from 5 to 20 percent of TMC construction costs and will vary depending on the number of field units needing maintenance (such as loop detectors) and the type of communication system installed.

Maintenance personnel requirements include a staff of trained personnel to perform communications maintenance, general equipment maintenance, and software maintenance. The size of this staff is dependent upon the type and size of TMC that is implemented in the Austin area, but is estimated at approximately one software maintenance person, one communications maintenance person, and two equipment maintenance persons present during all TMC operational hours. Operations personnel requirements are discussed in the Personnel Summary section.

Personnel Summary - The number of personnel needed by TxDOT and the City of Austin to operate a centralized traffic management center is identical to the staff needed regardless of their location, as previously identified in the Tragic Signal, Freeway Traffic Management sections. The only additional personnel needed to operate the center will be part of the operating committee, including the director or manager, 1 or 2 assistant directors, 4 support and secretarial staff, software manager, communication manager and a 24-hour security staff. The operating the Emergency Safety Center would be similar to the existing staffing level currently working as dispatchers in other locations. A 24 hour operation would require additional operational support staff. Staff needed by other agencies, such as Capital Metro. A 24-hour operation would require a minimum of 1 staff person per agency per shift for fill operation. However, with some cross training in off-peak periods, the number of staff could be halved.

Funding Summary - The cost of developing a centralized TMC primarily consist of the cost of constructing or leasing a building and installing all hardware, software, and communications. The total cost is summarized in **Table II - 24**, and includes estimates for the building, software, workstations, and internal communications. The costs of installation of all field equipment and communications to field locations is summarized in previous chapters. Software costs are estimated based on the recommended design of a PC based system. If a Unix/windows based system is chosen, costs for software alone can be expected to increase to $15 to 20 million. If the system is automated

Table II – 24

Estimated Cost of Centralized TMC
Austin Area-Wide ITS
Austin, Texas

Item	Estimated Cost
TMC Building	$3 to 6 million
Internal Communications (see Table II-23)	$ 1.6 million
Hardware	
40 Workstations @ $ 10,000 (includes 4 video monitors, controls, console, and CPU)	$400,000
4 Servers @ $20,000	80,000
Software	
Non-proprietary, PC based system	$ 3 to 5 million
Total	**$ 8 to 13 million**

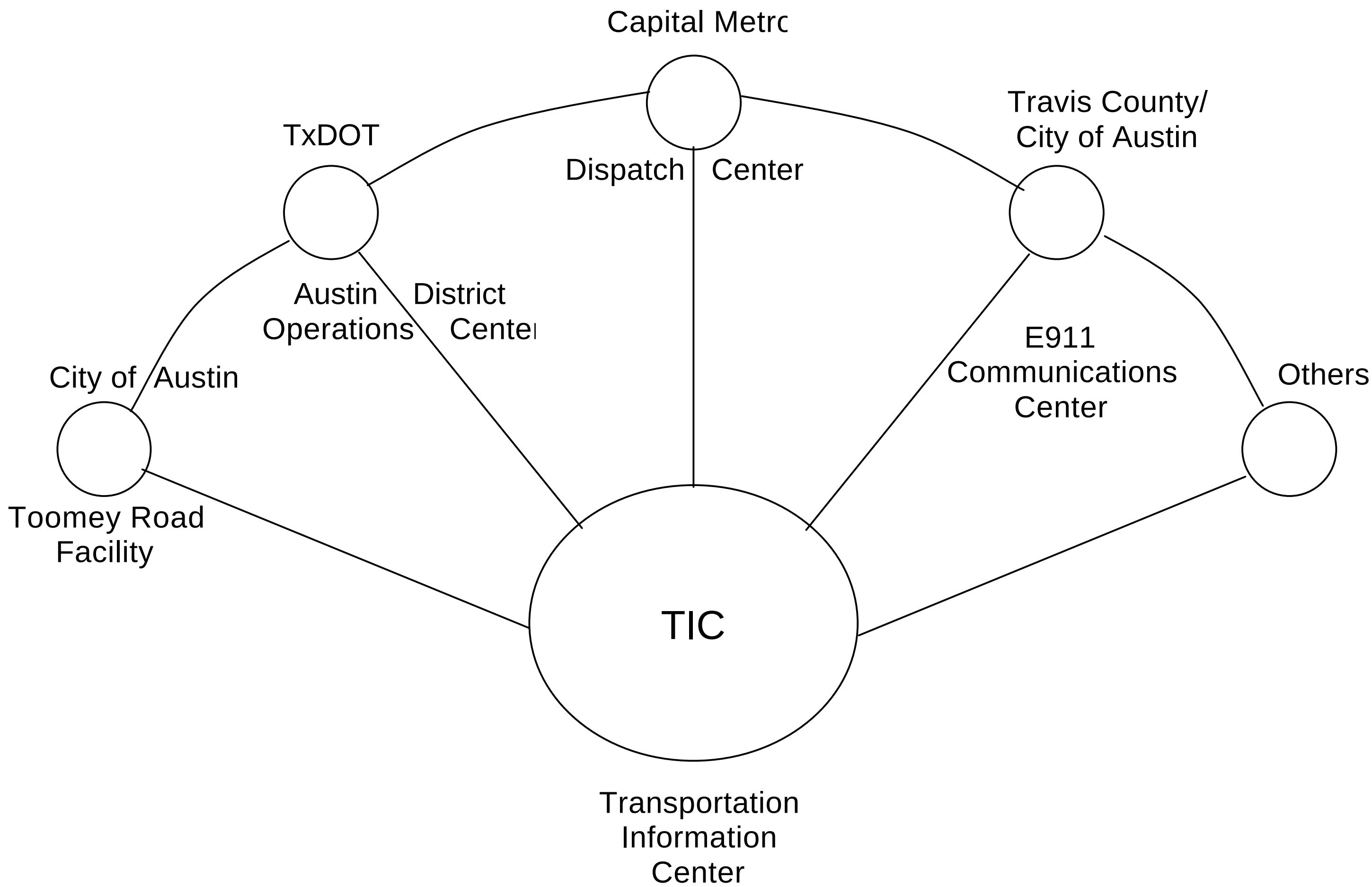
for many portions of the central system software, an additional $3 million would be needed for system integration. The automation portions could include what happens when a type of incident occurs in a specified section of the area. The agencies that provided input to the study are included in the cost estimates. The cost estimate does not include a major video display wall or press visitor rooms. The software allows each system to function separately and then communicate between agencies.

Funding could be through bond funds and Federal funds. It may be possible to rent a building temporarily, although the purchase/build concept would be preferable. A lease/purchase plan may also be possible.

Implementation/Phasing Summary - The implementation of a centralized traffic management center should be the long range goal of the Greater Austin Area. Separate traffic control centers will probably be needed initially due to limited funding resources. It may be that TxDOT and Capital Metro will have separate traffic control centers for their own systems initially and that all agencies could come together in one Operations Center (TMC) when the city's EMS and traffic control facilities are built as a result of a combined bond package. The Houston Area system should be "guideline" for the Austin Area. The Houston Area has a series of interlocal government agreements that allow joint operations, and maintenance. The governmental groups include TxDOT, Harris County, the City of Houston, and METRO.

Distributed Traffic Management Center

The second approach in developing a traffic management center for the Greater Austin Area is a distributed deployment system. **Figure II-35** illustrates a distributed TMC system architecture which involves the City of Austin, TxDOT, PSA, and Capital Metro operations to remain in their existing facilities, with improved communication systems connecting their operations together. This communications system includes data, voice, and video and is shared in order to unify all those entities into a complete traffic management system. In addition, a Transportation Information Center (TIC) or Incident Management Center (IMC) facility would be operated at a separate facility and staffed by one or two persons from each member agency. This facility would gather data from agencies and disseminate that information to the public.



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HOUSTON, TEXAS

NORTH AMERICAN CONTROLS CORPORATION
ADVANCED TRAFFIC ENGINEERING
KESSMAN & ASSOCIATES

Possible Distributed TMC Approach

Austin Area-Wide ITS

Austin, Texas

Figure II-35

Advantages - A distributed TMC approach provides for the following advantages:

- There is no single point of failure in any of the locations throughout the communications chain. That is to say, if the TxDOT location were to have a disaster, the other entities would continue to service the Greater Austin Area without interruption.
- It should be easier to find a location for each traffic control center with a decentralized system, since many agencies already have facilities in existence. For example, both TxDOT and the City of Austin have facilities available at present for traffic management.
- A distributed TMC approach could be quickly implemented at a lower cost than a centralized TMC approach. This type of a center could be implemented quickly as existing facilities could be used. Minimal modifications would need to be made to implement the recommended systems with the major efforts being focused on communications medium.
- With a distributed TMC approach, each agency could continue to operate as they currently do utilizing their existing management structure. Each agency could provide the level of services that they desire or their funding provides.

Disadvantages - Despite these advantages, the distributed TMC deployment approach provides the following disadvantages:

- The primary disadvantages to the distributed TMC approach is that cost effectiveness is lost because each location has to retrieve data, video, and voice communications instead of a shared common communications architecture asin a Centralized Traffic Management Center. Each agency has to be put on a network system throughout the entire Greater Austin Area. For example the City of Austin Transportation, which now has a small traffic management center, would be sampling the data throughout the Greater Austin Area. The communications system has to be configured so that TxDOT, EMS, Travis County, the Fire Department, and the Police Department, could utilize a portion of that telecommunications system. This type of architecture requires that the City Traffic Control System has to have its own communications architecture. TxDOT and all other agencies would have to acquire compatible communications architecture.
- Another disadvantage is that this type of distributed traffic management center provides for difficult coordination in case of a disaster where remote location communications is cut off to different parts of the city. If a power failure occurs in two to three parts of the city, or in a major area, this could cripple communications between TxDOT and the City of Austin Traffic Division and County agencies. This is what makes the centralized TMC approach very attractive in that all of the agencies are located within a common shared area and can effectively communicate either by telephone or directly face-to-face within the Traffic Management Center.

- Due to the communication logistics, a distributed TMC concept normally does not provide as many services as the centralized approach.
- There is less opportunity for personnel to work together and interact with each other. It is easier to work in your own world and not be as concerned with the overall picture in a decentralized system.
- The reduced opportunity for personnel to interact with each other can reduce efficiency of operations in reducing recurring and non-recurring congestion. Due to the distribution of personnel, communications between agencies may not be as rudimentary as in a centralized TMC approach.
- A decentralized system could also reduce fulfillment of benefits in multimodal operations. There would not be as much opportunity to develop a coordinated system design and application for public transportation and HOV operations and to develop a program for reducing vehicle emissions.
- The implementation of ITS user services will be more difficult to implement on a regional basis under a distributed system. This would be due to reduced communications, coordination, and cooperation.
- A distributed TMC approach also lacks a "TEAM" Image, because distribution of multiple agency operations could diminish the ability to build a unified support team.

Facilities Summary - The primary benefit of a distributed TMC approach is that each agency can utilize their existing facility, which reduces initial capital costs. The City of Austin could continue to utilize their existing facility at Toomey Road, while TxDOT could enhance their current operations at the Austin District Headquarters. Each agency's control center would need approximately 1300 square feet of total floor space, with about 700 square feet needed for operations activities and 600 square feet needed for the equipment room. The composite configuration of the distributed TMC approach operating as a single entity may require *six times* the resources previously identified for a centralized TMC. The major increase in space for a distributed system is the need for separate communications equipment at each facility, instead of consolidating the equipment into a centralized TMC. The major connection interface points or nodes are the expensive elements in distributed systems. Each location would eventually become a mini-TMC.

Equipment Summary - The majority of the equipment needed for a distributed TMC is identical to the equipment needed for a centralized TMC except the equipment is now distributed over several locations. In theory, hardware and software needs are identical, except that video conferencing capabilities should be added to the PC network to expedite communications between agencies. However, practically, there will be some redundancy in equipment and software in a distributed system. In a central system there will also be satellite offices or terminals. Video conferencing in a distributed TMC approach would permit each agency to better coordinate activities during times of emergencies.

Communications equipment needed by each agency in a distributed TMC approach is identified in **Table II - 25**. Since the 800 MHz system is not shared with other agencies, the cost of the 800 MHz trunking system will increase due to the fact that each location will require a digital controller, antenna tower, and other equipment necessary to integrate mobile talk groups.

Maintenance Summary - Operating and maintenance costs for TMCs operating in other cities average approximately $2.1 million per year, as identified previously. Average maintenance costs for the distributed TMC approach will be slightly higher than for the centralized TMC approach because of the additional facilities and communications equipment needed to operated this type of system.

Maintenance personnel requirements for the distributed approach are also similar to the centralized TMC approach and could include one trained staff of maintenance personnel that is responsible for maintaining all facilities in the TMC network. This staff would be slightly larger than for a centralized TMC and would be funded jointly by each participating agency. Operating personnel are discussed in the Personnel Summary section.

Personnel Summary - The number of personnel needed for a distributed system should be the same as for a centralized system. An overall center manager or director employed by the newly created legal entity is still needed to coordinate city and state operations, but his responsibilities and authority might be more difficult to achieve and maintain with a decentralized system. In addition, the TIC (which will coordinate all data gathering and the dissemination of the data to the public) will require at least one staff person from each agency during peak hours. However, these personnel are not necessarily additional staff members since they are probably already part of the existing staff. Additional personnel to operate and maintain the TIC, including the center director and support staff, are identical to those needed for the centralized TMC approach.

Table II – 25

Communications Equipment Needs and Cost for Each Agency in a Distributed Traffic Management Center
Austin Area-Wide ITS
Austin, Texas

Cabinet	Description	Estimated Cost
1	DS3 - 2 Shelves	$60,000
2	T1 Carrier Cabinet	20,000
3	Fiber Optic Cabinet	15,000
4	800 MHz Trunking	250,000
5	Video Switchgear	40,000
6	Test Equipment	30,000
7	PBX Switch	15,000
8	PBX Interconnects	2,500
		$432,500

Funding Summary - Hardware and software costs for the distributed and centralized TMC approaches are considered to be identical, as shown in **Table II - 26**. However, facility and communications costs for the distributed approach differ from the centralized approach. Facility costs for the distributed approach will be greatly less than the $3 to 6 million estimated for construction of the TMC because the distributed approach will greatly utilize existing facilities. Facility costs of approximately $1 to 2 million will be needed for construction of the TIC, including office space for the center director and support staff.

Communications costs will be considerably higher thancosts estimated for the centralized TMC approach because separate equipment is needed at each facility instead of consolidating the equipment in a single location. Communications equipment for each agency will cost over $430,000, as itemized previously in Table II - 25. Thus, with a minimum of five locations assumed to be part of the distributed system, communications equipment will cost over $2,150,000.

Implementation/Phasing Summary - As described previously, the distributed TMC approach should be utilized as an interim measure, while a centralized TMC for the Greater Austin Area is being designed and constructed. The first step in establishing a TMC in Austin is to create an organization to develop, operate, and maintain the center.

TMC Summary

A distributed system allows existing facilities and staff to be fully utilized. With a distributed system, a new building (TMC) would not have to be constructed (facility costs are hidden). A major communication mode would have to be constructed at each agency and/or office location for a distributed system. A centralized TMC should have fewer communication links if every manager does not require a full connection to the system. A centralized TMC generates synergy by having employees working side by side.

Table II – 26

Estimated Cost of Distributed TMC
Austin Area-Wide ITS
Austin, Texas

Item	Estimated Cost
TMC or TIC Building	$ 1 to 2 million
Internal Communications (see Table II-25)	$2.1 million
Hardware	
40 Workstations @ $ 10,000 (includes 4 video monitors, controls, console, and CPU)	$400,000
4 Servers @ $20,000	80,000
Software	
Non-proprietary, PC based system	$ 3 to 5 million
Total	**$6.5 to 9.5 million**

Generalized Costs

In costing an Advanced Traffic Management System, it is very difficult toprovide specific costs until an implementation plan is developed. The plan would include system and agency functions and a schematic system design, operation, and maintenance plan. The plan would define funding opportunities and implementation schedule. Generalized costs are illustrated on **Table II-27.** Specific costs would be provided in the implementation plan communications needs.

The City of Austin and TxDOT requested an estimation be made of possible bandwidth needs for an Austin Area-wide traffic signal system. The bandwidth allocation is shown on**Table II-28.** The proposed bandwidth allocation provides for present intersection controls and 100% growth capacity.

Table II-27

Unit Costs of Core Infrastructure
for Advanced Traffic Management System
Austin Area- Wide ITS
Austin, Texas

Item	Unit Capital Cost ($K/unit)	Unit Operating and Maintenance Cost ($K/unit)
SURVEILLANCE		
Inductance Loop Detectors	0.80	0.04
CCTV Cameras	20.00	1.00
HOV Lane Control & Monitoring	250.00	12.50
TRAVELER INFORMATION		
Fixed Changeable Message Signs & Controllers	200.00	10.00
Fixed Highway Advisory Radio & Controllers	20.00	1.00
COMMUNICATION		
Fiber Optic Cable (per mile)	240.00	12.00
Signal Communication (per intersection)	10.00	0.50
TRAFFIC MANAGEMENT CENTER		
Computers and Hardware	680.00	34.00
Software	220.00	11.00
Facilities and Communication	4,000.00	200.00
Operating and Maintenance Personnel	0.00	50.00
TRAVELER INFORMATION CENTER		
Computers and Hardware	102.00	5.10
Software	300.00	15.00
Facilities and Communication	4,000.00	200.00
Kiosks	30.00	10.00
Operating and Maintenance Personnel	0.00	50.00
INCIDENT MANAGEMENT EQUIPMENT		
Vehicles	50.00	2.50
Portable Highway Advisory Radio	50.00	2.50
Portable Changeable Message Signs	30.00	1.50
Operating and Maintenance Personnel	0.00	50.00
SYSTEM DESIGN AND INTEGRATION	5,400.00	0.00

SOURCE: Texas Department of Transportation, Intelligent Transportation Systems Draft Implementation Strategy

Table II-28

Bandwidth Allocation
Austin Area-Wide ITS
Austin, Texas

City of Austin

Total Number of Existing Intersections = 600

Proposed Number of Cameras - Every 13 intersections, roughly 50 cameras

Digital Data Bandwidth:

30 Communications City Segments plus additional 30 segments for future

- **60 Segments @ 1.152 MB/second Total Bandwidth**

Maintenance Voice Bandwidth:

- **60 Segments @ 3.84 MB/second Total Bandwidth**

CCTV Bandwidth:

- 150 Video cameras (50 present + 50 special events + 50 future)
- 60 Communications Segments @ 3 cameras/segment
- **900 MHz total Video Bandwidth**

Composite Raw Bandwidth: (Non compressed)

Digital Data 1.152 MB/second
Voice 3.84 MB/second
Video 900.000 MHz/second
904.992 MB/second

TxDOT

FTM = Projected 100 miles of Freeways

Video: 100 miles x 1 camera/mile = 100 cameras

Bandwidth = 100 cameras x 5 MHz/second = 500 MHz/second

Data & Voice: 100 miles/l0 miles/section = 10 freeway sections

10 sections x 1.554 Mhz + 15.54 = 515.54 Mhz

FTM total Bandwidth = 500 Mhz + 15.54 Mhz = 515.54 Mhz

TASK III

EVALUATE STATE OF THE ART
TRAFFIC MANAGEMENT TECHNIQUES
AND IVHS TECHNOLOGIES

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BACKGROUND

The U.S. Department of Transportation (DOT) Federal Highway Administration (FHWA) created the document *IVHS Planning and Project Deployment Process* to serve as a tool for transportation organizations to systematically plan for and implement IVHS technologies as part of an integrated transportation system. In this document FHWA refers to the concept of the "user service" approach to IVHS technology deployment. The deployment of IVHS technologies will produce a set of services to the users of the transportation system. These users may include travelers, drivers, transit operators, commercial fleet operators, regulators, emergency responders, and traffic management personnel. Examples of services could include but are not limited to traveler advisory, trip planning, incident detection, traffic control, vehicle and cargo monitoring, and signal pre-emption.

In order to support FHWA in their efforts towards nationwide deployment of IVHS technologies and services, the MITRE Corporation developed the report *Working Paper on IVHS User Services and Functions.* This report is provided in the appendix of FHWA's document *IVHS Planning and Project Deployment Process***.** This report provides more details on user services and technologies that support these services.

The Intelligent Transportation Society of America (ITS America) is a nonprofit educational and scientific association incorporated in August 1990. It's mission is to accelerate the deployment of ITS in the United States and is chartered as a utilized Federal Advisory Committee to the U.S. Department of Transportation. In 1992, ITS America identified the development of a national ITS architecture as the program's top research and development priority. Currently, ITS America has identified 29 user services which fall into seven general areas (**Table I-1**). The services that were given as examples in the previous paragraph fit under these seven general areas. ITS America defines these seven general areas as follows:

Travel and Traffic Management services provide an array of information services to help travelers plan trips and avoid delays. These category of services also provides improved surveillance and traffic control procedures and mechanisms to improve transportation system efficiency.

Travel Demand Management services provide information and incentives to manage transportation demand and encourage the use of high occupancy vehicles.

Public Transportation Management services improve the efficiency, safety, and effectiveness of public transportation systems for providers and customers alike. This category of services will make public transportation more attractive to potential customers.

Electronic Payment services automates financial transactions for all modes of surface transportation. This will help reduce delays on fee collection and provide accurate data for systems management.

Commercial Vehicle Operations services streamline administrative procedures, improve safety, and help efficiently manage commercial fleets.

Emergency Management services improve emergency notification and response times and enhance resource allocation.

Advanced Vehicle Control and Safety Systems services provide various forms of collision avoidance and safety precautions. Automated vehicles remain a longer-term objective.

Study User Service Objectives

In Task I, with information provided from survey responders and interviews, the Austin study identified several user service objectives. These services are categorized under the following service areas:

Travel and Traffic Management

- improve incident traffic control
- improve incident communications between agencies
- improve training for incident responders
- improve driver information
- improve communications with other modes

Travel Demand Management

- improve driver information
- improve communication with other modes

Public Transportation Management

- improve automatic vehicle location
- improve communications with other modes

Commercial Vehicle Operations

- improve automatic vehicle location
- improve communications with other modes

Emergency Management

- improve incident communications between agencies
- improve communications with other modes

EVALUATE TECHNIQUES

The Austin study created a matrix (**Table III-1**) in order to identify technologies that would support the desired services. The Austin study identified those technologies users have in use now, have in the planning process, or intend to use within the long term service plan (5-10 years). In addition to the interviews that identified technologies that would support these user services, the Austin study used the MITRE paper to further address technologies that would offer support. To evaluate the performance and reliability of the technologies, the Austin study used the Texas Transportation Institute (TTI), *Evaluation of IVHS Technology for User Services in the Dallas Urban Area* . A draft copy of the report used for the Austin area study has been included in Appendix IDA.

The Austin Study has identified the "Functional Areas" as follows, in order to categorize the technologies and their support of the user services.

Surveillance Need or Technology - What is the surveillance need or technology.

Traveler Interface - How the traveler will interface with information.

Guidance - What does the user need for guidance.

In-Vehicle Sensors - What in-vehicle sensors does the user need or already have.

Communications, Vehicle and Infrastructure- Communications of vehicle to infrastructure or infrastructure to vehicle.

Communications, Within Infrastructure- Communications from agency to agency.

Communications, Vehicle to Vehicle- Communications from vehicle to vehicle.

Control Strategies - What control strategies can the infrastructure use to provide the service.

Data Processing - What type of data processing is needed to support the service.

The matrix shown on **Table III-1** represents the five identified general areas and the technologies that support them. This matrix is further broken down by general areas and the user services that fit under that area **(Table III-2** thru **Table III-6). ITS** America identifies these user service areas as follows:

Austin ITS Functional Areas									
User Service Area	Surveillance Need or Technology	Traveler Interface	Guidance	In-Vehicle Sensors	Communications			Control Strategies	Data Processing
					Vehicle and Infrastructure	**Within Infrastructure**	**Vehicle to Vehicle**		
Travel and Traffic Management	Traffic Conditions, Weather, Video Image Processing, Police, Loops, CCTV	VMS, Car Radio, Visual Display, Key Board, Touch Screen	Position Display, Map Database	Odometer, Electronic Compass	Commercial Radio, HAR, Cellular Phones, Wide Area Two-Way Radio	Landlines	Wide Area Two-Way Radio	Ramp Meter, Lane/Ramp Closings, Signals	Dynamic Database, Static Database, Prediction, Incident Detection
Travel Demand Management	Traffic Conditions, Weather, Video Image Processing, Loops, CCTV	VMS, Visual Display, Key Board, Touch Screen	Position Display, Map Database	Odometer, Electronic Compass	HAR, Commercial Radio, Cellular Phone	Landlines	Not Yet Determined	Alternate Work Hours, Adjusted Fares, Signals, Ramp Meter, Lane/Ramp Closings	Dynamic Database, Static Database
Public Transportation Operations	Route Information, AVL, Loops, Probes, CCTV, Photo Sensors	Visual Display, Key Board, Touch Screen	Position Display, Map Database, GPS	Panic Button, Odometer, Electronic Compass	Beacons, Strobes, Wide Area Two-Way Radio	Landlines	Wide Area Two-Way Radio	Lane Restriction, Signals	Dynamic Database, Static Database
Commercial Vehicle Operations	Traffic Conditions, AVI, WIM, Weather Classification	Visual Display, Key Board	Position Display, Map Database, GPS	Odometer, Electronic Compass, Performance Monitoring	Wide Area Two-Way Radio, Cellular Phone	Landlines	Wide Area Two-Way Radio	Lane Restriction, Signals	Dynamic Database, Static Database
Emergency Management	Traffic Conditions, Weather, CCTV, Video Image Processing	Visual Display, Key Board	Position Display, Map Database	Odometer, Electronic Compass	Strobes, Wide Area Two-Way Radio	Landlines	Wide Area Two-Way Radio	Signals	Dynamic Database, Static Database

Austin ITS Functional Areas_Table III-1

Travel and Traffic Management

En-Route Driver Information - Driver advisories are given once travel begins. Driver advisories convey information about traffic conditions to drivers of personal, commercial and public transit vehicles. This information allows a driver to select the best route, or shift to another mode mid-trip if desired.

Traffic Control - Integrates and adaptively controls the freeway and surface street systems to improve the flow of traffic, give preference to transit and other high occupancy vehicles, and minimize congestion while maximizing the movement of people and goods. Through appropriate traffic controls, the service will also promote the safety of non-vehicular travelers, such as pedestrians and bicyclists. This service gathers data from the transportation system, fuses it into usable information, and uses it to determine the optimum assignment of right-of-way to vehicles and pedestrians. The real-time traffic information collected by the Traffic Control service also provides the foundation for many other user services.

Incident Management - Enhances existing capabilities for detecting incidents and taking the appropriate actions in response to them. The service will help officials quickly and accurately identify a variety of incidents, and to implement a response which minimizes the effects of these incidents on the movement of people and goods. Traffic movement adjustments over a wide area would be executed through the Traffic Control user service, while decisions at the site of the incident will be made by the police agencies. In addition, the service will help officials to predict traffic or highway conditions so that they can take action in advance to prevent potential incidents or minimize their impacts. While the users of this service are primarily public officials, commercial and transit operators, and the traveling public all benefit from improved incident management capabilities.

Austin ITS Functional Areas									
Travel and Traffic Management User Services	**Surveillance Need or Technology**	**Traveler Interface**	**Guidance**	**In-Vehicle Sensors**	**Communications**			**Control Strategies**	**Data Processing**
					Vehicle and Infrastructure	**Within Infrastructure**	**Vehicle to Vehicle**		
En-Route Driver Information	Traffic Conditions, Weather	VMS, Car Radio, Visual Display, Key Board, Touch Screen	Position Display, Map Database	Odometer, Electronic Compass	HAR, Commercial Radio, Cellular Phone	Landlines	Not Yet Determined	Not Yet Determined	Dynamic Database
Traffic Control	Loops, Weather, CCTV, Video Image Processing	VMS	Not Yet Determined	Not Yet Determined	HAR, Commercial Radio	Landlines	Not Yet Determined	Ramp Meter, Lane/Ramp Closings, Signals	Dynamic Database, Static Database, Prediction
Incident Management	Loops, Weather, CCTV, Video Image Processing, Police	VMS, Visual Display, Key Board	Position Display, Map Database	Odometer, Electronic Compass	Cellular Phones, HAR, Commercial Radio, Wide Area Two-Way Radio	Landlines	Wide Area Two-Way Radio	Lane/Ramp Closings, Signals	Dynamic Database, Static Database, Incident Detection

Travel and Traffic Management Functional Areas_Table III-2

Travel Demand Management

Pre-Trip Travel Information - Travelers access a complete range of inter-modal transportation information at home, work, and other major sites where trips originate. For example, timely information or transit routes, schedule transfers and fares, and ride matching serves are included. Real-time information on accidents, road construction, alternate routes, traffic speeds along given routes, parking conditions, event schedules, and weather information complete the service. Based on this information, the traveler can select the best departure time, route and modes of travel, or decide to postpone or not to make the trip at all. Reducing congestion and improving mobility benefits all potential travelers.

Demand Management and Operations (Renamed from Travel Demand Management) – Generates and communicates management and control strategies that support the implementation of programs to (1) reduce the number of individuals who choose to drive alone, especially to work, (2) increase the use of high occupancy vehicle and transit, (3) reduce the impacts of high polluting vehicles, and (4) provide a variety of mobility options for those who wish to travel in a more efficient manner, for example in non-peak periods. The service allows for employers to better accommodate the needs and lifestyles of employees by encouraging alternative work hours, compressed work weeks, and telecommuting. Travel demand management strategies could ultimately be applied dynamically when congestion or pollution conditions warrant. For example, disincentives such as increased tolls and parking fees could by applied during pollution alerts or when major incidents occur while transit fares would be lowered to accommodate the increased number of travelers changing modes from driving alone. Such strategies will reduce negative impacts of traffic congestion on the environment and overall quality of life.

Austin ITS Functional Areas									
Travel Demand Management User Services	**Surveillance Need or Technology**	**Traveler Interface**	**Guidance**	**In-Vehicle Sensors**	**Communications**			**Control Strategies**	**Data Processing**
					Vehicle and Infrastructure	**Within Infrastructure**	**Vehicle to Vehicle**		
Pre-Trip Travel Information	Traffic Conditions, Weather	Visual Display, Key Board, Touch Screen	Position Display, Map Database	Not Yet Determined	HAR, Commercial Radio, Cellular Phone	Landlines	Not Yet Determined	Not Yet Determined	Dynamic Database
Demand Management and Operations	Loops, Weather, CCTV, Video Image Processing	VMS, Visual Display, Key Board, Touch Screen	Position Display, Map Database	Odometer, Electronic Compass	HAR, Commercial Radio, Cellular Phone	Landlines	Not Yet Determined	Alternate Work Hours, Adjusted Fares, Ramp Meter, Lane/Ramp Closings, Signals	Dynamic Database, Static Database

Travel Demand Management Functional Areas_Table III- 3

Public Transportation Operations

En-Route Transit Information - Provides the same type if information as pre-trip planning services once public transportation travel begins. Real-time, accurate transit service information on board the vehicle helps travelers make effective transfer decisions and itinerary modifications as needed while a trip is underway.

Public Travel Security - Systems monitor the environment in transit stations, parking lots, bus stops, and transit vehicles and generates alarms either automatically or manually as necessary. This improves security for both transit riders and operators. Transportation agencies and authorities integrate this user service with other anti-crime plans.

Public Transportation Management - Computer analysis of real-time vehicle and facility status will improve operations and maintenance. The analysis identifies deviations from schedule and provides potential solutions to dispatchers and drivers. Integrating this capability with the Traffic Control Service can help maintain transportation schedules and assure transfer connections in intermodal transportation, Information regarding passenger loading, bus running times, and mileage accumulated will help improve service and facilitate administrative reporting. Automatically recording and verifying performed tasks will enhance transit personnel management. Improved efficiency benefits transit providers and customers alike.

Austin ITS Functional Areas									
Public Transportation Operations User Services	**Surveillance Need or Technology**	**Traveler Interface**	**Guidance**	**In-Vehicle Sensors**	**Communications**			**Control Strategies**	**Data Processing**
					Vehicle and Infrastructure	**Within Infrastructure**	**Vehicle to Vehicle**		
En-Route Transit Information	Route Information	Visual Display, Key Board, Touch Screen	Position Display, Map Database, GPS	Not Yet Determined	Beacons	Landlines	Not Yet Determined	Not Yet Determined	Dynamic Database, Static Database
Public Travel Security	CCTV, AVL	Not Yet Determined	Position Display, Map Database, GPS	Panic Button	Beacons, Wide Area Two-Way Radio	Landlines	Not Yet Determined	Not Yet Determined	Dynamic Database
Public Transportation Management	Loops, Probes, AVL, Photo Sensors	Not Yet Determined	Position Display, Map Database, GPS	Odometer, Electronic Compass	Strobes, Wide Area Two-Way Radio	Landlines	Wide Area Two-Way Radio	Lane Restrictions, Signals	Dynamic Database, Static Database

Public Transportation Operations Functional Areas-Table III- 4

Commercial Vehicle Operations

Commercial Fleet Management - The availability of real-time traffic information and vehicle location for commercial vehicles would help dispatchers to better manage fleet operations by helping their drivers to avoid congested areas and would also improve the reliability and efficiency of carriers pickup-and-delivery operations. The benefits from this service would be substantial for those intermodal and time-sensitive fleets that can use these ITS technologies to make their operations more efficient and reliable.

Austin ITS Functional Areas									
Commercial Vehicle Operations User Services	**Surveillance Need or Technology**	**Traveler Interface**	**Guidance**	**In-Vehicle Sensors**	**Communications**			**Control Strategies**	**Data Processing**
					Vehicle and Infrastructure	**Within Infrastructure**	**Vehicle to Vehicle**		
Commercial Fleet Management	Traffic Conditions, Weather, WIM, AVI, Classification	Visual Display, Key Board	Position Display, Map Database, GPS	Odometer, Electronic Compass, Performance Monitoring	Wide Area Two-Way Radio, Cellular Phone	Landlines	Wide Area Two-Way Radio	Lane Restrictions, Signals	Dynamic Database, Static Database

Commercial Vehicle Operations Functional Areas_Table III- 5

Emergency Management

Emergency Vehicle Management - This user service includes three capabilities: fleet management, route guidance, and signal priority. Fleet management will improve the display of emergency vehicle locations and help dispatchers efficiently task the units that can most quickly reach and incident site. Route guidance directs emergency vehicles to and incident location. Signal priority clears traffic signals in an emergency vehicle route. Primary users include police, fire, and medical units.

Austin ITS Functional Areas									
Emergency Management User Service	**Surveillance Need or Technology**	**Traveler Interface**	**Guidance**	**In-Vehicle Sensors**	**Communications**			**Control Strategies**	**Data Processing**
					Vehicle and Infrastructure	**Within Infrastructure**	**Vehicle to Vehicle**		
Emergency Vehicle Management	Traffic Conditions, Weather, CCTV, Video Image Processing	Visual Display, Key Board	Position Display, Map Database	Odometer, Electronic Compass	Strobes, Wide Area Two-Way Radio	Landlines	Wide Area Two-Way Radio	Signals	Dynamic Database, Static Database

Emergency Management Functional Areas_Table III- 6

TECHNOLOGIES

The matrices that have been presented address technologies that will support the user services that have been identified. These technologies and how they will offer support to these services are defined as follows:

Surveillance Need or Technology

Traffic Conditions - Prior to departing travelers, commercial, and emergency vehicle operators could access real-time information on traffic conditions in order to select the best route to get to their destination in order to avoid congested areas. This also provides the option for the travelers to change their mode of transportation or decide to postpone unnecessary trips.

Commercial vehicle dispatchers scheduling delivery routes could access real-time information on traffic conditions in order to aid them. Traffic conditions that report the beginnings of congestion may warn emergency response personnel to be on the alert for possible incidents occurring. While en-route travelers, commercial, emergency vehicle operators can access information on traffic conditions in order to determine if they need to alter the route they are on in order to get to their destination.

Weather - The user services that weather surveillance is listed under would provide them the same information. Prior to departure travelers or commercial vehicle dispatchers could plan their trip or routes based on the weather reports and what effect it would have on roadways condition. If the driver access's this information while en-route he or she could alter their route or change their mode of transportation. Along with weather conditions environmental sensors in the roadways or bridges would monitor the ice conditions of that facility in order for traffic operators to manage and control traffic. Along with traffic operators, emergency response personnel could prepare for incidents and the management of them.

Loops - Inductive loops are the most common form of detection used for traffic management. Loops can provide volume counts, presence detection, and lane occupancy measurements. Loops can be used to detect vehicle speeds by placing two loops a short distance apart. The distance between the loops divided by the time required for a vehicle to travel between the loops provides the speed of the vehicle. Information on the speeds at which vehicles are traveling would aid traffic operators in the detection of congestion, peak demand, or incidents. From this information traffic operators can control and manage traffic. Public transportation agencies would use the information provided from the loops on congestion or incidents to schedule or reroute their transit vehicles.

Closed Circuit Television (CCTV) - This technology has been used for many years for providing visual surveillance on the freeway system. It aids traffic operators in the detection of traffic conditions and conformation of incidents. CCTV systems allow for traffic operators to visually monitor sections of roadway in real-time, and to react directly to the actual conditions on the roadway. CCTV would aid emergency response agencies in the proper dispatch of emergency personnel and vehicles. CCTV systems would also aid in public travel security at transit transfer stations.

Video Image Processing - Video image processing detects vehicles by monitoring specific points in the video image of a traffic scene to determine changes between successive frames. For traffic management these systems can be used for visual surveillance, to obtain measurements of speed, vehicle classification counts, and potentially travel times in detection zones. Traffic operators and emergency response agencies could use this type of technology in place of loops and CCTV in order to detect congestion or incidents. This type of technology would aid emergency response agencies in the proper dispatch of emergency personnel and vehicles.

Police - Mobile police units are sometimes the first to detect or report an incident. Traffic operators could scan the police radio transmissions to become aware of incidents that might or might not be in view of the traffic management area.

Route Information - On board real-time information on traffic conditions and transit routes, schedules and transfers would allow for travelers to make transfer decisions and itinerary modifications.

Automatic Vehicle Location (AVL) - This technology determines a vehicles location relative to a map database. Approximate location of a vehicle can be determined and tracked as it traverses the transportation network. Transit vehicles equipped with an AVL system can be tracked and have their travel speeds monitored in order to determine if they will meet their arrival schedules.

Dispatchers that receive a distress or emergency call from a transit vehicle equipped with an AVL system, could monitor the location or movement of that vehicle.

Probes - Transit vehicles equipped with an on-board computer, and a two-way communications to a control center, or with no on-board computer, but properly equipped for AVI readers, can serve as roving sensors (or probes) to provide travel conditions in the transportation system. These vehicles will provide speed, travel time, and delay along links. This informationprovided would help in the detection (sensing) of incidents.

Automatic Vehicle Identification, (AVI) - AVI systems use vehicle-based transponders (radio or microwave-based) that can be read by equipment at fixed points to identify the vehicle. A roadside communication unit broadcasts an interrogation signal from its antenna. When an AVI-equipped vehicle comes within range of the antenna, a transponder (or tag) in the vehicle returns thatvehicles identification number to the antenna This technology could be used for identifying commercial vehicles at weight monitoring stations. Dispatchers could use this technology in identifying their vehicles that are overweight.

Photo Sensors - Photo sensors detect the presence of transit or emergency vehicles. It receives the light emitted from the strobe on the vehicle and causes (pre-empts) the traffic signal controller to advance to and/or hold a desired traffic signal display selected from signal phases normally available. The photo sensors internal circuitry transforms the optical energy form the strobes (optical emitter) into electrical signals for delivery via an optical detector cable to the phase selection equipment which in turn sends the signal to the traffic signal controller. Photo sensors have the capability of recognizing the different levels of light to distinguish between transit or emergency vehicles.

Weigh-In-Motion (WIM) - Pavement installed sensors an road mounted processors determine vehicle weight by taking into account axle weights, vehicle length, and vehicle speed. By calculating vehicle characteristics such as length, number of axles, and axle spacing, WM devices can classify vehicles and determine their compliance with weight standards without requiring commercial fleet operators to stop. This type of technology and the information it provides could also aid transportation engineers in pavement design and management.

Classification - Automatic Vehicle Classification systems are installed in the highway to collect vehicle classification data. These systems can be used in conjunction with weigh-in-motion stations. Automatic vehicle classification systems include sensors which detect the presence or passage of vehicles and detectors which receive the signals from the sensors. They also include a processor which calculates the vehicle length, number of axles, and axle spacing from which the vehicle class is determined and the recorder stores this data.

Traveler Interface

Variable Message Signs (VMS) - (Also referred to as changeable message signs)

VMS's communicate real-time information directly to motorists for warning, regulation, routing, and traffic management purposes. VMS could provide information to motorist on congestion ahead and suggest alternate routes, ride sharing, or alternate modes of transportation. For incident management traffic operators have the capability of not only warning motorist of an incident ahead but also provide which lanes are closed or suggest an alternate route.

Car Radio - Travelers en-route in their personal vehicle will tune to a radio station looking for traffic reports on traffic conditions or incidents, in order to select the best route.

Visual Display - In-vehicle visual displays would provide en-route real-time information to motorists while driving. In the case of congestion or incidents, it would provide the location of the situation and suggest an alternate route. A visual display system would show the location of congestion or an incident. From this the system would provide an alternate route for motorists or commercial fleet operators. These displays also aid emergency vehicle operators in providing the best response route to an incident. Visual displays can also provide pre-trip travel information in the home or office.

Key Board - A key board is a way in which the driver can enter or access information to a computer in the home, office, or vehicle. This device could be used for en-route or pre-trip travel information to access traffic conditions, incidents, navigation, or route selections. Emergency responders would use keyboards in order to access information on incidents they are responding to. Traffic operators would use this device in order to access information on traffic conditions and to output information to motorist on congestion or incident management. Commercial fleet dispatchers would not only use a keyboard to access information on traffic conditions, they would also use a keyboard to determine their pickup and delivery schedules.

Touch Screen - A device that is used for the same purposes as a key board. A touch screen is a convenient means for a user to select on-board system options since the position of the user's finger indicates the function which he or she wishes to invoke. When the user points to an item on the display screen, an infrared light grid overlaying the display screen is broken. Users en-route would access information on traffic conditions, incidents, navigation, or route selections. Users would also use this at home and in the office to access information on pre-trip travel.

Guidance

Position Display - Position displays provide information on the driver's current position in the transportation network. The vehicles position is overlaid on a map to the surrounding street network. For en-route or pre-trip driver information, position display will show where the drivers location is in relation to their intended destination. It will also show where congestion or an incident is located. Transit operators and dispatchers would also use this technology not only for locating their transit vehicles position in order to evaluate the arrival schedules, but also in the event of an emergency they can track their vehicles. Commercial vehicle operators can use position display the same as drivers in order to determine their location in relation to their destination. Commercial vehicle dispatchers would use this technology not only to determine if drivers are on schedule, but also to access information on traffic conditions to determine pickup and delivery schedules. Emergency vehicle operators and traffic operators would use position display to determine location of congestion or incidents. Emergency responders would then use position display to determine their location in relation to the incident.

Map Database - The map database includes the coordinates or other descriptors of the road network for the metropolitan or regional area. This system will include the location of parking lots and other traffic related facilities. The database contains street names including alternate names, speed limits, normal travel times, turn and other time-of-day restrictions. It will also include pertinent traffic control informationas a result of maintenance, congestion, or an incident that will support vehicle route selection and guidance. A map database would aid motorists in routing them to their destination prior to trip travel or en-route. It would also aid commercial and transit vehicles in determining their schedule times to their destination. Transit vehicles could also be tracked on a map database when ever a distress call comes in. Guidance from this technology would aid emergency response vehicles to the shortest route to an incident.

Global Positioning Systems (GPS) - The GPS system locates a vehicles position using radio signals broadcast from satellites orbiting the earth. These systems can locate a vehicle in the transportation network with a high degree of accuracy. In order to get an accurate reading on the vehicles, the receiver in the vehicle must receive transmissions from three satellites. This is called a triangulation technique. Travelers, transit, and commercial fleet agencies could use this technology not only for tracking their vehicle location or routes but also for security to ensure their fleets do not wander from designated routes.

In Vehicle Sensors

Odometer - Odometers for the automobile are usually driven by flexible shafts attached to the drive train, and display distances to the nearest 0.1 mile. However, these types of odometers are not accurate enough for navigation and vehicle location. New electronic odometers can accurately measure travel distance in increment smaller than one inch and are used in navigation. Route guidance and navigation systems, especially those systems that use dead-reckoning/map-matching techniques, rely on the odometer to provide accurate distance measurements. Travelers, transit, commercial fleet, and emergency response agencies could all use the vehicles odometers to track their distance to their point of interest, of destination. An electronic odometer would provide an accurate means of distance measurement for a route guidance or navigational system.

Electronic Compass - The electronic compass consists of two electric coils wound around a highly permeable core material. A third coil carries an alternating current which induces an alternating voltage in the coils. The magnitude of the phase shift in the induces voltages depends upon the orientation of the vehicle in the earth’s magnetic field. For dead-reckoning and map-matching electronic compass are critical for these systems. They rely on compass readings to accurately determine the heading of the vehicle. The heading in combination with the cumulative distance traveled since the last heading change are used to determine the position of the vehicle in the transportation network. Travelers, transit, commercial fleet, and emergency response agencies that rely on systems for determining their heading would require that they have an electronic compass.

Panic Button - A panic button on transit vehicles provide direct warning to the dispatcher that there is an emergency on the vehicle. If the dispatcher has vehicle tracking or locating capabilities they can automatically start monitoring the location of that vehicle while emergency responders are being sent for assistance.

Performance Monitoring - In-vehicle systems for commercial vehicles would monitor driver fatigue and performance. Driver condition sensors would monitor drowsiness, slow or excessive reactions and take corrective measures. Sensors may include a breathalyzer system which would not allow the vehicle to be started if the driver is intoxicated. Vehicle monitoring systems and enhanced vision systems can aid drivers in perceiving and reacting to hazardous and low visibility conditions.

Communications, Vehicle and Infrastructure

Highway Advisory Radio (HAR) - HAR is a broadcast service provided from low powered transmitters located along the roadway and motorists while en-route would receive it on the vehicle's standard AM radio. The low power of the transmitters allows for a limited range of the broadcast to a few miles. Motorists are instructed to tune to their vehicle radio to a specific frequency through roadside or overhead signs. The information is usually a pre-recorded message, although live messages can also be transmitted. The information being broadcast to motorists is on the traffic conditions ahead. These conditions may involve congestion, accidents, stalled vehicles, traffic or routing patterns caused by construction or special events. Prior to travel travelers within transmission range could access this information through their office or home radios. HAR would aid motorist while en-route to re-evaluate the route their on. It would help on the dissemination of information on traffic control, incident, and demand management.

Commercial Radio - Most commercial radio stations include traffic reports as part of their regular programming during the rush hour periods of the day. The advantage of this approach is that traffic information is reaching a large segment of the driving population with little or no additional costo the public agency or for specialized in-vehicle equipment. Commercial radio provides information on traffic conditions to travelers prior to travel, and en-route on congestion, accidents, stalled vehicles, and routing patterns. However, the timeliness and accuracy of thee information being broadcast is not very reliable.

Cellular Phone - A large number of travelers carry a cellular phone in their vehicles. A majority of incidents that occur out in the transportation network are reported through cellular phones. Motorists or commercial vehicle operators could access a number to call of they want to receive information on traffic conditions in order to plan or make changes to their route prior to travel or while en-route. If they have an on board computer system that provides route selection or guidance they could use a cellular modem to communicate with a control center on real-tome traffic conditions.

Wide Area Two-Way Radio - Wide area radio system offers two-way communication between the traffic management center and a large number of vehicles over a wide geographic region such as a metropolitan area. These systems can be used to broadcast traffic and other travel information to vehicles such as travel times. A control facility can transmit route selection and guidance information to specific vehicles such as emergency response or commercial. This type of communication would greatly aid various emergency response agencies to communicate among each other especially at the site of an incident.

Beacons - Beacons provide localized communications between the infrastructure and vehicles. Data can be transferred to and from the vehicles at high data rates between 400 Kbps and 1 Mbps. To avoid multiple vehicles contending for the same uplink channel to the communication system, the coverage area of a single beacon is limited to less than 100 feet. Therefore, beacons are usually located at intersections or key decision points. Intersection placement allows for specific information to be broadcast to the vehicle. For example, transit vehicles that are coming up to the next stop could receive information on the approaching stopping point. Also, transit vehicles that have an emergency could send out a distress call to the dispatcher via beacons.

Strobes - The strobes or optical energy emitting unit produce precisely timed pulses of high capacity optical energy. Strobes can be programmed to different levels of frequency in order for the photo sensors that tie into the traffic signals to distinguish between emergency response or transit vehicles.

Communication, Within Infrastructure

Landlines - Landlines are the backbone for communication within the infrastructure of a traffic management system and an ITS system. Depending on the required data transmission rates there are three different types of communication mediums that make up the landline system. Those are twisted pair wire, coaxial cable, and fiber optics.

Twisted pair wire are mostly used for traffic signal control and loop detector systems. To minimize interference with information that is being transmitted, two wires are wrapped around each other and covered with a plastic shield. A single twisted pair cable is not used to carry information from several devices to a control center because of the greater capacity requirements of a trunk line system.

Coaxial cable is used to connect numerous traffic control devices to the traffic control center. Coaxial cable is used for transmitting voice, digital, and video data.

Fiber optics use pulsating light wave to transmit data digitally for communication systems. Fiber optic cable provides a high quality transmission of video, data, and voice data. Compared to other mediums, fiber optics allows for transmission of much higher data volumes and video images.

Communications, Vehicle to Vehicle

Wide Area Two-Way Radio - Refer to Vehicle and Infrastructure

Control Strategies

Ramp Metering - Ramp metering uses traffic signals at the freeway entrance ramp to control the demand of traffic entering so that the combined freeway and ramp traffic does not exceed the capacity of the freeway. This promotes a smoother operation on the freeway main lanes by allowing them to adjust their speeds on the outside lane as one vehicle or a small platoon of vehicles are permitted by the traffic signal to enter the freeway.

Lane/Ramp Closings - Closing selected entrance or exit ramps helps to improve traffic flow on freeways that operate at or near capacity. Weaving maneuvers between lanes form vehicles entering and exiting the freeway effectively reduce the capacity of that section of freeway. Ramp closings are used where other control strategies such as ramp metering, have failed to control the demand maintain the desired flow on the freeway. Ramp closings have also been used in the event of an incident in order to control and prevent traffic from the incident site.

Lane closing on a freeway is also a control strategy for improving capacity. Such as, the lane closure on a freeway segment just before an entrance point improves the merging operations on the freeway segment and prevents overflow onto surface streets. Lane closings are also used for advance warning of an incident or maintenance activity.

Signals - Traffic signals allows for control and the orderly progression of vehicles through the transportation network. When traffic signals are properly maintained and timed, improvements in progression, air quality, and fuel consumption can be achieved. Some traffic signal systems may require equipment upgrade to achieve optimum conditions Advanced communications between a traffic management center and a fully adaptive traffic signal system allow for control to current changing traffic patterns. Ability to control an adaptive traffic signal system would aid in control of traffic during incidents and when congestion is high. Communication between a strobe and the traffic signals would allow for transit and emergency response vehicles to either activate or extend the green time of the traffic signal when responding to an incident or when behind schedule. Commercial vehicles capable of communication with a traffic management center can have the traffic signal they are approaching green time or clearance interval extended to allow for start up time or for the vehicles inability to stop easily.

Alternate Work Hours - Alternate work hours allows for employees to travel in a more efficient manner during non-peak periods. Employers can better accommodate the needs and lifestyles of employees by encouraging alternative work arrangements such as variable work hours, compressed work weeks, and telecommuting. Alternate work hours would help in the reduction of demand on the transportation network during peak periods.

Adjusted Fares - Adjusted fares could be implemented when congestion or pollution conditions warrant. Disincentives such as increased tolls and parking fees could be applied during pollution alerts or when major incidents occur. During pollution alerts or special city events transit fares could be lowered to accommodate the increased number of travelers changing modes from driving alone.

Lane Restriction - Lane restriction applications would allow for transit and commercial vehiclesto park in adjacent lanes restricted only for their us. This would allow for these vehicles to load and unload without impeding the flow of traffic.

Data Processing

Dynamic Database - Dynamic database are constantly updated in response to current conditions in the transportation network. Dynamic data includes real-time data that describes an event as it happens. The following are examples of the type of data provided by a dynamic database.

- Loop detector data from a freeway surveillance system or traffic signal system.
- Current location and travel time of individual transit and commercial vehicles.
- Current location and travel time of probe vehicles.
- Current availability of parking at specific parking facilities.

Dynamic databases permit the real-time management of traffic as it occurs. It provides real-time routing of vehicles, adaptive traffic signal control, and dynamic management of transit vehicles.

Static Database - Static databases provide historical information about traffic conditions throughout the transportation network. The following are examples of the historical information static databases can provide.

- Traffic volume and travel time information throughout the transportation network by time-of-day and day-of-week.
- The type and location of traffic control devices in the network.
- Transit schedules and stop locations.
- The locations and cost for parking facilities.

When real-time information is not available static database can provide alternative information.

Static database provides a measure of comparing real-time data against historical data to determine when conditions are out of the ordinary, suggesting some type of congestion which might be recurrent or the result of an incident.

Prediction - Algorithms are being developed to provide real-time traffic prediction on traffic flows, queue lengths, and delays based on current measurements of volume and speed. These algorithms would use real-time origin-destination data obtained from vehicles equipped with an in-vehicles device and two-way communications capability to predict where and when congestion will occur. Information gathered would then be integrated with traffic management and traffic control to provide accurate information on predicted traffic conditions and develop strategies for the best routes and modes of transportation to avoid areas of congestion.

Incident Detection - For incident detection algorithms have been developed for automatically detecting incidents on a freeway system using detector data. The following are the different types of algorithms that are for incident detection,

- Pattern recognition are comparative algorithms. They compare measured traffic conditions to pre-established thresholds.
- Time series uses statistical procedures to detect significant changes in traffic patterns over time.
- Complex theoretical models predict future traffic conditions usingtraffic measures and historical data.

REFERENCES

The following documents contain information used as the basis for recommendations made in this task. The reader is encouraged to become familiar with these documents.

IVHS Planning and Project Deployment Process, Federal Highway Administration, Version 1.0 April 1993.

IVHS Architecture Development Program, Interim Status Report, IVHS America, April 1994.

ITS Architecture Development Program, ITS America, Phase I, November 1994.

Working Paper on IVHS User Services and Functions, MITRE, November 1992.

TASK IV

IDENTIFY/ASSESS ROADWAYS

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INTRODUCTION

Establishing roadway priorities was an important part of developing an Intelligent Transportation System (ITS) Early Deployment Plan (EDP) for the Austin metropolitan area. It (1) provided an initial assessment of roadway operational and safety problems; (2) assisted with identifying and defining potential ITS projects; and most importantly, (3) was based on the priorities of local transportation stakeholders, the Austin ITS Steering Committee.

The primary goal of this task was to develop a roadway priority list that represents the priorities of local transportation entities that serve various transportation markets in the Austin area. In this effort, the Austin ITS Steering Committee played an important role. First, their input was used to define the universe of roadways to consider in a technical prioritization process. Next, staff assigned to the ITS EDP (i.e., the Study Team) evaluated each roadway to assess its operational and safety characteristics. The evaluation produced a priority list that was presented to the Steering Committee for comments and approval. And finally, their comments were incorporated into the final roadway priority list. Identifying priority roadways establishes areas for further investigation to determine the appropriateness of applying ITS.

After prioritizing roadways at a global level, the operational characteristics of each roadway should be evaluated to identify the most problematic areas. As outlined in this report, an arterial street on the priority list underwent further evaluation to assess operational characteristics and to identify problematic areas. Signal delay, stops, accidents, emergency response times, and transit on-time performance were used in the evaluation. Once problem locations are identified, a more microscopic investigation should be performed to determine the cause of the problems. Ultimately, ITS may provide a solution to the problems.

The last section of this report proposes an alternate route planning process to accommodate incident diverted traffic. The Federal Highway *Administration's Freeway Incident Management Handbook*[1] was the source of the alternate route planning process.

ROADWAY PRIORITIZATION

Austin ITS Steering Committee Role

Initial input from the Austin ITS Steering Committee drove the roadway prioritization process. Each Steering Committee member was requested to submit a list of their "top 10" roadways in priority order. In addition, they were asked to identify the limits for each roadway. Top 10 lists were submitted by the Capital Metropolitan Transportation Authority, City of Austin Urban Transportation Commission, City of Austin Department of Public Works and Transportation, Federal Highway Administration, Texas Department of Transportation, Transportation Professionals of Central Texas, Travis County Public Improvements and Transportation Department, and the University of Texas. Copies of these lists are provided in Appendix IVA

The members approached this prioritization task from different perspectives. During a Steering Committee meeting, the attending members presented their prioritization approach. A summary of the presentations is provided below:

Capital Metropolitan Transportation Authority (Capital Metro): Mike Ouimet presented Capital Metro's priority list. Their list focused on principle transit corridors. These corridors received the greatest amount of transit service. Mr. Ouimet also mentioned that they are looking at providing enhanced transit service along these corridors in the form of light rail transit (if approved by the voters) and technologies (e.g., transit signal priority).

City of Austin Transportation Division: David Gerard with the City of Austin explained that their list was based on a congestion map developed through the Congestion Demand Management (CDM) study. The map illustrates congested roadways based on a methodology developed by the Texas Transportation Institute[2]. Existing traffic volumes and number of lanes were the two primary variables used in the methodology to determine whether a roadway was congested. Mr. Gerard primarily focused on arterial streets under the assumption that the freeways would be listed in other members' lists. All together, 37 roadways were submitted by the City of Austin. Mr. Gerard indicated that they had to struggle with identifying their top 10 roadways since they would like to have all of the congested roadways considered in the Early Deployment Plan. In addition, Mr. Gerard presented a list of problems encounter along these roadways and potential improvements

City of Austin Urban Transportation Commission (UTC) John Hickman presented the Urban Transportation Commission's roadway priority list. He along with two other Commissioners prepared their list from their general knowledge of the Austin transportation system and CDM work done by the City of Austin.

Texas Department of Transportation (TxDOT): Bubba Needham explained that he used a network perspective that provided connectivity between the roadways to identify TxDOT's top 10 roadways. Besides the freeway network, Mr. Needham listed roadways that provide cross- town connections between north and south Austin and east and west Austin. He also listed Red River Street since it may be a viable option to accommodate diverted traffic from IH 35 during an incident. Mr. Gerard also indicated that although Congress Avenue did not make the City of Austin's top 10 list, it too could serve as a viable alternative to IH 35 during an incident.

Travis County Public Improvements and Transportation Department (PITD): Through correspondence, David E. McKay with the PITD believed that the priority list submitted by the Urban Transportation Commission provided "the best direction toward improving overall County traffic movement." Mr. McKay added, "Thoroughfares providing alternate routing to and from these corridors during peak traffic periods present additional needs and improving these facilities would certainly follow in consideration."

University of Texas (UT): To identify their priorities, Dr. Michael Walton along with his colleagues used a system perspective that provided connectivity between the roadways. They focused on finking major freeways with arterial streets based on their understanding and appreciation of transportation issues in Austin.

In all, 25 roadways were submitted by the Steering Committee (refer to **Table IV-l).** The roadway limits reflect the furthest north/south or east/west limit submitted by the Steering Committee members. The limits for five roadways, however, resulted in the primary roadway overlapping with another roadway. These roadways included: (1) Ben White Boulevard from Loop 1 to FM 973, (2) Lamar Boulevard/Guadalupe Street from Parmer Lane to MLK Boulevard, (3) Lamar Boulevard from IH 35 to US 290, (4) Burnet Road from IH 35 to 38th Street, and (5) 45th Street from Loop 1 to IH 35. The overlaps usually resulted from different views about the function a particular roadway should serve. Eliminating the overlaps was needed to facilitate the roadway prioritization process. The primary change to remove the overlaps was to split the original roadway into two or more roadways. The splits occurred at points where the roadways changed names. The roadway segments that resulted from the split retained the same priority as the original roadway. These changes are shown in the top 10 lists submitted by the Steering Committee members (refer to Appendix IVA). Nonetheless, the original roadways were important to the agencies that submitted them and need to be remembered to understand their desired functions and to identify potential ITS projects that could enhance these functions.

Prior to the technical evaluation, a simple prioritization process was used to develop a clearer picture of the Steering Committee’s roadway priorities as a group. The first priority on each member’s list received a score of 10, the second priority received a score of nine and so forth until the tenth priority received a score of one. A cumulative score was then determined for each roadway (refer to Appendix IVB). **Table IV-1** lists the 25 roadways in descending order of cumulative score (note: six roadway pairs received the same cumulative score). As expected, the freeways are the top priorities followed by major and minor arterial streets. These 25 roadways established the universe of roadways to undergo a technical prioritization process.

Technical Prioritization Process

The fundamental goals of ITS are to improve the transportation system’s operational efficiency and safety. With these goals in mind, average vehicle delay rate and average accident frequency were chosen respectively to represent each roadway’s operational and safety characteristics. In addition, the data required to compute these measures of effectiveness (MOEs) were readily available and relatively current (1991 to 1994). The following sections discuss the roadway inventory process, the methods used to compute average vehicle delay rate and average accident frequency, how these MOEs were used in the technical prioritization process, and ultimately, the roadway prioritization table.

No.	Roadway	From	To	Cumulative Score	Rank
1	US 183	RM 620	SH 71	69	1
2	IH 35	FM 1325	FM 1327	66	2
3	Loop 1	IH 35	William Cannon Dr.	65	3
4	SH 71	US 290	FM 973	37	4
5	Lamar Blvd.	IH 35	SH 71	34	5
6	Koenig Ln.	Loop 360	Springdale Rd.	31	6
7	Burnet Rd.	Loop 1	38th St.	20	7
8	Congress Ave.	Town Lake	Slaughter Ln.	17	8
9	Loop 360	RM 2244	Lamar Blvd.	16	9
10	Guadalupe St.	W. 51st St..	Cesar Chavez St.	12	10
11	Riverside Dr.	Lamar Blvd.	SH 71	12	10
12	Parmer Ln.	FM 1431	IH 35	11	12
13	S. 1st St.	Town Lake	Slaughter Ln.	10	13
14	W. Guadalupe St.	Lamar Blvd.	W. 45th St.	10	13
15	6th/5th St.	Loop 1	Pleasant Valley Rd.	9	15
16	Airport Blvd.	Lamar Blvd.	US 183	9	15
17	Enfield Rd./15th St.	Loop 1	IH 35	7	17
18	38th St.	Loop 1	IH 35	6	18
19	45th St.	Loop 1	IH 35	6	18
20	RM 620	US 81	SH 71	4	20
21	Cesar Chavez St.	Loop 1	Springdale Rd.	3	21
22	RM 2244	Barton Creek Blvd.	Loop 1	2	22
23	William Cannon Dr.	Loop 1	IH 35	2	22
24	Red River St.	E. 45th St.	Cesar Chavez St.	1	24
25	Spicewood Spring Rd./ Anderson Ln.	Loop 360	Lamar Blvd.	1	24

Note: This list is not the final roadway priority list approved by the Austin ITS Steering Committee. This list serves to develop a preliminary picture of the Steering Committee’s roadway priorities as a group.

Preliminary Austin ITS Steering Committee Roadway Priorities_Table IV-1

Roadway Inventory

Each roadway was inventoried to identify points where names changed, to locate major cross-streets, to determine block numbers, and to estimate distances between cross-streets (refer to Appendix WC). Identifying points where the roadway changed names was necessary to ensure the accident history correctly matched a specified intersection or roadway section. Major cross-streets included every signalized intersection and grade separated structure within the roadway limits. Block numbers were also needed to compile accident data, specifically, mid-block accidents. Approximate block numbers were estimated from a city map that identifies block numbers at varying intervals along each roadway. Two sources were used to estimate distances between cross streets. Previous travel time studies were one source. A distance measuring instrument (DMI) was connected to the travel time vehicle's transmission to record distances. For sections where travel times studies were not conducted, estimates were made from a scaled map of Austin. The scaled map produced estimates that were typically within +/- 100 feet of the distances measured with the DMI.

Average Vehicle Delay Rate

Seven computations were typically performed to determine average vehicle delay rate for each roadway. Besides the roadway inventory, two data sources were used to compute average vehicle delay rate: (1) travel time studies conducted during the A.M.-peak (7:00 a.m. to 8:30 a.m.) and P.M.-peak (4:30 p.m. to 6:00 p.m.) periods in 1991, 1992, 1993, and/or 1994 and (2) 1992 24-hour volume counts. The following sections present the computations and data used to estimate average vehicle delay rate.

Travel Rate

Travel rates were computed from the travel time studies. Travel rate is the time in minutes required to travel a section of roadway if it were one mile in length (i.e., travel time divided by travel distance). Equation 1 illustrates the basic travel rate formula.

$$tr = \frac{tt}{td} \qquad (1)$$

where,

tr = travel rate (minutes/mile);
tt = travel time (minutes); and,
td = travel distance (miles).

Average Travel Rate

The travel time studies typically divided each roadway into two or more sections to facilitate data collection. For instance, IH 35 was divided into two sections: (1) FM 1325 to Yager Lane and (2) Yager Lane to William Cannon Drive. For each section, several (between four and ten) travel time runs were usually performed in both directions and peak periods. The travel rates resulting from each travel time run were averaged to produce a single travel rate for each direction and peak period (refer to Equation 2). To illustrate, six travel time runs were conducted on the IH 35 (1) section between FM 1325 and Yager Lane in the northbound direction during the A.M.-peak period. An average was taken of the resulting six travel rates to arrive at an average travel rate for the specified direction and peak period.

$$atr_{x,y} = \frac{tr_1 + tr_2 + \; . \; . \; . \; . \; + tr_n}{n} \qquad (2)$$

where,

atr = average trave1 rate, (minutes/mile);
x = direction of travel--NB, SB, EB, or WB;
y = A.M.- or P.M.-peak period; and,
n = number of travel time runs.

Average Section Travel Rate

Next, the travel rates for each direction and peak period, as determined above, were averaged to produce an average section travel rate (refer to Equation 3). Using the section of IH 35 from FM 1325 to Yager Lane as an example again, the average travel rates for the northbound direction during the A.M.- and P.M.-peak periods were added to the travel rates for the southbound direction during the A.M.- and P.M.-peak periods and then divided by four to produce an average section travel rate.

$$astri = \frac{\Sigma atr_{x,y}}{n} \qquad (3)$$

where,

$astr_i$ = average section travel rate (minutes/mile);
i = roadway section number; and
n = number of average travel rates for section “i”, 1 to 4.

On certain sections of Cesar Chavez Street, Enfield Road, and 45th Street, travel times studies were only conducted in the peak direction during the peak periods. Therefore, only two average travel rates were used to compute the average section travel rate. Three average travel rates were available for one section of Cesar Chavez Street. For the remaining roadways, however, four average travel rates were available for each section.

Average Roadway Travel Rate

Since the travel time studies typically required dividing the roadways into sections, a weighted average was used to determine a travel rate for the entire roadway (refer to Equation 4). The weighting is based on the length of each roadway section, As stated previously, IH 35 was divided into two sections. Therefore, the average section travel rate from FM 1325 to Yager Lane and Yager Lane to William Cannon Drive was multiplied by their corresponding section lengths and then divided by the total distance from FM 1325 to William Cannon Drive to produce an average travel rate for IH 35.

$$artr = \frac{\Sigma(astr_I \times d_I)}{\Sigma(d_I)} \qquad (4)$$

where,

artr = average roadway travel rate (minutes/mile) and
4 = length of roadway section "i" (feet).

Travel time studies were not conducted on the sections of US 183 and SH 71 under reconstruction. Therefore, average roadway travel rates were not available for these roadways. In addition, travel time information was only available for a short section of 5th and 6th Street between West Lynn Street and West Avenue. Since this section was not believed to accurately represent the travel rates along the entire length of 5th and 6th Street, travel rates were not computed. Travel time information was also not available for West Guadalupe Street.

Nearly every roadway had sections where travel time studies were not conducted. Since these sections were relatively short, it was assumed that the travel rates, as determined above, adequately represented the sections where travel rate data was not available.

Average Desired Travel Rate

Now that an estimate of the average roadway travel rate on each roadway was determined, the next step towards developing an average vehicle delay rate was to compute a desired travel rate. For this study, a desired travel rate was based on the speed limit. Since the speed limits typically varied along each roadway, a weighted average was used to compute the desired travel rate (refer to Equation 5). The weighted average is based on the speed limit within each speed zone and the zone's length.

$$adtr = \frac{60 \times \Sigma d_I}{\Sigma(sl_1 \times d_I)} \qquad (5)$$

where,

adtr = average desired travel rate (minutes/mile);
60 = conversion factor (miles/hour - miles/minute);
4 = length of speed zone “i” (feet); and
sl_i = speed limit in zone “i” (miles/hour).

Average Vehicle Delay Rate

Average vehicle delay rate[3] for a roadway is composed of two components: (1) a traffic volume and (2) a delay rate. The traffic volume component allows a relative comparison between roadways based on the amount of vehicles experiencing delay. An average 24-hour volume was determined for each roadway using 1992 volume data[4]. The traffic volumes were reported for various sections along each roadway. Therefore, a weighted average based on each section’s traffic volume and length was used to estimate an average 24-hour volume for the roadway (refer to Equation 6).

$$a24v = \frac{\Sigma\,(24Hr.\ Volume_i \times d_I)}{\Sigma\, d_I} \qquad (6)$$

where,

a24v = average 24-hour volume (vehicles/day);
24-Hr. Volume, = 24-hour volume for section “i” (vehicles/day); and,
d_i = length of roadway section carrying 24-hour volume, (feet).

Since the A.M.- and P.M.-peak period travel rates were combined to determine an average roadway travel rate, the A.M.- and P.M.-peak hour volumes were used. Two assumptions were made at this point. First, peak-period travel rates are the same as peak-hour travel rates. Second, 10 percent of the 24-hour traffic volume on any roadway was assumed to occur during the A.M.-peak hour and again during the P.M.-peak hour. The 10 percent value (i.e., “K” factor) is a rough estimate of the proportion of daily traffic occurring during the peak hour on an urban freeway[5,6]. In this study, however, the 10 percent estimate was applied to freeways and arterials. Having made these two assumptions, an average vehicle delay rate was estimated by multiplying the traffic volume component, 20 percent (10 percent in the A.M.-peak hour and 10 percent in the P.M.-peak hour) of the 24-hour traffic volume, by the delay rate component, the difference between average desired travel rate and average actual travel rate (refer to Equation 7). The roadway ranking based exclusively on average vehicle delay rate is provided in Appendix IVD, Table IVD- 1.

$$avdr = 0.2 \text{ x } a24v \text{ x } (adtr\ artr) \qquad (7)$$

where,

avdr = average vehicle delay rate (lost minutes/mile) and
0.2 = estimated percent of average 24-hour volume traveling during both the A.M.- and P.M.-peak hours.

Average Accident Frequency

Average accident frequency was the second MOE used to compare roadways. Signalized intersection and mid-block accidents during 1993 and 1994 were used to compute average accident frequencies. The City of Austin's accident data base was used to retrieve accidents within the city limits. TxDOT's data base was used to retrieve those accidents outside the city limits. Two years of accident data were used to better represent the typical accident frequency along each roadway. An average accident frequency (accidents/mile/year) was estimated by adding the signalized intersection and mid-block accidents together and then dividing by two (since two years of accident data were used) and the length of each roadway in miles (refer to Equation 8). The roadway ranking based on average accident frequency is provided in Appendix IVD, Table ND-2.

$$aaf = \frac{\Sigma\, ia_i + \Sigma\, mba_i}{2 \times rl} \qquad (8)$$

where,

aaf = average accident frequency (accidents/mile/year);
ia_i = total accidents at intersection '5" in 1993 and 1994;
mba_i = total mid-block accidents in section '5" in 1993 and 1994;
2 = conversion factor to average accidents/year; and,
rl = entire roadway length (miles).

Technical Prioritization Method

The previous sections outlined how the two roadway prioritization MOEs, average vehicle delay rate and average accident frequency, were determined. The next step in the technical prioritization process combined these two values into one number for each roadway. First, the average vehicle delay rate values were normalized by dividing each value by the highest average vehicle delay rate. The average accident frequencies were also normalized in the same manner. Next, the normalized values were added together and divided by two to yield a mean unweighted score. The mean unweighted scores were then listed in descending order to produce a roadway prioritization table.

At this point, a presentation was made to the Steering Committee to receive comments from the members on the technical prioritization process. Their primary recommendation was to combine the Steering Committee's roadway priorities, **Table IV-l,** with the average vehicle delay rate and average accident frequency data. This recommendation was incorporated into the final prioritization table. The cumulative scores for the roadways in **Table IV-l** were normalized in the same manner discussed previously. All three normalized scores were added together and divided by three. The mean unweighted score for the roadways without an average vehicle delay rate were determined by adding the normalized values for average accident frequency and Steering Committee priorities together and dividing by two. The roadways were reprioritized based on the revised mean unweighted scores. The final roadway priority list approved by the

Steering Committee is shown in **Table IV-2.**

Roadway	From	To	Average Vehicle Delay Rate: Actual ((lost min/mile))	Average Vehicle Delay Rate: Normalized (Actual/Highest) (A)	Average Accident Frequency: Actual (act/mile/yr)	Average Accident Frequency: Normalized (Actual/Highest) (B)	Steering Committee Priorities: Actual (cumulative Score)	Steering Committee Priorities: Normalized (Actual/Hig) (C)	Meta Unweighted Score (A + B + C)[b]	Rank
US 183	RM 620	SH 71	a	N/A	45.8	0.61	69	1.00	0.80 b	1
Loop 1	IH 35	William Cannon Dr.	-7,964	1.00	19.1	0.25	65	0.94	0.73	2
IH 35	FM 1325	FM 1327	-6,429	0.81	26.6	0.35	66	0.96	0.71	3
Lamar Blvd.	IH 35	SH 71	-4,610	0.58	56.3	0.74	34	0.49	0.61	4
Riverside Dr.	Lamar Blvd.	SH 71	-4,610	0.58	75.6	1.00	12	0.17	0.58	5
38th St	Loop 1	IH 35	-5,932	0.74	64.7	0.86	6	0.09	0.56	6
Guadalupe St.	51st St	Cedar Chavez St.	-5,290	0.66	58.9	0.78	12	0.17	0.54	7
SH 71	US 290	FM 973 (bergstrom)	a	N/A	39.5	0.52	37	0.54	0.53b	8
6th/5th St	Loop 1	Pleasant Valley Rd.	a	N/A	69.8	0.92	9	0.13	0.53b	9
Parmer Ln.	RM 620	IH 35	-7,949	1.00	14.5	0.19	11	0.16	0.45	10
Congress Ave	Town Lake	Slaughter Ln.	-3,321	0.42	44.4	0.59	17	0.25	0.42	11
Burnet Rd	IH 35	38th St.	-3,075	0.39	42.0	0.56	20	0.29	0.41	12
Koenig Ln	Loop 360	Springdale Rd.	-3,134	0.39	26.7	0.35	31	0.45	0.40	13
Enfield Rd	Loop 1	IH 35	-1,766	0.22	56.8	0.75	7	0.10	0.36	14
Airport Blvd	Lamar Blvd.	US 183	-2,504	0.31	47.3	0.63	9	0.13	0.36	15
45th St	Loop 1	IH 35	-4,761	0.60	26.8	0.35	6	0.09	0.35	16
Loop 360	RM 2244	Lamar Blvd.	-4,160	0.52	20.0	0.26	16	0.23	0.34	17
Cesar Chavez St.	Loop 1	Springdale Rd.	-2,975	0.37	44.9	0.59	3	0.04	0.34	18
William Cannon Dr.	Loop 1	IH 35	-2,418	0.30	48.4	0.64	2	0.03	0.32	19
RM 2244	Barton Creek Blvd	Loop 1	-3,685	0.46	30.3	0.40	2	0.03	0.30	20
South 1st St	Town Lake	Slaughter Ln.	-1,568	0.20	32.3	0.43	10	0.14	0.26	21
Red River St.	45th St	Cedar Chavez St.	-1,507	0.19	33.4	0.44	1	0.01	0.22	22
Spicewood Springs Rd/ Anderson Ln	Loop 360	Lamar Blvd.	-1,716	0.22	29.6	0.39	1	0.01	0.21	23
RM 620	IH 35	SH 71	-964	0.12	9.0	0.12	4	0.06	0.10	24
W. Guadalupe St	Lamar Blvd.	W. 45th St.	a	N/A	0.0	0.00	10	0.14	0.05b	25

a Travel time information was not available for three roadways.
b. Mean unweighted score is based on average accident frequency and Steering Committee priorities

Austin ITS Steering Committee Roadway Priority Table_Table IV-2

ARTERIAL-STREET PROBLEM IDENTIFICATION

After prioritizing roadways at a global level, the operational characteristics of each roadway should be evaluated (1) to identify the most problematic areas and (2) to quantify existing conditions. Knowing the existing magnitude of the problem is necessary for measuring the effectiveness of strategies aimed to address the problem (e.g., before and after studies). Once problem locations are identified and quantified, a more microscopic investigation (e.g., field investigations) should be performed to determine the cause of the problems. Ultimately, ITS may provide a solution to the problems. Nonetheless, traditional transportation engineering tools, like safety studies and signal timing adjustments, should also be considered to address the problems. Although ITS (e.g., dynamic lane control signs) can address some of the site-specific problems discussed in the following text, most ITS elements are geared toward system level improvements (e.g., incident management, traveler information, adaptive signal control, transit signal priority).

Lamar Boulevard was selected as a case study to illustrate a process that identifies problematic locations and quantifies existing conditions along one of the top 25 priority roadways identified by the Austin ITS Steering Committee. Signal delay, stops, accidents, emergency response times, and transit on-time performance were the MOEs used in this case study. Emergency response times and transit on-time performance were not used to identify problematic areas, but to identify trends in operational performance. These MOEs are readily available from Austin transportation stakeholders. A similar process could also be applied to freeways.

Objectives

1. Identify locations that experience the poorest operational characteristics. Stop delay, stops, and accident frequencies at signalized intersection along with mid-block accident rates were used to identify these locations.
2. Identify trends in emergency response times and dispatching characteristics of emergency medical service (EMS) units.
3. Identify trends in transit on-time performance.

Study Area

The Lamar Boulevard study area extends from IH 35 at the north end to Ben White Boulevard at the south end. This section is approximately 16.1 miles in length and contains 43 signalized intersections.

Stop Delay

Data Collection

Travel time studies were used to measure stop delay on Lamar Boulevard approaches to signalized intersections during the A.M.- and P.M.-peak periods in 199 1, 1992, 1993, 1994, and

1995. Seven o'clock in the morning to 8:30 a.m. defined the A.M.-peak period and 4:30 p.m. to 6:00 p.m. defined the P.M.-peak period. The initial data collection effort to establish baseline travel time conditions on all roadways of interest began in 1991 and ended in 1994. Therefore, signal delay data during this initial period were grouped together and labeled as "1991/l994" data. Comparison are made between the 1991/1994 and 1995 data collection periods. Four study periods existed in each data collection period: (1) A.M.-peak southbound, (2) A.M.-peak northbound, (3) P.M.-peak southbound, and (4) P.M.-peak northbound. Cross-street stop delay data was not collected.

Objectives

1. Which intersections consistently experienced unacceptable delays (level-of-service "E"--stopped delay = 40.1 to 60.0 sec/veh or greater was considered an unacceptable level of delay) during both the 1991/1994 and 1995 data collection periods?
2. Which intersections exhibited an increase in the number of study periods operating ata LOS E or greater from 1991/1994 to 1995?
3. Did signal delay increase from 1991/1994 to 1995?

The answers to these questions will be used to indicate where recurring congestion occurs during the peak periods and whether it is increasing.

Analysis and Findings

Stop delay data for 1991/1994 and 1995 are summarized in **Table IV-3.** Shaded study periods indicate that the respective Lamar Boulevard approach experienced a level-of-service (LOS) "E" or greater. (Please refer **to Table IV-3.** It provides a clearer picture of the intersections experiencing unacceptable delay levels than the following lists.) **Table IV-4** illustrates the change in peak, off-peak, and total stop delay from 199 l/l 994 to 1995.

1. Five intersections consistently experienced unacceptable delays during both the 1991/1994 and 1995 data collection periods (refer to **Table IV-3).** Although Lamar Boulevard was retimed during December 1994/January 1995, these intersections continued to exhibit recurring congestion (signal timing changes may not be able to improve operations).

    1. Rundberg Lane
    2. 38th Street
    3. 24th Street
    4. 6th Street
    5. 5th Street

2. Seven intersections exhibited an increase in the number of study periods operating at a LOS E or greater from 1991/1994 to 1995 (refer to **Table IV-3).**

    1. Braker Lane
    2. Morrow Street
    3. Justin Lane
    4. Koenig Lane
    5. 38th Street
    6. 24th Street
    7. MLK Boulevard

3. Signal delay increased from 1991/1994 to 1995.

    A. In 1995, more intersections (10 intersections versus eight intersections) experienced a LOS E or greater more frequently (15 periods versus eight periods) than in 1991/1994 (refer to **Table IV-3).**

Major Cross-Streets (signalized Intersections)	A.M.-Peak Period				P.M.-Peak Period			
	Southbound		Northbound		Southbound		Northbound	
	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)
N. I 35 WF	--	--	--	--	--	--	--	--
W. Parmer Ln.	--	--	--	--	--	--	--	--
W. Yager Ln.	--	--	--	--	--	--	--	--
North Bend Dr.	--	--	1	4	--	--	1	0
W. Braker Ln.	15	46	0	9	24.6	34	28	51
Kramer Ln.	5	0	0	2	6	8	1	0
Meadows	0	0	0	0	0	0	0	0
Masterson Pass	0	0	0	0	1	0	2	0
Rutland Dr.	10	34	0	0	6	13	6	2
W. Rundberg Ln.	15	8	5	22	24.9	28	125	89
Peyton Gin Rd.	0	6	0	3	10	1	2	14
Thurmond St.	2	0	3	0	0	0	0	0
W. Anderson Ln./Research Blvd. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Morrow St.	8	0	--	0	5	17	--	42
W. St. Johns Ave.	--	0	6	0	--	0	0	0
Airport Blvd.	0	9	7	7	0	4	4	24
Justin Ln.	0	6	2	0	17	10	6	48
Brentwood St.	0	4	0	0	0	8	1	2
Denson Dr.	0	14	1	0	0	2	6	0
W. Koenig Ln.	9	57	0	2	22	12	19	39
W. North Loop Blvd	11	33	0	10	4	0	29	6
W. 51st St.	0	0	19	0	0	0	17	12
W. Guadalupe St.	0	0	--	0	0	0	--	0
W. 45th St.	--	0	0	9	--	1	13	20
W. 38th St.	2	40.3	14	12	9	41	47	48
W. 34th St.	11	0	26	30	26	0	27	25.0
W. 29th St.	2	7	1	8	5	7	0	29
W. 24th St.	29	41	0	41	64	68	0	37
W. MLK Blvd.	0	0	--	1	0	0	--	54
W. 15th St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Parkway	--	14	0	0	0	0	0	0
W. 12th St.	0	5	0	11	0	0	11	6
W. 10th St.	0	0	0	0	42	0	0	2
W. 9th St.	0	0	2	15	25.0	19	5	14
W. 6th St.	10	5	3	0	91	75	3	0
W. 5th St.	2	0	56	65	5	4	5	9
W. 1st St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
W. Riverside Dr.	0	0	15	31	56	22	0	11
Barton Springs Rd.	7	12	45	29	39	6	20	14
Treadwell St.	0	2	0	4	0	4	3	2
Hether St./W. Mary St.	0	12	0	0	7	0	0	0
W. Oltorf St.	0	2	18	0	2	0	16	16
Bluebonnet Ln.	2	10	0	0	25.2	0	0	5
Manchaca Rd.	0	0	0	0	0	0	0	5
Barton Skwy.	11	7	0	8	8	2	3	5
Panther Trl.	0	2	0	0	0	6	0	0
Brodie Oaks (Pull Mid Block)	--	--	--	--	--	--	--	--
W. Ben White Blvd. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes: 1. intersection approaches with stop delay >= LOS E (40.1 sec/veh) are shaded.
2. "GS" refers to grade separated cross streets.

Stop Delay for Lamar Boulevard Signalized Intersection Approaches_Table IV-3

Direction	A.M. Peak				P.M. Peak				%D 1991/1994 to 1995
	SB		NB		SB		NB		
	1991/ 1994	1995	1991/ 1994	1995	1991/ 1994	1995	1991/ 1994	1995	
Peak	119	305	139	163	300	138	345	548	28
Off-Peak	32	71	85	160	224	254	55	83	43
Total	151	376	224	323	524	392	400	631	33

Note: Directional traffic volume Splits indicate the change from peak to off-peak direction occurs immediately south of 15th Street in the A.M. peak and 12th Street in the P.M. peak (refer to Appendix IVE).

Cumulative Peak and Off-Peak Directional Stopped Delay (sec/veh)_Table IV-4

B. Lamar Boulevard signal stop delay increased 28 percent in the peak direction, 43 percent in the off-peak direction, and 33 percent when the peak and off-peak directions were combined from 1991/l 994 to 1995 (refer to **Table IV-4).**

Stops

Data Collection

The travel time studies used for stop delay were also used to examine stops. Each time a stop delay was recorded, it indicated that the travel time study vehicle had to stop. A ratio was developed with the number of travel time runs when the study vehicle had to stop in the numerator and the total number of travel time runs in the denominator. This ratio was used to indicate how frequently vehicles had to stop.

Objectives

1. Which intersections consistently required travel time study vehicles to stop at least 75 percent of the time during both the 1991/1994 and 1995 data collection periods?
2. Which intersections exhibited an increase in the number of study periods requiring the study vehicle to stop at least 75 percent of the time from 199 l/1994 to 1995?
3. Did the percentage of stops increase from 1991/1994 to 1995?

The answers to these questions will be used to indicate where recurring congestion occurs during the peak periods and whether it is increasing. In addition, the answers should support those findings for stop delay as well as identify additional locations where congestion exists.

Analysis and Findings

The 1991/1994 and 1995 number of stops and number of travel time runs are summarized in **Table IV-5** Any Lamar Boulevard approach requiring the travel time vehicle to stop more than 75 percent of the time is shaded in **Table IV-5.**

1. Two intersections consistently required travel time study vehicles to stop at least 75 percent of the time during both the 1991/1994 and 1995 data collection periods (refer to **Table IV-5).** These intersections also consistently experienced unacceptable delay levels in 1991/1994 and 1995.

   1. Rundberg Lane 2. 6th Street

2. Eight intersections exhibited an increase in the number of study periods requiring the study vehicle to stop at least 75 percent of the time from 1991/l 994 to 1995 (refer to **Table IV-5).**

    1. Braker Lane
    2. Rundberg Lane
    3. 45th **Street**
    4. 38th Street
    5. 34th Street
    6. 29th Street
    7. 24th Street
    8. 5th Street

A. In 1995, more intersections (nine intersections versus seven intersections) more frequently (14 periods versus nine periods) required the study vehicle to stop at least 75 percent of the time than in 1991/1994 (refer to **Table IV-6).**

B. The percentage of stops increased 21 percent in the peak direction, 38 percent in the off-peak direction, and 29 percent when the peak and off-peak directions were combined from 1991/1994 to 1995 (refer to **Table IV-6).**

Direction	**A.M. Peak**				**P.M. Peak**				**%D 1991/1994 to 1995**
	SB		**NB**		**SB**		**NB**		
	1991/ 1994	**1995**	**1991/ 1994**	**1995**	**1991/ 1994**	**1995**	**1991/ 1994**	**1995**	
Peak	18	23	12	23	42	22	28	39	21
Off-Peak	15	21	14	26	22	24	16	26	38
Total	17	23	13	25	27	23	25	35	29

Note: Directional traffic volume splits indicate the change from peak to off-peak direction occurs immediately south of 15th Street in the A.M. peak and 12th Street in the P.M. peak (refer to Appendix IVE).

Peak and Off-Peak Directional Stop Percentages_Table IV-6

Major Cross-Streets (signalized Intersections)	A.M.-Peak Period				P.M.-Peak Period			
	Southbound		Northbound		Southbound		Northbound	
	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)	1991/1994 (sec/veh)	1995 (sec/veh)
N. I 35 WF	--	--	--	--	--	--	--	--
W. Parmer Ln.	--	--	--	--	--	--	--	--
W. Yager Ln.	--	--	--	--	--	--	--	--
North Bend Dr.	--	--	2/21	1/6	--	--	2/18	0/7
W. Braker Ln.	13/21	4/6	0/14	4/6	14/19	7/7	5/11	4/7
Kramer Ln.	1/14	0/9	0/14	1/6	1/11	1/7	1/11	0/7
Meadows	0/14	0/9	0/14	0/6	0/11	0/7	0/11	0/7
Masterson Pass	0/14	0/9	0/14	0/6	1/11	0/7	1/11	0/7
Rutland Dr.	4/14	3/6	0/14	0/6	2/11	4/7	3/11	1/7
W. Rundberg Ln.	4/14	2/6	1/14	6/6	4/11	3/7	11/11	7/7
Peyton Gin Rd.	0/14	2/9	0/14	1/6	6/11	1/7	1/11	5/7
Thurmond St.	1/14	0/6	4/14	0/6	1/11	0/7	0/11	0/7
W. Anderson Ln./Research Blvd. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Morrow St.	3/14	0/6	--	0/6	1/11	2/7	--	5/7
W. St. Johns Ave.	--	0/6	6/8	0/6	--	0/7	0/13	0/7
Airport Blvd.	0/8	2/6	2/8	1/6	0/13	1/7	4/13	4/7
Justin Ln.	0/8	1/6	1/8	0/6	6/13	2/7	4/13	3/7
Brentwood St.	0/8	1/6	0/8	0/6	0/13	3/7	1/13	1/7
Denson Dr.	0/8	3/6	1/8	0/6	0/13	1/7	3/13	0/7
W. Koenig Ln.	5/8	3/6	0/8	1/6	6/13	3/7	7/13	4/7
W. North Loop Blvd	2/8	3/6	0/8	1/6	4/13	0/7	5/13	1/7
W. 51st St.	0/8	0/6	8/8	0/6	0/13	0/7	13/13	5/7
W. Guadalupe St.	0/8	0/6	--	0/6	0/13	0/7	--	0/7
W. 45th St.	--	0/9	0/7	2/6	--	1/7	2/6	7/7
W. 38th St.	1/7	3/6	2/7	2/6	1/6	6/7	4/6	5/7
W. 34th St.	2/1	0/6	5/7	6/7	3/6	0/7	3/6	5/6
W. 29th St.	1/7	1/6	1/7	6/7	2/6	2/7	0/6	6/6
W. 24th St.	4/7	6/6	0/7	7/7	4/6	6/7	0/6	3/6
W. MLK Blvd.	0/7	0/7	--	1/7	0/6	0/7	--	4/6
W. 15th St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Parkway	--	4/6	0/7	0/7	0/6	0/7	0/7	0/6
W. 12th St.	0/8	1/6	0/8	3/7	0/6	0/7	2/7	1/6
W. 10th St.	0/8	0/6	0/8	0/7	3/6	0/7	0/7	1/6
W. 9th St.	0/8	0/6	1/8	5/7	3/6	3/7	1/7	4/6
W. 6th St.	7/8	2/6	1/8	0/7	5/6	6/7	1/7	0/6
W. 5th St.	1/8	0/6	4/8	6/7	1/6	1/7	2/7	1/6
W. 1st St. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
W. Riverside Dr.	0/8	0/6	2/8	2/7	5/6	4/7	0/7	1/6
Barton Springs Rd.	1/8	1/6	3/8	3/7	6/6	2/7	3/7	3/6
Treadwell St.	0/8	1/6	0/8	2/7	0/6	2/7	3/7	1/6
Hether St./W. Mary St.	0/8	4/6	0/8	0/7	1/6	0/7	0/7	0/6
W. Oltorf St.	0/8	1/6	3/8	0/7	1/6	0/7	5/7	4/6
Bluebonnet Ln.	1/8	3/6	0/8	0/7	4/6	0/7	0/7	2/6
Manchaca Rd.	0/8	0/6	0/8	0/7	0/6	0/7	0/7	1/6
Barton Skwy.	7/8	1/6	0/8	3/7	4/6	1/7	0/7	2/6
Panther Trl.	0/8	1/6	0/8	0/7	0/6	1/7	0/7	0/6
Brodie Oaks (Pull Mid Block)	--	--	--	--	--	--	--	--
W. Ben White Blvd. (GS)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes:
1. intersection approaches which required the study vehicle to stop more than 75 percent of the time are shaded.
2. "GS" refers to grade separated cross streets.
3. The percentage of stops increased from 1991/1994 to 1995.

Lamar Boulevard Travel Time Study Vehicle Stop Frequency_Table IV-5

Accidents--Intersection and Mid-Block

Data Collection

The Austin Police Department's accident data base was used to retrieve Lamar Boulevard accident data. Nineteen ninety-three and 1994 accidents were averaged to more accurately represent the typical accident frequency in a given year. Accident frequency was the measure of effectiveness (MOE) used at intersections. An intersection accident rate was not used since 24-hour cross-street traffic data were not readily available for every signalized intersection. Accident rates (accidents/hundred million vehicle miles traveled = HMVM) were the MOE used for each mid-block between two adjacent signalized intersections. Nineteen ninety-two, 24-hour mid-block traffic volumes were available from previous work performed while prioritizing roadways for the Austin ITS Steering Committee. Therefore, these volumes were used to compute mid-block accident rates.

Objectives

1. Identify intersections experiencing the greatest accident frequency?
2. Identify mid-block sections experiencing the greatest accident rate?

Answers to these questions will identify locations that experience higher rates of non-recurring congestion than other locations along Lamar Boulevard.

Analysis and Findings

Table IV-7 depicts the accident frequency for each signalized intersection and accident rate for each mid-block section. Top 10 intersections and mid-block sections are shaded in**Table IV-7.**

1. The top-10 intersections experiencing the greatest accident frequency were:

1. Braker Lane-- 18 acc./year
2. Rundberg Lane-- 17.5 acc./year
3. Rutland Drive-- 12.5 acc./year
4. 6th Street--10 acc./year
5. 38th Street--g.5 acc./year
6. 5th Street--7.5 acc./year
7. Morrow Street--7.5 acc./year
8. 45th Street--7 acc./year
9. Koenig Lane--7 acc./year
10. 12th Street--6.5 acc./year
11. Barton Springs Road--6.5 acc./year
12. Manchaca Road--6.5 acc./year

2. The top- 10 mid-block sections experiencing the greatest accident rate were:

1. Rutland to Rundberg—2206/HMVM
2. St. Johns to Airport—989/HMVM
3. North Loop to 51st—763/HMVM
4. Masterson Pass to Rutland—750/HMVM
5. Koenig Lane to North Loop—668/HMVM
6. Braker to Kramer--661/HMVM
7. Airport to Brentwood--583/HMVM
8. 10th to 9th-548/HMVM
9. Rundberg to Peyton--489/HMVM
10. 9th to 6th—484/HMVM

Major Cross-Streets (signalized Intersections)	Accidents	
	Intersection	Mid-Blocks
	(accidents/year)	(accidents/HVM)M)
N. I 35 WF	0.0	176
W. Parmer Ln.	4.0	231
W. Yager Ln.	2.5	119
North Bend Dr.	0.5	242
W. Braker Ln.	18.0	661
Kramer Ln.	5.0	385
Meadows	3.5	174
Masterson Pass	4.0	750
Rutland Dr.	12.5	2206
W. Rundberg Ln.	17.5	489
Peyton Gin Rd.	4.5	402
Thurmond St.	2.0	
W. Anderson Ln./Research Blvd. (GS)	n/a	391
Morrow St.	7.5	
W. St. Johns Ave.	5.0	989
Airport Blvd.	4.0	
Justin Ln.	4.0	583
Brentwood St.	5.5	387
Denson Dr.	3.0	298
W. Koenig Ln.	7.0	668
W. North Loop Blvd	5.5	763
W. 51st St.	2.0	252
W. Guadalupe St.	4.0	94
W. 45th St.	7.0	322
W. 38th St.	9.5	370
W. 34th St.	3.0	278
W. 29th St.	4.5	104
W. 24th St.	5.0	86
W. MLK Blvd.	3.5	54
W. 15th St. (GS)	n/a	239
Parkway	0.0	218
W. 12th St.	6.5	148
W. 10th St.	2.5	548
W. 9th St.	2.5	484
W. 6th St.	10.0	307
W. 5th St.	7.5	
W. 1st St. (GS)	n/a	107
W. Riverside Dr.	5.0	402
Barton Springs Rd.	6.5	359
Treadwell St.	0.0	276
Hether St./W. Mary St.	5.5	458
W. Oltorf St.	5.5	154
Bluebonnet Ln.	4.0	269
Manchaca Rd.	6.5	--
Barton Skwy.	4.5	323
Panther Trl.	5.5	454
Brodie Oaks (Pull Mid Block)	n/a	453
W. Ben White Blvd. (GS)	n/a	n/a

Notes:
1. Accident data based on 1993 and 1994 Austin Police Department statistics.
2. "GS" refers to grade separated cross streets.
3. Boxes outlined in bold represent the mid-block accident rate between the intersections above and below the box.

Lamar Boulevard Intersection and Mid-Block Accident Data_Table IV-7

Traffic Flow Summary--Stop Delay, Stops, and Accidents

Data Collection

This section summarizes data from the signal delay, stops, and accident sections.

Objective

1. Identify priority locations to focus ITS or traditional transportation engineering recommendations.

Combining stop delay, stops, and accident data into one table provided a clearer picture of where to focus ITS recommendations.

Analysis and Findings

Table IV-8 summarizes and combines stop delay, stops, and accidents. Although mid-block data (i.e., link lengths, 24-hour volumes, and accident rates) are placed on an intersection row, the data actually refers to the mid-block between that intersection and the intersection immediately below it. An asterisk ("*“) represents the number of study periods at each intersection that exhibited at least a LOS “E” or required the study vehicle to stop at least 75 percent of the time.

Major Cross-Streets (signalized Intersections)	Distance (feet)	1992 24-Hr. Vol. (veh/day)	Signal Delay		Stops		Accidents	
			1991/1994	1995	1991/1994	1995	Top-10 Intersect	Top-10 Mid-Blk.
			(SPs>=LOS E)					
N. I 35 WF	6600	2490						
W. Parmer Ln.	2224	15510						
W. Yager Ln.	6609	16620						
North Bend Dr.	1079	16620						
W. Braker Ln.	905	30240		**		*	18	661
Kramer Ln.	2188	33510						
Meadows	1242	33510						
Masterson Pass	2533	33510						750
Rutland Dr.	800	40170					12.5	2206
W. Rundberg Ln.	2180	37300	*	*	*	**	17.5	489
Peyton Gin Rd.	2360	38130						
Thurmond St.		38130						
W. Anderson Ln./Research Blvd. (GS)	4400	40080						
Morrow St.	1800	39100		*			7.5	
W. St. Johns Ave.	780	40820			*			989
Airport Blvd.	380	30790						
Justin Ln.	1150	30790		*				583
Brentwood St.	1580	30790						
Denson Dr.	1890	30790						
W. Koenig Ln.	2040	33960		*			7	668
W. North Loop Blvd	890	25570						763
W. 51st St.	1010	25570			**			
W. Guadalupe St.	2100	25570						
W. 45th St.	3488	25735				*	7	
W. 38th St.	1040	26340	*	**		*	9.5	
W. 34th St.	2072	26340				**		
W. 29th St.	4720	26430				**		
W. 24th St.	1857	31810	*	***		***		
W. MLK Blvd.	1700	31810		*				
W. 15th St. (GS)	1300	32550						
Parkway	204	32550						
W. 12th St.	774	37900					6.5	
W. 10th St.	418	37900	*					548
W. 9th St.	947	37900						484
W. 6th St.	498	37900	*	*	**	*	10	
W. 5th St.		48070	*	*		*	7.5	
W. 1st St. (GS)	2257	48070						
W. Riverside Dr.	1381	40380	*		*			
Barton Springs Rd.	2066	35120	*		*		6.5	
Treadwell St.	3061	35120						
Hether St./W. Mary St.	900	35120						
W. Oltorf St.	2370	43660						
Bluebonnet Ln.	1599	43660						
Manchaca Rd.	401	43660					6.5	
Barton Skwy.	2850	34580			*			
Panther Trl.	1382	34580						
Brodie Oaks (Pull Mid Block)	1200	34580						
W. Ben White Blvd. (GS)								

Notes:
1. Accident data is based on 1993 and 1994 Austin Police Department statistics.
2. "GS" refers to grade separated cross streets.
3. "SPs" refer to study periods. Four study periods existed during each data collection period: (1) A.M.-peak southbound, (2) A.M.-peak northbound, (3) P.M.-peak southbound, and (4) P.M.-peak northbound.
4. Asterisks represent the number of study periods having the characteristics described in the column's header.
5. Although mid-block data (i.e., link lengths, 24-hour volumes, and accident rates) are placed on an intersection row, the data actually refers to the mid-block between that intersection and the intersection below it. Shaded link lengths are estimated.

Lamar Boulevard Traffic Flow Characteristics and Accident Summary_Table IV-8

1. Table IV-8 reveals four somewhat distinct patterns where considerable delays, stops, and accidents existed on Lamar Boulevard.

   1. Braker Lane to Kramer Lane, primarily Braker Lane (approximately 1000 feet)
   2. Masterson Pass to Peyton Gin, primarily Rundberg Lane (approximately 5600 feet)
   3. 45th Street to MLK Boulevard (approximately 13,200 feet)
   4. 12th Street to 5th Street (2700 feet)

   A number of the primary cross streets (e.g., Braker, Rundberg, 45th, 3&h, 6th 5th) included in these sections provide connections to freeways parallel to Lamar Boulevard, either Mopac and/or IH 35. In addition, sections #3 and ##4 provide access to major traffic generators like the University of Texas and the central business district, respectively. Therefore, congestion is expected at the major cross-streets that intersect Larnar Boulevard.

Emergency Response Times and Dispatching Characteristics

Data Collection

The City of Austin Emergency Medical Service (EMS) Department provided average response time and dispatches per day data for the EMS fleet from 1990 to 1994. This data was analyzed to establish trends in EMS response times.

Although EMS data does not readily lend itself to analyzing response times along specific routes, a method to estimate route specific response times may be possible. EMS uses serial zones to identify the origin and destination of EMS units when dispatched to an emergency. EMS's database does not contain information about which route the EMS unit traveled to an emergency.

EMS response times on Lamar Boulevard, however, could be estimated by analyzing response times to and from serial zones adjacent to Lamar Boulevard. This approach does not guarantee that an EMS unit used Lamar Boulevard to respond to an emergency. It is recommended that transportation and EMS staff work closely together to prioritize roadways or areas for improvements in emergency response times.

Supporting information pertaining to EMS and the Fire Department are provided below:

1. EMS has two response time goals: (1) respond to 90 percent of advance calls (life or limb threatening) within eight minutes and (2) respond to 90 percent of basic calls within 10 minutes.
2. The Fire Department's goal is to respond to any fire emergency within three minutes inside the city limits.
3. More than 60 percent of the Fire Department's calls are first responder calls for EMS.
4. EMS response times include three stages: (1) process--from the time a 911 call is received until a dispatch call is sent to the EMS unit (unit is toned out); (2) time-out-of-station--from the time an EMS unit is toned out until it starts moving; and (3) drive time--from the time the vehicle starts moving until it makes patient contact.
5. Fire response times currently include two stages: (1) time-out-of-station and (2) drive time.

<u>Objectives</u>

1. Are EMS average response times increasing over time?
2. How many times per day, on average, is an EMS unit dispatched?

Call Type	Average Dispatches/Day						Average Dispatches/Day					
	1990	**1991**	**1992**	**1993**	**1994**	**1990-1994 Avg. Annual % D**	**1990**	**1991**	**1992**	**1993**	**1994**	**1990-1994 Avg. Annual % D**
Advance	7.12	7.16	7.27	7.39	7.62	1.7	28.05	29.54	29.75	31.41	34.28	5.1
Basic	7.05	7.31	7.49	7.79	7.96	3.1	63.52	68.21	69.04	68.56	71.09	2.9
Total	7.07	7.27	7.42	7.66	7.84	2.6	91.57	97.75	98.79	99.97	105.4	3.6

Note:
1. 1990 to 1994 average annual changes are compounded rates.
2. Advance calls are those that are life or limb threatening and likely require administering drugs.

City-Wide Emergency Medical Services Average Response Times and Dispatches/Day_Table IV-9

Fire Department response times were not available during the preparation of this report. Although the trends for EMS units are probably similar to fire units, any final conclusions should include Fire Department data.

Analysis and Findings

EMS average response times and dispatches per day are summarized in Table IV-9.

1. From 1990 to 1994, average response times for EMS units increased. City-wide average response times increased 2.6 percent annually.
2. As of 1994, on a city-wide basis, EMS units are dispatch approximately 106 times per day. City-wide dispatches increased at an annual rate of roughly 3.6 percent from 1990 to 1994.

Transit On-Time Performance

Data Collection

Lamar Boulevard serves a substantial portion of three bus routes:

1. #1--North Lamar (turns into /#13 South Congress)
2. #38--Lamar/Westgate (turns into #37 Colony Park)
3. #45--Copperfield

Capital Metropolitan Transportation Authority (Capital Metro) provided on-time performance data for these three routes and for their entire bus fleet. If a bus is either more than five minutes behind schedule or one minute ahead of schedule it is considered not on-time. On-time performance studies are performed monthly. The #l also provides service to South Congress

Avenue as the #13. The #38 also provides service to Colony Park as the #37. On-time performance data reflects the combined routes, not Lamar Boulevard exclusively.

Objectives

1. How is transit on-time performance changing over time?
2. If on-time performance falls to an unacceptable level, what are the impacts to Capital Metro?

Analysis and Findings

On-time performance data from 1991 to 1994 are summarized in Table IV-10. These tables revealed the following findings:

1a. From 1991 to 1994, on-time performance improved on the two bus routes in which Lamar Boulevard is the primary route, #l and #3 8. On-time performance data were not available for the #45.

1b. On-time performance, however, decreased at an annual rate of 0.7 percent for the entire Capital Metro bus fleet from 1991 to 1994.

1c. Observing the actual trend in on-time performance for each year, however, does not establish a clear trend whether on-time performance is getting better or poorer for either of the two bus routes using Lamar Boulevard or for the entire bus fleet.

2. During the day, when on-time performance falls to an unacceptable level on Lamar Boulevard, Capital Metro will dispatch another bus. The capital cost for a bus is approximately $200,000 to $225,000.

Primary Lamar Bus Routes	**On-Time Performance (%)**				
	1991	**1992**	**1993**	**1994**	**1991-1994 Avg. Annual %** D
l--North Lamar (13--S. Congress)	87.8	87.3	86.9	89.4	0.6
38--S. Lamar/Westgate (37--Colony Park)	87.1	93.9	87.4	92.5	2.0
45--Copperfield	n/a	n/a	n/a	n/a	n/a
All Capital Metro Routes	90.6	93.0	90.6	88.6	-0.7

Transit On-Time Performance_Table IV-10

Although on-time performance data was analyzed for Lamar Boulevard, it is recommended that additional discussions between Capital Metro and the City of Austin Transportation Division occur to discuss transit related problems on their priority roadways. These discussions may show that data other than on-time performance are more appropriate for quantifying transit problems. In addition, these discussions would set the stage for developing potential solutions to the problems.

Summary of Findings

Traffic Flow

1. Locations consistently experiencing recurring congestion in the peak periods were identified.
2. Stop delay increased from 1991/1994 to 1995. A greater increase in stop delay was seen

in the off-peak direction than the peak direction. In addition, the P.M.-peak period experienced a greater amount of stop delay than the A.M.-peak period.

3. Stop percentages increased from 19910994 to 1995. A greater increase in stop percentage was seen in the off-peak direction than in the peak direction. In addition, the P.M.-peak period experienced a higher stop percentage than the A.M.-peak period.
4. Locations experiencing non-recurring congestion (i.e., high accident intersections and mid-block sections) were identified.
5. Four somewhat distinct patterns where considerable delays, stops, and accidents existed on Lamar Boulevard were identified.
   a. Braker Lane to Kramer Lane, primarily Braker Lane (approximately 1000 feet)
   b. Masterson Pass to Peyton Gin, primarily Rundberg Lane (approximately 5600 feet)
   c. 45th Street to MLK Boulevard (approximately 13,200 feet)
   d. 12th Street to 5th Street (2700 feet)
6. A correlation appears to exist between highly congested locations and accident experience.

Emergency Response Times and Dispatching Characteristics

1. EMS response times increased 2.6% annually from 1990 to 1994 on average throughout the city.
2. As of 1994, on a city-wide basis, EMS units are dispatched 106 times/day on average.
3. From 1990 to 1994, city-wide dispatches increased at annual rate of roughly 3.6 percent.

Transit On-Time Performance and Ridership Characteristics

1. From 1991 to 1994, a clear trend in transit on-time performance was not demonstrated with the data analyzed.
2. When on-time performance falls to unacceptable levels during the day, an additional bus is dispatched to Lamar Boulevard.

The previous process outlines steps to identify problematic locations and to quantify existing problems. The following steps are recommended to occur after the previous process is completed: (1) perform a more detailed investigation of the problematic locations to determine the cause of the problems; (2) generate potential solutions (either traditional transportation engineering or ITS solutions) to address the problems; (3) select and plan the implementation of a solution; (4) implement the solution; (5) evaluate the solution; and (6) revise the solution based on the evaluation.

ALTERNATE ROUTE PLANNING PROCESS

When major incidents occur on a freeway or arterial street (e.g., one of those roadways in the Steering Committee's roadway priority list), a key element of traffic management is diversion of traffic to other surface streets or freeways to by-pass the incident. These alternate routes should be pre-selected based on incident scenarios developed for each section of the freeways and arterial streets. Following selection, a plan should be developed for each alternate route to better accommodate diverted traffic, to reduce time deciding where to detour traffic, and to avoid unsuitable routes. Most of the following alternate route planning process is found in the *Freeway incident Management Handbook*[1] prepared by Dunn Engineering Associates for the Federal Highway Administration. Although freeways are stressed in developing alternate route plans, these plans can also be applied to arterial streets.

Introduction

The purpose of an alternate route plan is to provide the framework and guidelines for responding to incidents that require closure of section(s) of the freeway or arterial street system. Traffic will be re-routed onto adjacent surface streets that parallel the route experiencing the incident, and guided to return to their original route at the next appropriate location.

Specifically, the plan will: (1) identify alternate traffic routes for each section of the system; (2) establish authority and responsibility of the transportation, police, and other affected agencies; and (3) document the notification process and standard procedures to be utilized for implementing the alternate route(s) and later removal following the termination of the incident period.

Incident Management Team

The first step is to identify organizations and officials likely to have a vested interest in establishing an incident management program. These organizations may include: elected officials, state, county, and city transportation departments, public safety organizations—law enforcement, emergency medical services, and fire protection, transit operators, towing services, commercial traffic reporters, and environmental protection agencies.

Incident Management Team Tasks

Task 1--Project Scope

Identify the sections of the system for development of an alternate route plan.

Task 2--Assemble and Index Data

Data required to develop an alternate routing plan shall be assembled and indeed. This data will include the following:

- roadway maps and plans
- location of maintenance shops
- location of police jurisdictions
- traffic data
- freeway, ramp, arterial street, and potential alternate route traffic volumes
- accident summary records at critical locations on alternate routes
- existing signing on freeway, arterial street, and potential alternate routes

Task 3--Establish Alternate Route Criteria

Criteria shall be established under which alternate routes shall be selected. These include:

- length of alternate route versus freeway route
- jurisdiction of detour (i.e., number of travel lanes, number of signalized intersections, number of turns, number of left turns, number of route changes)
- accident history
- capacity

Criteria shall be established for alternates which are:

- long term
- short term

Task 4--Identify Preliminary Alternate Routes

Assemble a set of preliminary detour routes and sketch on 8 l/2” x 11”sheets.

Task 5--Drive and Videotape Preliminary Alternate Routes

Each preliminary route shall be driven and critical sections or junctions videotaped. Critical turn areas shall also be video taped. Total distance of each route shall be determined. Relevant features and characteristics shall be recorded such as structures with limited overhead clearance, weight restrictions, route number changes, and school zones.

Task 6--Revise Preliminary Alternate Routes

Based on the data and experience of driving the preliminary routes, a revised set of alternate routes will be prepared. These will be presented as simplified maps on 8 l/2”x 11” sheets with explanations and descriptions of significant features.

Task 7--Identify Problem Areas

A list of alternate routes shall be compiled indicating any problem sections. The problem section will be keyed to the simplified map of the detour route. These problems will include:

- significant delays
- limited fuel availability (diesel and conventional)
- overhead clearance limitations
- structures with weight limitations
- residential areas
- school, hospital, church zones
- high accident zones
- heavy pedestrian flows

- tight turn radii
- locations where temporary signals may be necessary will be identified

Task 8--Identify Commercial Vehicle Restrictions

Alternate routes with vehicle restrictions shall be compiled including weight, length, height, and any other restrictions.

Task 9--Determine Signing

The following aspects of signing shall be analyzed and recommendations made:

A. On Freeway

- type (i.e., velcro, small semi-permanent, large guide)
- storage (stockpiling, locations of stockpiles, computerized inventory)
- fabrication (by agency, by contractor)
- placement
- erection (truck mounted, permanent folding sign, post requirements)

B. Off Freeway

- permanent trailblazers
- placement (location on detour routes from diversion point to re-entrance point)
- temporary signing
- storage (stockpiling, locations of stockpiles, computerized inventory)
- fabrication (by agency, by contractor)
- placement
- erection (truck mounted, permanent folding sign, post requirements)

C. Trailer Mounted Variable Message Signs (VMS)

- assess the need for trailer mounted VMS

Task 10--Assess Highway Advisory Radio

The Use of highway advisory radio (HAR) will be assessed for use in emergency alternate routing. Aspects to be explored are:

- permanent HAR locations
- truck mounted HAR
- compatibility with other operations
- construction
- weather advisory

This task should also consider using a public telephone number to convey alternate route information.

Task 11--Develop Operational Procedural Guide for Termination of Alternate Routes

An operational procedural guide shall be developed. This guide shall be targeted to enforcement and other personnel with incident traffic management responsibilities. The guide shall notify, identify, and explain each affected party's duties including where signs are stored and who is to erect them both on and off the freeway or arterial street.

The assistance and concurrence of the involved officials shall be obtained in development of this guide. The following aspects shall be included:

- responsible parties and duties
- maintenance
- state police patrols
- roadside service to disabled vehicles
- retrieval of signs and/or temporary covering
- storage
- replacement
- restocking of maps
- responsible parties for videotaping incident and traffic management aspects for post-incident review

Task 12--Develop Notification Procedures

Notification procedures shall be developed that will follow the alternate routes to be updated on a continuous basis if affected by construction of a permanent or long-term nature, closures of surface street routes, bridge limitations or other factors.

Task 13--Estimate Costs

Cost to implement the procedures, identified for alternate routing shall be estimated. These costs shall include:

- signs
- printing
- material
- trucks
- other equipment

REFERENCES

1. *Freeway Incident Management Handbook,* U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., July 1991.

2. *Quantifying Congestion,* Final Report, NCHRP Report 7- 13, National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Washington, D.C., September 1995.

3. *Determining Travel Time,* Procedure Manual, Public Administration Service, Chicago, Illinois, 1958.

4. *1992 Traffic Volumes Austin Metropolitan Area,* Austin Transportation Study, Austin, Texas, September 1993.

5. *Highway Capacity Manual,* Special Report 209, Transportation Research Board, National Research Council, Washington, D.C. 1985.

6. *Traffic Engineering,* McShane, W.R. and P.R. Roger, Prentice Hall, Englewood Cliffs, New Jersey, 1990.

TASK V

AUSTIN ITS

STRATEGIC DEPLOYMENT PLAN

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IMPEDIMENTS TO SUCCESS

An ITS strategic deployment plan involves much more than a simple list of projects and date to execute them. A specific project and a date to deploy it are the easiest features of a strategic deployment plan. Much research has been done to identify and resolve technical constraints to deployment. The major constraint to ITS deployment are institutional barriers. Overcoming institutional constraints must be a part of any ITS strategic deployment plan.

The institutional constraints in the Austin area are related to the fragmentation of responsibility. The Austin area must integrate the transportation goals of the local state DOT, city public works, transit agency, public safety agencies, private enterprise, and public expectation. This integration must constantly take place at many levels for Austin to realize the promise of ITS. ITS deployment must move from a discrete transportation improvement to an integrated part of any transportation improvement. The “I” in ITS stands for “intelligent” not “independent”. Specific impediments in the Austin area include lack of integrated improvement projects, lack of personnel expertise, lack of common standards, lack of evaluation data, and lack of public knowledge.

Integrated Projects

A recent review of proposed projects reveals just how disjointed ITS deployment is in the Austin area. TxDOT proposes freeway traffic management systems (FTMS) designed to manage freeway traffic with little or no consideration for the parallel frontage roads or intersecting arterial. Unless origination and destination lie immediately off the freeway local users will see little overall benefit to the millions invested in the system. Public safety agencies generally originate off the freeway system and considerable response time is spent on arterial. Transit agencies exhibit similar characteristics. Fragmented FTMS will mostly benefit travelers passing through the city and will have little local cost benefit ratio. Signals timed without consideration given to the size of the platoon being released to a freeway entrance ramp is another example of an unintegrated transportation system. A public transportation system that only provides transit information will not attract travelers if it does not provide the same level of information about other modes of transportation for comparison. Although these example projects may be promoted under the guise of ITS, in reality, the lack of integration results in little local community benefit.

Improvement projects, especially ITS projects, should receive an integrated, multi-agency review, regardless of agency responsibility, prior to deployment. The problems encountered when traveling from point A to point B in Austin are integrated between freeway, arterial, and mode of transportation. A solution must be equally integrated. Recently, TxDOT began including a duct bank for ATMS communications in freeway reconstruction plans. This needs to be taken a step further to include communication needs for city signalized intersection control and transit communication needs. Likewise, city signal communication trunks along arterial also should consider accommodating transit communication needs.

Personnel Expertise

Now that the need for multi-agency review has arisen, these agencies must find competent staff to identify and review technical areas pertaining to their respective agency. Technical areas that transportation agencies often lack expertise in are telecommunications, computer electronics, and video systems. These areas must be understood if agencies are to integrate services. Personnel familiar with these technical areas are needed during design, operation, and maintenance of projects deployed. Although the private sector can provide assistance in these areas, agencies must obtain some expertise in order to seek out appropriate assistance.

In the current era of downsizing and “doing more with less”, obtaining a staff of expertise for each agency is unlikely. While an agency can train a few individuals, the burden of integrated ITS, is likely too great to be borne by a single agency. Local agencies in Austin, public and private, must rely on one another, in some integrated form or fashion, to design, operate, and maintain ITS. Partnership arrangements must be made allowing expertise to flow seamlessly from one agency to another. Partnerships could also be formed to hire expertise from outside to service all agencies.

Finally, agency personnel should have access to a multitude of information. The more information personnel have access to, the better the chances of making “intelligent” decisions. The Internet provides agency personnel with information from around the world. More importantly, the Internet provides for the “exchange” of information.

Common Standards

Lack of common standards will also prevent successful ITS deployment. This can be most easily seen in Austin’s signal control systems. During TxDOT roadway reconstruction inside the city limits, TxDOT will assume liability of signal operation utilizing NEMA controllers within the limits of reconstruction. Outside these limits the City of Austin will retain liability of signal operation utilizing Type I70 controllers. A once seamless coordinated signal system has now been dissected into three distinct systems. It isn’t so much that one agency uses NEMA and the other uses Type 170, rather, it is the lack of a common communication standard between the NEMA and Type 170. If an operator only had to know what information to give a controller and did not have to know how to give it, a single agency might be more likely to retain signal control along a route during construction.

The National Transportation Communications/ITS Protocol (NTCIP) has recently been formulated to address the problem described above. NTCIP is a standard communications protocol. NTCIP will define how traffic management systems will communicate with each other and field devices such as signal controllers.

NTCIP is immediately aimed at traffic management systems and selected field devices such as signal controllers, variable message signs (VMS), and highway advisory radio (HAR). Automatic vehicle location/identification (AVL/AVI) systems are not yet addressed. AVL receives information from global positioning satellites (GPS) orbiting the earth to determine precise location. The communication protocol from GPS to receiver is a standard developed by the military. The communications protocol from GPS receiver to the management center is currently proprietary to each vendor. Without a communications standard, GPS receivers on a transit bus can not be understood by an emergency services center.

Additionally, NTCIP will not define how a traffic management system communicates with a transit or emergency services management system. To integrate these systems a standard communications protocol will have to be defined. The National ITS Architecture Project, sponsored by the U.S. DOT, will come close to, but wiI1 not define protocols. An architecture describes the system operation, what each component of the system does, and what information is exchanged. The architecture does not define standards or protocols, but rather, identifies where they are needed.

Common standards are not just needed between management systems. Installation standards for field devices will also facilitate seamless integration. Inductive loops, for instance, are installed by both TxDOT and the City. The way inductive loops need to be installed foran actuated signal are different from adaptive or even responsive signal control. To facilitate a smooth transition to integration, commonly installed field devices should conform to a standard. This would facilitate multi-agency, as well as, contracted design operations, and maintenance.

Evaluation Data

ITS will not be successful if public expectations are not met. Every ITS project deployed should have provisions for evaluation. Sometimes public expectation demands quantified results. Not only should standard measures of effectiveness be employed, but how the information is stored and presented should be integrated among agencies.

Information or data management systems should also be standardized. For example, consider traffic accident databases. This information is important to all agencies, including DOT, public works, transit, and emergency services. None, neither collect nor store, accident data the same way. The TxDOT and the City almost never produce an identical accident analysis. Geographic information systems (GIS) also lack standardization among local agencies. GIS uses large databases to display information graphically onto geographic maps. If the transit agency's GIS system, indicating demand, can not be integrated with the GIS system used by emergency services, indicating crime, it will be difficult to gauge the safety of proposed routes. To evaluate and measure the effectiveness of ITS these information systems must be integrated.

Public Knowledge

The degree of effectiveness of ITS deployment may well hinge on how much of it the public is able to understand. Deployment of ITS will almost always necessitate some degree of public education. ITS involves complex technical and institutional issues. The media can be a powerful and effective tool in educating the public about ITS deployment projects. Project deployment could be more effective if integrated with media coverage.

DEPLOYMENT PREREQUISITES

Integrated ITS will involve the active participation of multiple agencies. These agencies must have a clear understanding of their role in each project. This role may change from project to project as experience dictates. Careful and well documented project planning will increase chances of successful deployment. A project proposal should include detailed descriptions communicating the role of involved agencies. Prior to deployment, a project proposal should be circulated among Austin agencies for input and comments. As a minimum, the proposal should include a technical plan, financial plan, operation plan, and an evaluation plan. These plans can also be used to educate the public about a specific ITS project.

Technical Plan

A technical plan describes how the project is intended to work and why it is necessary. The plan should describe the functions and capabilities achieved with project deployment. How the project is integrated or will provide integration of multiple systems or services is important. Part of this integration will usually include how it is compatible with the existing infrastructure. In addition to describing the technical theory of design, the plan should also describe any partnership arrangements. Multi-agency and public/private partnerships are encouraged. The plan should clearly describe responsibilities, authority, and communication among partners.

Financial Plan

A financial plan will illustrate how the project will be funded. Funding of the design, construction, operations, and maintenance of the project should be clearly identified. Funding responsibilities of each partner should also be clearly identified. Innovative financing is encouraged. This plan should describe how the project is integrated into the existing local planning process.

Operation Plan

An operation plan describes how the project will function from day to day. The operation plan should also include a management and staffing plan. This plan would describe roles of existing personnel and an approach for obtaining and training new personnel. Personnel provided by partner agencies should be clearly identified. The operation plan should also describe how equipment involved in the project will be upgraded and maintained. It is desirable to include participation by the private sector in the operation plan. The financial plan is an integral part of the operation plan. One will not be successful without the other.

Evaluation Plan

The evaluation plan should describe how the project will be periodically evaluated during its entire life. Specific benefits of the project deployment should be identified. The evaluation plan should identify specific measures of effectiveness. The plan should describe the data that will be collected, who will collect it, and where it will be stored. The evaluation plan should contain provisions to correct situations resulting in unacceptable evaluations.

DEPLOYMENT INITIATIVES

Agencies involved in this study have developed specific deployment initiatives for their agency. In addition, this study identified specific user service area initiatives meeting a user service plan and supported by certain functional areas. The initiatives of each agency should support the user service plan. Initiatives for the TxDOT Austin District and the City of Austin Transportation Division have been included in Appendix V. Initiatives for transit, emergency services, and

Travis County are encouraged. The agency initiatives developed have four distinct similarities. These similarities include surveillance, incident management, a centralized and multi-agency service center, and traveler information.

Surveillance

Surveillance is the foundation of ITS User Services. If surveillance is not directly needed to implement a strategy it will most certainly by needed to efficiently complete an evaluation. Detection is the most common form of surveillance. As an example, surveillance includes having someone use a video camera to actively scan conditions. Detection might use that same camera, employing video image detection, to detect the passage of vehicles and report it to a control system. Pneumatic tubes, inductive loops, magnetic sensors, radar, sonar, and video images are all forms of detection. Surveillance also includes reviewing events. Travel time, response times, delivery and pick-up times, arrival and departure times are events. Austin must deploy more surveillance to implement and manage ITS projects.

Incident Management

Incident management provides for quick and often easily perceived benefits. Extensive surveillance is often not necessary to deploy this service. Often good incident management principles, adhered to by all agencies, will result in easily perceived benefits by the public. Surveillance is often needed to collect event data associated with incident management to measure the effectiveness of the service. Although incident management is very cost effective, it may involve overcoming many institutional barriers. The sooner Austin agencies confront these barriers, the sooner the public will realize the benefits.

Centralized and Multi-Agency Service Center

Centralized and multi-agency service centers are appropriate in every metropolitan are. However, Austin is uniquely poised to develop such a center. Core transportation agencies in the Austin area including DOT, public works, transit, and emergency services are all replacing and upgrading infrastructure at the same time. The timing is nearly perfect for these agencies to centralize. Centralization allows agencies to combine funds, perhaps affording the opportunity to acquire and utilize more enhanced equipment. Centralization also addresses many institutional issues not solved by technology alone. Services provided in a centralized facility include traffic, transit, emergency, and information. A centralized and multi-agency service center would improve the communications among Austin agencies. Incident management may provide the impetus necessary to bring these agencies together.

Traveler Information

Traveler information is one of the information services made available with a centralized and multi-agency service center. Many of the benefits of integrated ITS services hinge on information being efficiently delivered to the public. Traveler information includes information on different modes of travel. Modes of travel include car, bus, airplane, bicycle, and foot.

REGIONAL PERSPECTIVES

Now that some ITS operational tests have been completed across the country, the concept of regional centers has developed. This concept may have developed in an effort to reduce costs of ITS deployment and also to include rural areas in ITS deployment. While the concept of deploying ITS in a regional fashion can be explained technically, exactly what constitutes a “region” is difficult to define. Part of ITS deployment includes determining how big of an area will be affected by the deployment. As more technically advanced centers are constructed, many are struggling to justify their existence after construction.

The TxDOT San Antonio District completed construction of a management center in 1995. Since that time the center has aggressively pursued “regional” transportation management. The TransGuide Center has embarked on a mission to manage transportation in congested border areas such as Laredo. Laredo is some 154 miles from San Antonio. Austin, by contrast, is only 79 miles from the “Alamo City”, yet a TransGuide “regionally” controlled roadway facility does not exist in the corridor between these two metropolitan areas.

It is, perhaps, difficult to understand how integrated and responsive management can take place over the information superhighway. While there may be no technical boundaries to regional centers, there would certainly appear to be political and institutional boundaries.

However, Austin isn't really selfish either. Plans for a new 911, radio, and computer aided dispatch center include Travis County and smaller, surrounding cities such as West Lake Hills and Pflugerville. The TxDOT Austin District executes maintenance agreements with the City of Austin to maintain many signalized locations in the Austin area. However, the Austin District retains the maintenance and liability of numerous signalized locations in its 11 county region outside the Austin area, including growing metropolitan areas such as Round Rock, Georgetown, and San Marcos. These cities could greatly benefit from a centrally controlled real-time adaptive signal system. This is important because the economies of these areas are integrated. They are tied together by a network of roadways much like the blood vessels of your hand.

TxDOT grappled with regional issues in 1991 when the Texas legislature mandated the Department consolidate from twenty-four districts to just eighteen. Many regional political and institutional issues were confronted in this reorganization attempt. However, compromise prevailed and, as **Figure V-l** indicates, acceptable "regional" boundaries were defined. This could be a starting point for metropolitan areas in Texas to begin defining regional information service centers. On the other hand, it should be noted, to no one's real surprise in Texas politics, TxDOT later reorganized into no less than the current twenty-five regional areas as shown in **Figure V-2.** This is one more than they originally started with when reorganization began.

Whether Austin develops its own centralized and multi-agency service center or not, local ITS deployment must somehow relate to the larger transportation picture of regional deployment initiatives. This definitely needs to take place with information services. Agencies in San Antonio need to know the conditions in Austin in order to efficiently move people and goods to Dallas/Ft. Worth, for instance.

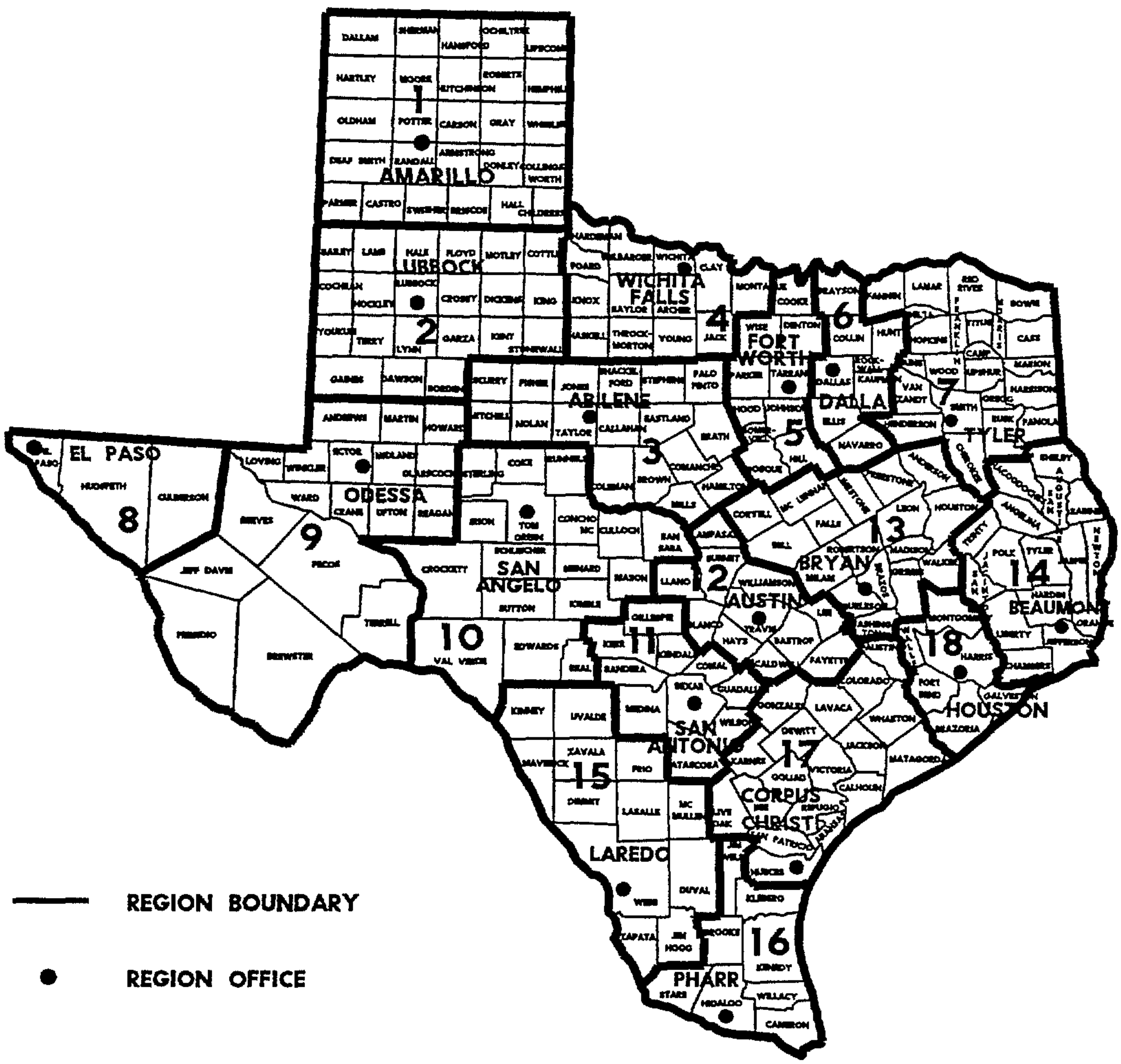
DEPLOYMENT SCHEDULE

This report has identified several issues relating to ITS deployment in the Austin area. For integrated ITS deployment to be realized in Austin, institutional issues must be resolved. **Table V-l** illustrates a recommended deployment schedule to realize full ITS benefits within 10 years. However, there is also a need to begin deployment of agency initiatives. It is assumed that agencies will continue to deploy initiatives meeting the User Service Plan while working to integrate projects. The schedule has been formulated considering existing agency staff resources. The table focuses on deployment over the next 5 years. After this time it is anticipated any ITS service can be easily implemented.

TEXAS

DEPARTMENT OF TRANSPORTATION

PROPOSED REGIONAL ALIGNMENTS

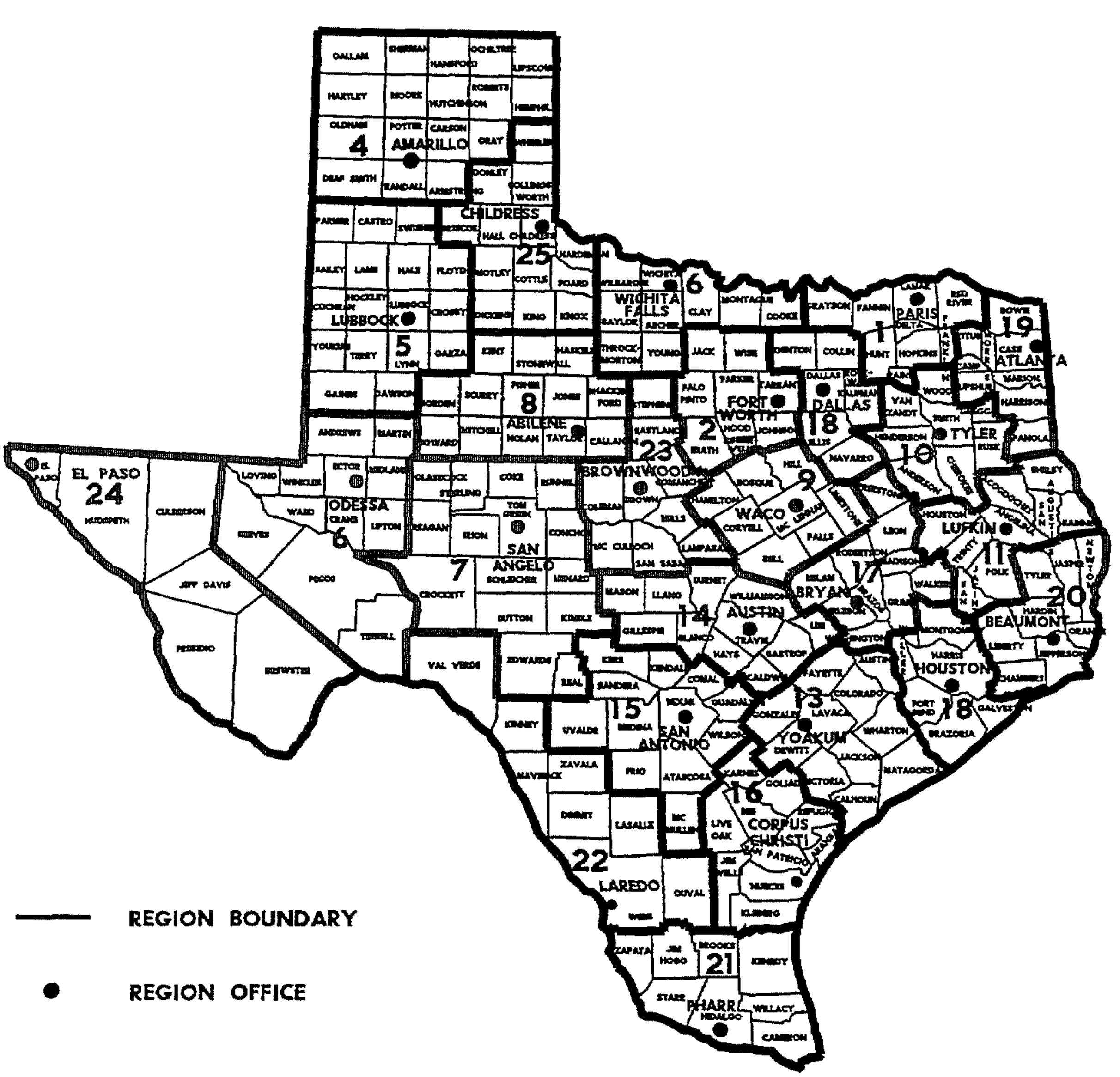


Proposed TxDOT Regional Alignments_Figure V-l

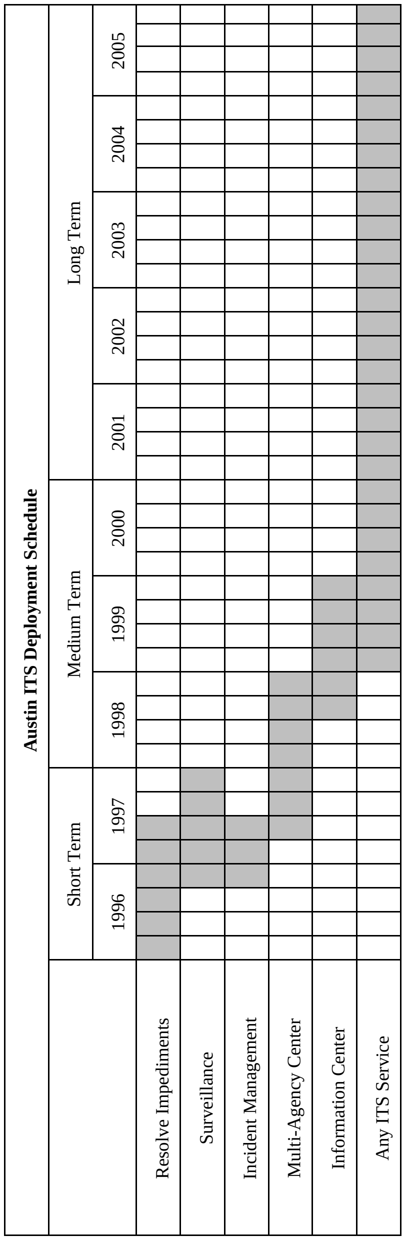
TEXAS

DEPARTMENT OF TRANSPORTATION

EXISTING REGIONAL ALIGNMENTS



Existing TxDOT Regional Alignments_Figure V-2



Austin ITS Deployment Schedule_Table V-l

TASK VI

AUSTIN ITS PLAN

ASSESSMENT/EVALUATION CRITERIA

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INTRODUCTION

Evaluation procedures are essential to establish ITS program support among the public, elected officials, and transportation professionals. The public maintains a vested interest because any expenditure of public funds requires documentation of benefits to those supplying the funds. Elected officials are involved because of their interest in the benefits that their constituents derive from the public fund expenditures. They are the ones that will have to decide funding priorities among a variety of competing programs. And finally, transportation professionals also need to be aware of the effectiveness of new approaches addressing traditional transportation problems. Since they make recommendations to elected officials, if they can demonstrate the benefits to the traveling public through public expenditures, funding is much more easily secured. In addition, transportation professionals must be the stewards in the expenditure of those public funds. Evaluation results will also allow them to prioritize the implementation of ITS projects that show the greatest benefits early during implementation.

Evaluation procedures should not only quantify ITS program effectiveness, but they should also aim to present results in terms that are clearly understood by each of the above mentioned groups. These groups can not be expected to lend their support if the effectiveness of an ITS program is not quantified and clearly presented to each of them. Clearly defined evaluation procedures prior to implementation will provide a means to document and present those benefits.

When defining the evaluation procedure, it is important to remember that evaluation is a continuous process. The first step is to define the goals and performance objectives of the project in question. It is critical to establish realistic expectations appropriately fitted to the situation. One way to accomplish this is to examine the results that other cities have been able to produce on similar projects. Also, computer simulation programs can be used to produce reasonable order of magnitude assessments. And finally, judgment of transportation system operators can provide valuable insights as to how certain changes might effect the system.

Using these references as an initial evaluation, the goals can be more realistically defined. Then, once the project has been completed, the actual evaluation takes place. Its results are compared to the redefined goals to see what benefits the project provided.

Once again, it is critical to keep the public informed throughout the entire process. They need to know what is being done for them and the value of it. They must be provided information about the project and its expected benefits prior to implementation, continuously throughout the implementation, and upon project completion.

Due to daily travel time variations, the public may have a difficult time perceiving the benefits of an individual project. For this reason, keeping the public continuously informed and involved is mandatory. The public must be assured that they are having an impact on the evaluation process. The next section of this chapter will define various traffic study evaluation techniques, both quantitative and qualitative, that can be used to provide measures of effectiveness for an ITS program. It will then go on to match the measures of effectiveness with specific ITS strategies.

And finally, it will define more specific techniques that can be used to increase public awarenesson ITS efforts and benefits.

EVALUATION TECHNIQUES

The first step is determining what each evaluation technique requiresas inputs and what measures of effectiveness it produces as outputs. It is important to chose an evaluation technique that does not exceed available input resources, but still produces the desired output measurement.

The evaluation techniques have been divided into three categories. The first of these is surveys. This section typically requires a higher inputof personnel time interacting withthe user to discover their opinions. It also dictates the use of a properly designed set of questions to solicit comments relating to the proper measure of effectiveness. Opinion surveys can be used in nearly every situation, but survey methods must be very carefully applied. The second category is computer simulation models. This section requires personnel with extensive training on the particular computer software plus the actual hardware, software and input data. It does not necessarily produce real world results, but can be used to make accurate before and after comparisons. Computer simulation is dependent on model calibration of themodel. A well calibrated model will produce accurate results, but there will always be some skepticism which needs to be considered. The final category is observation. This typically requiresmore infrastructure and personnel effort, but typically produces robust data.

Each of these categories contains a number of specific evaluation techniques that are described on the following pages. The resource or data requirements are listed along with the measures of effectiveness that the technique provides. The personnel resource requirement defines the number of people necessary to complete the task. There are three personnel levels: low meaning zero to one person, moderate requiring two to three people, and high encompassing four or more. **Table VI-1** shows a summary of each technique and the corresponding measures of effectiveness.

Techniques	Measures of Effectiveness								
	Travel Times	Traffic Volumes	Speeds	Delay	Fuel Consumption	Emissions	Vehicle Occupancy	Response Time	User Satisfaction
Surveys									
Interviews	Opinion		Opinion	Opinion			X		X
License Plate	X		X				X		X
Post Cards	Opinion		Opinion	Opinion			X		X
Telephone	Opinion		Opinion	Opinion			X		X
Travel Log	X		X	X			X		X
Model									
CORFLO	X	X	X	X			X		
DYNASMART	X	X	X	X	X	X			
FRESIM	X	X	X	X	X	X			
NETSIM	X	X	X	X	X	X			
FREQ	X	X	X	X	X	X			
PASSER II				X	X				
PASSER III				X					
TRANSYT-7F	X			X	X				
Observation									
ATR Stations		X							
AVI	X		X						
Pneumatic Tubes		X	X						
Radar			X						
Screen Line		X							
Test Car	X		X	X	X	X			
Video Tape		X		X					

Traffic Study Techniques Used to Provide Measures of Effectiveness_Table VI-l

Surveys

Interviews

An interview survey involves personal interviews with a target audience. The audience could be motorists, transit riders, pedestrians, bicyclists, or commercial vehicle operators. Interviews are typically conducted along the roadside, at signalized intersections, at parking facilities, or other locations where the target audience is accessible. The interview sample size should be based upon the variability of the target population.

MOEs Provided: *vehicle occupancy, origin, destination, and possible personal opinions on travel times, speeds, and delay.*

Resource Requirements: *interview questions, traffic control plan.*

Personnel Requirement: *high.*

License Plate

Two license plate survey techniques exist. The first technique requires recording several or all digits of vehicle license plate numbers at predetermined stations by observers. The recorded license plate numbers are used to trace vehicles through the study area determining origins, destinations, and travel times. This method is advantageous for studies of single routes. This method is not practical for large study areas due to the manpower requirements. This technique usually does not permit more than 60 percent of the vehicles to be traced through the studyarea. The second technique involves recording the entire licenseplate number either manually or by videotape, identifying vehicle ownership from registration records, and sending a survey to each owner with return postage prepaid.

MOEs Provided: *travel times, speeds, vehicle occupancy, origin, destination.*

Resource Requirements: *data collection form, possibly video camera and tapes.*

Personnel Requirement: *high.*

Post Cards

This technique is similar to the interview technique, but facilitates data collection under heavy traffic conditions where vehicles cannot be stopped long enough for an interview. Post card questionnaires are handed to drivers as they pass the survey stations. Drivers complete the return-addressed, stamped post card and drop it in the mail. Typical return rates average between 25 and 35 percent.

MOEs Provided: *occupancy, origin, destination (trip purpose, frequency, departure and arrival times, vehicle classification) and opinions on travel times, speeds, and delay.*

Resource Requirements: *post card survey, traffic control plan.*

Personnel Requirement: *high.*

Telephone

Telephone surveys can provide similar information as the previous techniques.

MOEs Provided: *vehicle occupancy, origin, destination and opinions on travel times, speeds, delay.*

Resource Requirements: *target audience telephone numbers, telephone, survey questions.*

Personnel Requirement: *high.*

Travel Log

Travel logs can be completed in several ways. The first method would be to select a group of participants who are willing to record all trips made in a day or week's time in a travel log. Information should include the location of origin, destination and all stops made in between and the corresponding time of each, the total trip time and length, vehicle occupancy, and any problems or delays that were encountered along the way and their duration. A second method would procure the same type of information, but would select the participants by targeting a large company or office complex and asking all occupants to keep a log of their travels for one day.

MOEs Provided: *travel times, speeds, delay, vehicle occupancy, origin, destination.*

Resource Requirements: *pre-printed log sheets.*

Personnel Requirements: *high.*

MODELS

CORFLO

CORFLO is a component model of TRAF simulationsystem designed for the integrated urban network or corridor analysis at a macroscopic level with traffic assignment capabilities. The program models automobiles, trucks, buses, and car pools on freeways and surface streets in a single, integrated environment.

MOEs Provided: *travel times, volumes, speeds, delay*.

Data Requirements: *link and turning movement volumes (%), saturation flow rates, intersection geometries, link speeds, intersection spacing, signal timing data--cycle length, green times, phase sequence, offsets, yellow and all-red interval, intersection and link geometries.*

DYNASMART

Dynasmart was developed for studying the effectiveness of alternative information-supplying strategies, as well as alternative information/control systemconfigurations for urban networks. The simulation program models the response of the drivers to the information/control, the nature of the traffic flow that results from drivers responses and applied network control, and the dynamics of the routes in the network that affect the driver and control system decisions.

MOEs Provided: *travel times, volumes, speeds, delay, fuel consumption, emissions, origin, destination.*

Data Requirements: *network data including number of nodes, zones, links, etc.; number of loading intervals and associated time (O-D matrix); type of intersection control; signal timing data--cycle length, phasing, max green, min green, yellow and all-red interval; link data--speeds and number of lanes; ramp data; variable message sign data; and allowable movements data.*

FREESIM

FREESIM is a component model of the TRAF simulation system designed of microscopic freeway simulation. A microscopic simulation model is one in which each vehicle is modeled as a separate entity. The behavior of each vehicle is represented in the model through interactions with its surrounding environment, which is the freeway geometry and other vehicles. The program is capable of modeling l-5 thru lanes, l-3 lane ramps, grades, curves, superelevation, lane additions, lane drops, incidents, work zones, and auxiliary lanes. The programs operational features include lane-changing, ramp metering, surveillance system, different vehicle types of 2 passenger and 4-truck, heavy vehicle lane bias of restriction, different driver habits, and warning signs for lane drops, incidents and off ramp. However, the model will not model HOV's or reduced lane width.

MOEs Provided: *travel times, volumes, speeds, delay, fuel consumption, emissions.*

Data Requirements: *time period classification, link geometry, link operation, freeway turning movements, surveillance specification, incident specification , lane additions or drops, metering* *strategy, location of meter detectors, flow rates, percent trucks and car pools, incident detection specification, incident detection specification, incident detection algorithm.*

NETSIM

NETSIM is a component model of the TRAF simulation family designed for microscopic simulation of individual vehicle flow for each vehicle type and their assigned lanes. It has the capabilities of simulating existing and evaluating improvements made to a network of intersections along with their type of control (e.g., yield signs, stops signs, fixed-time signals, actuated signals, and signals with different cycle lengths). The program is also capable of simulating and evaluating bus routes and the location of the bus station.

MOEs Provided: *travel times, moving times, delay, efficiency, stopped time, queue time, queue lengths, speed, link volume occupancy, link storage, fuel economy, emissions, bur station capacity, empty bus station time, bus dwell time, number of buses serviced, bus trips on route, bus travel time on route.*

Data Requirements: *approach length for each intersection, number of lanes, allowable movements, vehicle turning volumes, signal cycle length, phase length, phase sequence, signal offset, phase sequence, minimum and maximum green time, and vehicle extensions for actuated-signal control.*

FREQ

FREQ consists of a family of demand-supply models of freeway corridor operating environments- The latest versions of PREQ is FREQ10PL, a freeway priority lane simulation model and FREQ10PE, a priority entry model

MOEs Provided: travel *times, travel distance, ramp delay, length of ques, average speed, emission rates, contour maps of traffic performance, fuel consumption, and cost-benefit performance index for different HOV operational designs.*

Data Requirements: *subsection lengths, subsection capacities, subsection speed-flow curves, position and capacities of on and off ramps, grades, number of lanes, origin-destination data, occupancy distribution at each on-ramp, geometric connection to alternative* routes *and percent of vehicles turning off the arterial, HOV lane design and position.*

PASSER II

Passer II is a microcomputer program that was developed to improve signalized intersection operations and arterial progression. It has the capabilities of evaluating existing conditions through simulation or optimization of any configuration from an individual signalized intersection to the progression along an arterial system.

MOEs Provided: *delay, fuel consumption, capacity*.

Data Requirements: *turning movement volumes, saturation flow rates, intersection geometries, phase sequence, link speeds, intersection spacing, signal timing data--cycle length , green times, offsets, yellow and all-red interval.*

PASSER III

Passer III can be used to analyze pre-timed or traffic-responsive, fixed sequence signalized diamond interchanges. The program can evaluate existing or proposed signalization strategies, determine signalization strategies which minimize the average delay per vehicle, and calculate signal timing plans for interconnecting a series of interchanges on one-way frontage roads.

MOEs Provided: *delay,* capacity.

Data Requirements: *turning movement volumes, saturation flow rates, intersection geometries, phase sequence, link speeds, intersection spacing, signal timing data--cycle length, green times, offsets, yellow and all-red interval.*

TRANSYT-7F

TRANSYT-7F is a traffic flow simulation and signal timing optimization program. The program has the capabilities of coordinating a signal system for an arterial of a network.

MOEs Provided: *travel times, speeds, delay, fuel consumption.*

Data Requirements: *turning movement volumes, saturation flow rates, intersection geometries, phase sequence, link speeds, intersection spacing, signal timing data--cycle length, green times, offsets, yellow and all-red interval.*

OBSERVATION

Automatic Traffic Recorder (ATR) Stations

ATR stations are permanently installed recorders at representative locations on various highway systems throughout the state with both rural and urban traffic characteristics represented. The continuous data that is collected from these recorders is the basis for development of future traffic trends and volumes that are essential for highway planning and design. There are currently 7 ATR stations located within the Austin study area. They collect daily information such as traffic counts and vehicle classification.

MOEs Provided: *traffic volumes, capacity (if saturated).*

Resource Requirements: *ATR station.*

Personnel Requirement: *low.*

Automatic Vehicle Identification (AVI)

Automatic Vehicle Identification systems use vehicle-based transponders that can be read by equipment at fixed points to identify the vehicles

MOEs Provided: *travel times, speeds, origin, destination.*

Resource Requirements: *AVI system--transponders, readers, communication infrastructure, map database (some type), software, and probe* vehicles.

Personnel Requirement: *low.*

Pneumatic Tubes

Pneumatic tubes are placed across a roadway and used to record the number of crossing axle pairs. This information can be used to estimate the number of vehicles passing that location over a designated time period. This technique can easily be implemented for 24 hour periods.

MOEs Provided: *volume, capacity (if saturated).*

Resource Requirements: *pneumatic tubes, recorders.*

Personnel Requirement: *low.*

Radar

Use of radar requires an individual to be at one specific location on a roadway and use a radar device to gather and record spot speeds.

MOEs Provided: *speeds.*

Resources Required: *radar device, data collection form.*

Personnel Requirement: low.

Screen Line

A screen line intersecting a defined boundary of the study area at two points, is established to divide the internal study area into two parts. Classified, hourly volume counts are made at the crossing of the screen line. A comparison is then made between the number of trips having their origin on one side of the screen line and their destination on the other. Historically, the Colorado River has been used as a screen line for Austin origin-destination surveys.

MOEs Provided: *volumes, capacities (if saturated).*

Resources Required: *traffic volume recorder device.*

Personnel Requirement: low.

Test Car

A test car would require a vehicle with specially equipped fuel consumption and emissions monitoring gauges. Specially trained drivers would operate the test car over a predetermined path in order to test the variances in travel times, speeds, and delay.

MOEs Provided: *travel times, speeds, delay, fuel consumption, emissions, origin, destination.*

Resources Required: *test vehicle, stop watch, distance measuring instrument, data collection form, fuel consumption and emission monitoring devices.*

Personnel Requirements: *moderate.*

Video Tape

Video taping requires an individual to stand at a designated area and video the flow of traffic passing that point. The video should contain an automatictime stamp on the film. The tape can later be examined to count volumes and observe delays in that particular area. A disadvantage would be that data could only be collected at one particular spot at a time without using multiple people, each with their own camera.

MOEs Provided: *traffic volumes, delay, capacity (if saturated).*

Resources Required: *video* camera.

Personnel Requirement: *moderate to high.*

ITS STRATEGIES

Having matched measures of effectiveness with available evaluation techniques, it is now possible to examine the ITS user services and recommend the measure of effectiveness that best evaluates the ITS strategies for each user service. The following pages separate the ten groups of ITS services into the strategies that fall under them and then briefly describe how surveys, models, or observation techniques can be used to determine the corresponding measures of effectiveness. This information is summarized in **Table VI-2** thru **Table VI-6**.

It is important to realize that surveillance is considered to be an integral part of all other ITS systems and therefore could not be separately evaluated. It should be implemented as a foundation for all user services and then be used to assist in evaluating them.

Travel and Traffic Management ITS User Service / ITS Strategy	Measures of Effectiveness								
	Travel Times	Traffic Volumes	Speeds	Delay	Fuel Consumption	Emissions	Vehicle Occupancy	Response Time	User Satisfaction
En-Route Driver Information									
Commercial Radio	S		S	S			S		
Changeable Message Signs	S		S	S			S		
Highway Advisory Radio	S		S	S			S		
On-board Computer (w/real-time traffic information)	S, M	M	S, M	S, M	M	M	S		
Traffic Control									
Adaptive Signal Control	S, M,O		S, M,O	S, M,O	M	M			
Ramp Metering	S, M,O	M,O	S, M,O	S, M,O	M	M			
Changeable Message Signs	S	O	S	S					
Lane Control Signals	M,O	M,O	M,O	M,O					
Incident Management									
Courtesy Patrols	S	O	S	S					S
Incident Management Plan				S, M,O					

Note: Assumes that surveillance systems are m place. Legend : S = surveys, M = model, O = observation

Measures of Effectiveness for Evaluating Travel and Traffic Management ITS Strategies_Table VI-2

En-Route Driver Information

Commercial Radio

The effectiveness of commercial radio would probably be best determined using travel logs to compare the difference between a controlled group who received information on congestion and incidents via the radio versus those who received no en-route information. It would also be important to log the reaction of the user to the information received.

MOEs to determine: *travel times, speeds, delay, vehicle occupancy*.

Technique: Survey.

Changeable Message Signs (CMS) - Fixed

Fixed changeable message signs are used to alert drivers to tune into highway advisory radio (HAR) for information on roadway conditions ahead. A survey point placed after the CMS, or travel logs, will best determine what percentage of the users paid attention to the sign and sought further information.

MOEs to determine: *travel times, speeds, delay*.

Technique: Survey.

Highway Advisory Radio (HAR)

This would best be evaluated by travel logs with a designated percentage of the participants tuned into the HAR and changing their travel plans accordingly.

MOEs to determine: *travel times, speeds, delay*.

Techniques: Survey.

On-board Computer System with Real-time Information

Survey techniques can be used as above with the added possibility of mail outs or telephone surveys to a pre-determined list of users with equipped vehicles. Simulation can be used in the from of Dynasmart to assign certain percentages of the population to receive the information and test for all of the MOE's above.

MOEs to determine: *travel times, volumes, speeds, delay, fuel consumption, emissions.*

Techniques: Survey and *model.*

Traffic Control

Adaptive Signal Control

In order to evaluate changes made in the signal timing plan for a particular situation, all three evaluation techniques can be used. The appropriate computer simulation model can be used in advance to optimize the signal timing based on the estimated or previously experienced changes in volumes, while observation and survey techniques are more appropriate after the timing changes have been implemented to test their impact.

MOEs to determine: *travel times, speeds, delay, fuel consumption, emissions.*

Technique: *Survey, model, and observation.*

Ramp Metering

Similarly, ramp metering effects can be pretested using a modeling package like Dynasmart to determine all the listed measures of effectiveness. Observation and survey techniques should be used once the service is active to determine public perception as well as actual changes in travel times, speeds, and delays.

MOEs to determine: *travel times, volumes, speeds, delay, fuel consumption, emissions.*

Technique: Survey, *model, and observation.*

Changeable Message Signs (CMS) - Portable

Portable CMS's could be used to warn of a lane closure ahead or possibly detour traffic. The best measure of its effectiveness would be found through surveying the users to see if they were impacted by the sign's message. Observation techniques such as video tape or pneumatic tubes can also be used to note changes in traffic volumes in areas before and after the CMS's.

MOEs to determine: *travel times, volumes, speeds, delay.*

Technique: Survey *and observation.*

Lane Control Signals

Simulation models can be used to some extent for a very general picture of how traffic flows would change, however it is difficult to simulate actual driver behavior and their reaction to the lane control signals. Driver behavior plays a major role in this evaluation, so the preferred method would be observation, using primarily pneumatic tubes and video tape to capture the changes in volumes, speeds, and delay.

MOEs to determine: *travel times, speeds, delay.*

Technique: *Model and observation.*

Incident Management

Courtesy Patrol

This strategy could best be evaluated by having some information on the lengthof delays cause by incapacitated vehicles before the courtesy patrol was instituted. Surveys given to the users of the service could give their opinion on changes in travel times, speeds, and delay and most importantly their satisfaction after being assisted by the courtesy patrol. In this instance, observation could be used to report the volume, or number of people, taking advantage of the service

MOEs to determine: *travel times, volumes (users), speeds, delay, user satisfaction.*

Technique: *Survey and observation.*

Incident Management Plan

All three techniques can be used to determine reductions in delay on a before and after basis. Surveys would procure optimal results if they were issued to the police officers on the scene instead of to the general public who would have no concept of a reduction in their delay due to the plan.

MOEs to determine: *delay*.

Technique: *Survey, model, and observation.*

Travel Demand Management ITS User Service ITS Strategy	Measures of Effectiveness								
	Travel Times	Traffic Volumes	Speeds	Delay	Fuel Consumption	Emissions	Vehicle Occupancy	Response Time	User Satisfaction
Pre-Trip Travel Information									
Television	S,O	S,O	S,O	S,O	M,O	M,O			
Computer	S,O	S,O	S,O	S,O	M,O	M,O			
Radio	S,O	S,O	S,O	S,O	M,O	M,O			
Newspaper	S,O	S,O	S,O	S,O	M,O	M,O			
Kiosks	S,O	S,O	S,O	S,O	M,O	M,O			
Demand Management and Operations									
Alternative Work Hours	S,M,O	S,M,O	S,M,O	S,M,O	M,O	M,O			
Telecommute	S,M,O	S,M,O	S,M,O	S,M,O	M,O	M,O			

Note: Assumes that surveillance systems are m place. Legend : S = surveys, M = model, O = observation

Measures of Effectiveness for Evaluating Travel Demand Management ITS Strategies_Table VI-3

Pre-Trip Travel Information

Television, Computer, Commercial Radio, Newspaper, Kiosks

All of the strategies listed above can be evaluated by the use of computer models, but that does not differentiate between the alternatives from which the user can receive the information. Surveys, such as trave1 logs, produce the most accurate information by allowing the user to specify which source he received the information from and then indicate how that information affected his trip, be it a change in time of departure, mode, or route. Modeling the system can be used to determine if the information is resulting in reducedfuel consumption and emissions. Observation can be used to determine if the information is getting out by measuring changes to suggested alternate routes and/or a reduction of traffic on the route in question.

MOEs to determine: *travel times, volumes, speeds, delay, fuel consumption, emissions.*

Technique: *Survey, model, and observation.*

Demand Management and Operations

Alternate Work Hours

Alternate work hours include flex time, compressed work weeks, or any other variations in the weekly schedule that brings at least some employees into work at times different than the peak. All three techniques would be effective in measuring the changes as long as a large enough sample is effected. The most practical methods would be survey and observation techniques performed at the site participating in the alternate work hours program.

MOEs to determine: *travel times, volumes, speeds, delay, fuel consumption, emissions.*

Technique: *Survey, model, observation.*

Telecommuting

Similarly, surveys to the telecommuters and observations at participating sites would yield the most accurate results because sample sizes will likely be too small to create a significant impact throughout the rest of the system. Simulation models can be used to determine effects on the system if significant levels of telecommuting were to ever be achieved.

MOEs to determine: *travel times, volumes, speeds, delay, fuel consumption, emissions.*

Technique: *Survey, model, and observation.*

Other **Demand Management and Operations** Strategies can be found under **Public Transportation Management**.

En-Route Transit Information

Kiosks

This strategy could be evaluated through opinion surveys of the users indicating their feelings on changes in travel times or delays after using the kiosks. Observation techniques could measure the volume of users who access the kiosk as an indication of their reliance on it.

MOEs to determine: *travel times, volumes, delay, user satisfaction.*

Technique: Survey *and observation.*

Annunciators

Once again, various forms of the survey technique could be used to assess the users perceived changes in their travel times and/or delays with the assistance of annunciators. Survey responses have the potential of being higher with a more captive audience and personal contact by the surveyor.

MOEs to determine: *travel times, delay, user satisfaction.*

Technique: Survey.

LED Message Sign

The same measures apply as with the annunciators.

MOEs to determine: *travel times, delay, user satisfaction.*

Technique: Survey.

Public Travel Security

Oh-board Cameras and Silent Alarms

These work together to increase safety for the user. Their effectiveness can really be measured by surveys to the passengers regarding any increase in travel security they may have experienced since the systems were installed. Because most passengers may not notice a difference, surveys to the drivers regarding differences before and after the system installations may also be useful.

MOEs to determine: *user satisfaction.*

Technique: Survey.

Other **Public Travel Safety** Strategies can be found under **Public Transportation Management**.

Public Transportation Operations **ITS User Service** **ITS Strategy**	Measures of Effectiveness								
	Travel Times	Traffic Volumes	Speeds	Delay	Fuel Consumption	Emissions	Vehicle Occupancy	Response Time	User Satisfaction
En-Route Transit Information									
Kiosks	S	O		S					S
Annunciators	S			S					S
LED Message Signs	S			S					S
Public Travel Security									
On-Board Cameras									S
Silent Alarm									S
Public Transportation Management									
AVI/AVL	O		O	O					
Automatic Passenger Counting							O		
Mechanical Systems Monitoring				O	O	O			
Transit Signal Priority	M,O	M,O	M,O	M,O	M	M	S,O	O	
Ridesharing/Vanpooling	S,M,O	S,M,O	S,M,O	S,M,O	M,O	M,O	S,O		S

Note: Assumes that surveillance systems are m place. Legend : S = surveys, M = model, O = observation

Measures of Effectiveness for Evaluating Public Transportation Operations ITS Strategies_Table VI-4

Public Transportation Management

Automatic Vehicle Identification (AVI)/Automatic Vehicle Location (AVL)

By equipping the vehicles with AVI and/or AVL systems, it is possible through observation to know their exact location at any moment. This makes it possible to determine travel times, speeds, and delays for the vehicles to insure on-time performance.

MOEs to determine: *travel times, speeds, delay.*

Technique: *Observation.*

Automatic Passenger Counting

This strategy uses observation to determine vehicle occupancy by keeping track of the number of boarding and deboarding passengers at each stop.

MOEs to determine: *vehicle occupancy.*

Technique: *Observation.*

Mechanical Systems Monitoring

This strategy employs gauges that are attached to the mechanical systems to determine if there are any malfunctions or loss of fluids. Observation techniques similar to a test car situation are used to test these systems.

MOEs to determine: *delay, fuel consumption, emissions.*

Technique: *Observation.*

Transit Signal Priority

Simulation models and observation can be used to determine the effects on both busses and opposing street vehicles if the transit vehicle is given priority. Surveys can also be used to determine vehicle occupancy in order to compare the number of persons moved with and without the transit signal priority.

MOEs to determine: *travel times, volumes, speeds, delay, fuel consumption, emissions, vehicle occupancy.*

Technique: Survey, *model, and observation.*

Ridesharing/Vanpooling

This uses all three techniques to measure every type of effectiveness. Simulation models provide results in theory, while survey and observation bring out user reactions and actual numbers for reductions in vehicles on the road which will hopefully lead to reductions in travel times and delay.

MOEs to determine: *travel times, volumes, speeds, delay, fuel consumption, emission, vehicle occupancy, user satisfaction.*

Technique: *Survey, model, and observation.*

Commercial Vehicle Operations ITS User Service ITS Strategy	Measures of Effectiveness								
	Travel Times	Traffic Volumes	Speeds	Delay	Fuel Consumption	Emissions	Vehicle Occupancy	Response Time	User Satisfaction
Commercial Fleet Management									
AVI/AVL	O		O	O					
Weigh-In-Motion	O		O	O					

Note: Assumes that surveillance systems are m place. Legend : S = surveys, M = model, O = observation

Measures of Effectiveness for Evaluating Commercial Vehicle Operations ITS Strategies_Table VI-5

Commercial Fleet Management

Automatic Vehicle Identification/Automatic Vehicle Location

Same as **Public Transportation Management**

Weigh-in Motion

Uses observation techniques such as AVI to determine if the commercial vehicles are being processed faster in order to reduce travel times and delays and increase productivity.

MOEs to determine: *travel times, speeds, delay.*

Technique: *Observation.*

Emergency Vehicle Management

Emergency Vehicle Preemption Signal

Most of the measures of effectiveness can be found through simulation models by adjusting the signal timing to represent an emergency vehicle receiving extra green time and examining the effects on the rest of the system. Observation can also be used as long as there is a database for comparison of the travel times of the emergency vehicle in the before and after case. Reduction in delay can be measured by changes in travel times.

MOEs to determine: travel times, speeds, delay, fuel consumption, emissions

Technique: Model and observation

Automatic Vehicle Identification/Automatic Vehicle Location

Same as **Public Transportation Management**

Emergency Management ITS User Service ITS Strategy	Measures of Effectiveness								
	Travel Times	Traffic Volumes	Speeds	Delay	Fuel Consumption	Emissions	Vehicle Occupancy	Response Time	User Satisfaction
Emergency Vehicle Management									
Emergency Vehicle Signal Preemption	O		O	O					
AVI./AVL	O		O	O					

Note: Assumes that surveillance systems are m place. Legend : S = surveys, M = model, O = observation

Measures of Effectiveness for Evaluating Emergency Management ITS Strategies_Table VI-6

PUBLIC AWARENESS

Many of the strategies outlined above will produce results that are tailored towards the understanding of the transportation engineer. However, as was mentioned earlier, when designing the evaluation procedures there is a need to not only pick the most appropriate measure to quantify the benefits, but to also make sure that the results are easily understood by the public. Customer expectations and perceptions should be tied back into the evaluation loop and possibly even be used to redefine the goals and objectives of the project. In fact, public opinion is so important that what is most easily understood by the public may be what guides the selection of a specific evaluation technique in the end.

Once the results of any evaluation of an ITS project have been compiled into a format that the general public can understand, there are a variety of ways to get that information to them. Below is a list of some techniques that can be used to inform the public about upcoming ITS efforts and already realized benefits.

News Releases

These can be broadcast over television, radio, or in the newspaper. It is important to gain the support of the media early on so that they will report enthusiastically on the benefits of ITS.

Media Meetings

Meetings can be scheduled with the media to disseminate information on planned or completed ITS projects. At these meetings the MOE's resulting from the projects are released.

Public Access Television Stations

This allows more in depth coverage on local projects already existing and those that are being planned. It enables the transportation system designers and managers more time and more control over what messages are being relayed through more comprehensive interviews.

Radio Commercials

Radio commercials succinctly stating benefits realized by a new project can be broadcast on all the major radio stations throughout the day. They have the advantage of repetition.

"Fun Facts" on the Changeable Message Signs

When the static CMS signs are not being used to relay freeway congestion information, theycan intermittently display quick facts on transportation improvement projects.

Presentations to Boards and Commissions

This would help to generate the support needed among elected officials. The only requirement would be a short presentation as to the latest standings of the ITS projects.

Survey people in attendance at Board/Commission Meetings

Even if there were no presentation at a particular meeting, this would be the ideal place to distribute surveys as everyone exited in order to ascertain their knowledge about or interest in the latest transportation projects.

Telephone Prerecorded Messages

A prerecorded menu could be developed to send a caller to one place for complaints, another for compliments, and yet another for general information and facts. If they were on hold waiting to speak with someone, instead of piping musicin, transportation facts could be recited in the background.

Brochures/Videos

Brochures capitalizing on the positive aspects should be made available to various groups and organizations or at meetings, conferences, and other events. Videos could also be borrowed to help inform the public.

Any of these options can be used alone, or in some combination, with the goal of educating everyone about ITS in order to generate more support. There are a lot of improvements that can be made, but they all require funding. In order to get that funding, the public needs to know what is going on and be able to add some input as to how they think things should be handled.

TASK VII

IH 35 ACTION PLAN

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ACTION PLAN

User service objectives for incident management were identified in Task I of this study. Additional information concerning roadway incident management has been discussed in Task II. Task III identified techniques and technologies associated with incident management. Accident information, a type of incident, was presented in Task IV for the IH 35 corridor. Task V identified incident management as part of a strategic plan for the Austin area. Task VI identified assessment and evaluation criteria for incident management. This task more specifically addresses incident management for the IH 35 corridor.

Challenges and Opportunities

Improving incident management on theIH 35 corridor has been the subject of several past Austin Traffic Management Team (TMT) meetings. It is desirable to develop a incident management plan to reduce delay to the travelers along the corridor. Information and response must be coordinated and integrated between the agencies responding to an incident in order to achieve this result. Technical, as well as, institutional issues must be mitigated between agencies involved.

Freeway Traffic Management

The TxDOT Austin District has aggressively pursued the implementation of a freeway traffic management (FTM) system, including integration of a courtesy patrol, to provide incident management support for the IH 35 corridor. Implementation of these supporting techniques and technologies has proven to be a challenge.

FTM systems have been deployed in a few areas of Texas, however, standard, uniform deployment has not taken place. These systems have been costly in construction and especially in operations and maintenance. These issues are an important factor in the equation for implementing incident management support along the IH 35 corridor in downtown Austin.

Major investment studies are currently under way to completely rehabilitate IH 35 in the downtown Austin area. Schematics reveal a drastic change in the section of the roadway from right of way to right of way line. Installing a traditional FTM system in this area will most likely not be cost effective at this time. TxDOT has been reluctant to install the traditional proven FTM systems in this area for fear it could all be destroyed during rehabilitation.

Courtesy patrol implementation has equally suffered from operational, financial, and institutional issues. Although courtesy patrol was finally implemented in 1997, the operational staff of 5 is spread thinly over 75 centerline miles of roadway, 27 of which include IH 35. Efforts to increase patrol staff have been unsuccessful to date, even though public response to implementation has been supportive. Finding and increasing funding for this incident management support continues to represent a significant hurdle to overcome.

Traffic Signal Management

Incident signal timing plans along the downtown IH 35 corridor were developed under the Traffic Light Synchronization (TLS) Program in 1992. These timing plans were intended to be implemented during a freeway incident with significant diversion to the frontage road arterial. These signal plans have never been implemented due to a variety of technical and institutional issues.

The usefulness of these plans, once implemented, was uncertain. The plans were developed assuming all traffic volume diverted from the freeway to the arterial. This volume was distributed among several ramps somewhat arbitrarily. The plans were developed using the PASSER family of programs, however, a more comprehensive corridor model may be more appropriate. Data for a more robust corridor model was not available. Implementing and then revising the plans to several controllers from an antiquated central control system in a timely fashion was also of concern.

PASSER revealed that progression along the frontage road arterial was limited due to specific lane assignments at intersections. Many of the intersections along this corridor have only one thru lane for traffic traveling parallel to the freeway.

In addition, informing the driver that signal timings had been changed to encourage diversion was not addressed. Drivers would have no assurance or indication that the signal timings had, in fact, been changed. Many drivers often prefer to "wait out" an incident rather than divert, having limited information.

Emergency Services

A roadway incident can include three principle emergency service responses. These services are police, fire, and medical. The responsible agencies for these services have a policy for who is responsible at the incident scene. For instance, if the incident is a car fire with no injuries, the fire department would have control of the incident scene. This policy is logical, however, the impacts to transportation are not always favorable.

Police officers in the Austin area generally receive some traffic control training. Fire and medical personnel typically do not. Obviously, fire and medical incidents often impose a more serious impact to transportation simply by virtue of the training of the individual in charge at the incident scene. However, even when the police are in charge of an incident scene there are sometimes a decreased level of concern for transportation issues.

Actions

Specific actions must be taken by each agency involved in responding to an incident before a plan can be developed that will significantly and noticeably reduce delay to travelers. These actions will provide the foundation for a desirable incident management plan.

Texas Department of Transportation

Previous tasks have identified the importance of surveillance in the success of ITS services. Certainly, a lack of regular and reliable traffic information along the IH 35 corridor has inhibited the implementation of incident management support. Changeable message signs and lane control signals will not be effective if roadway conditions are not known. Innovative and cost effective surveillance solutions must be sought out, implemented, and information shared with other incident response agencies.

Innovative and significant funding sources for incident management support must be found. “Piecemeal” deployment with short staffs will not achieve desired ITS user services.

To summarize, it is recommended that the TxDOT Austin District take the following near term actions:

- deploy surveillance technologies along the IH 35 downtown corridor.
- expand the courtesy patrol service to permit dedicated service in the IH 35 downtown corridor.

City of Austin Traffic Signals

TxDOT has executed a maintenance agreement with the City of Austin to maintain traffic signal timings along the IH 35 downtown corridor. Although a corridor modeling program may produce more useful signal timing plans for an incident, they most likely will need to be altered during the incident in a timely fashion. In addition, lane assignments may need to be altered or dynamic lane assignment technology may need to be implemented to achieve maximum results from a incident signal timing plan. Some activities need to be coordinated with TxDOT. The City of Austin and TxDOT both maintain a license to transmit traveler information on 0.530 MHz a.m. These agencies can coordinate transmission on this frequency to provide real time traveler information especially during an incident.

To summarize, it is recommended that the City of Austin Traffic Signals take the following near term actions:

- upgrade the current signal control system to provide timely modifications of signal timing plans during an incident.
- coordinate use of the existing a.m. transmitter, located near the IH 35 downtown corridor, to provide real time incident information.

City of Austin Emergency Services

Coordination of the emergency service response has been a recognized concern in the Austin area. Late in 1997 emergency services in the Austin area began implementation of an Incident Command System (ICS). ICS is a uniform method of procedures for commanding the incident scene. All responding agencies are included in the training for ICS; however, emergency services have the priority to complete training. ICS includes traffic control; however, transportation agencies desire a functional role in the development traffic control training.

To summarize, it is recommended that the City of Austin Emergency Services take the following near term actions:

- functionally involve transportation agencies in the development of training.

PLANS, SPECIFICATIONS, AND ESTIMATE (PS&E)

The sponsoring agencies were determined at the to quickly deploy some ITS technology identified in this study that would be useful to the Austin area. A major emphasis in this study was the need for surveillance technology. This technology is necessary to either efficiently operate an ITS service or is needed to evaluate its performance. To accomplish this task TxDOT prepared PS&E for three projects involving surveillance technologies along the IH 35 corridor. All of these projects have been approved for construction with the assistance of the Federal Highway Administration. An overall location map is illustrated in Appendix VIIA.

The first project to include PS&E for surveillance technologies along IH 35 is a Surface Transportation Program Metropolitan Mobility/Rehabilitation project. This project was selected for funding by the local metropolitan planning organization. The project involved installing closed circuit television cameras at two intersections along IH 35. One camera was located at 6th Street in downtown Austin and the other was located at the intersection of the east leg of US 290 at IH 35 in north Austin. These cameras are located near existing freeway changeable message signs (CMS) and lane control signal (LCS) arrays. These cameras will be used to verify incidents in the area along the freeway corridor, as well as, intersecting arterials. These cameras can also be used to verify the operation of existing traffic control devices. These locations are detailed in Appendix VIIA. A contract for this construction was awarded with the second project in November 1996. Completion is estimated in August 1998.

A second project was modified to include PS&E for surveillance technologies along IH 35. This project is a National Highway System Traffic Management System project to install Austin's first comprehensive freeway traffic management system along US 183. This project crosses the IH 35 corridor. The PS&E for this project was modified to include incidental duct bank and two cameras along IH 35 at the US 183 interchange. These locations are detailed in Appendix VIIA. This contract was awarded in November 1996 and completion is expected in August 1998.

The third project includes PS&E to install a system of detectors near two camera locations on IH 35. One location is the 1500 block of M 35 in downtown Austin. The second location is the 4700 block of IH 35. These detector locations are detailed in Appendix VIIA. These detectors will supply information to freeway traffic management software located at the TxDOT Austin District to automatically alarm when established thresholds are exceeded. This contract was awarded in November 1997 and completion is expected in April 1998.

APPENDIX IA

TELEPHONE INTERVIEW OF IVHS EDP CITIES

TELEPHONE INTERVIEW OF IVHS EDP CITIES

Background

Our purpose for contacting other metropolitan areas with Intelligent Vehicle Highway System (IVHS) Early Deployment Plan (EDP) grants was to gain information and contacts that should prove valuable in the development of our plan. During April, 1994, nine areas were contacted: Boston, Massachusetts; Dallas, Texas; Denver, Colorado; Greenville, South Carolina; Louisville, Kentucky; Portland, Oregon; Raleigh/Durham/Chapel Hill, North Carolina (throughout the tables, Raleigh/Durham/Chapel Hill is referred to as Raleigh); San Francisco, California; and, Tampa, Florida. These areas were selected since they were at different stages of the EDP process and varied in geographical location.

A telephone interview was conducted with the person(s) responsible for or familiar with the development of the EDP for each area. The responses to the questions were generated from the telephone interview and information contained within each area's proposal/work outline or plan. The results of the interviews are summarized in the following text and tables.

Interview Summary

1. a. What is the status of your plan?
b. Can we get a copy of your work outline?
c. What are the tasks of your plan?

As planned, each city varied in the amount of work completed on their plan. Raleigh/Durham/Chapel Hill and San Francisco were anticipating to begin developing an EDP in July and June of this year, respectively. Dallas was approaching midway. Greenville and Louisville were expecting to be completed this year. Boston, Denver, Portland, and Tampa had completed each of their respective EDPs.

Depending on the status of the EDP, each area agreed to send either a copy of their proposal/work outline or completed plan.

Table 1 provides the status and major tasks of each plan.

2. Which agencies have you involved in your planning process?

Results of this question revealed that the type of agencies involved in the EDP planning process varied from area to area (refer to Table 2). In some areas, nearly 30 agencies were involved. Of the nine cities contacted, however, four agencies were most frequently cited as being involved in the EDP planning process: state department of transportation/highway department, county, city, and transit. A transportation engineer typically represented the states, counties, and cities. At times, however, an elected official may represent a smaller city.

3. How did you get them involved?

In Boston, a kick-off meeting was held with various local transportation agencies in the area to expose them to IVHS and how it could benefit each agency. Agencies in Dallas were already meeting on a regular basis and decided to form a separate group to serve as the steering committee for the EDP. Planning efforts in Denver focused on developing a freeway plan; therefore, the Colorado DOT was the primary agency involved After the proposal was approved for Greenville, a presentation about the planning process was made to the two MPOs in the area requesting their guidance. A similar presentation was made to the other agencies in Greenville. In Louisville, letters were sent out to perspective transportation agencies requesting their attendance at the initial meeting. At the meeting, IVHS videos from Chicago were shown to demonstrate that IVHS technologies exist and are currently in operation. To solicit participation from transportation agencies in Portland, a steering committee and technical advisory committee were formed and additional one-on-one and group meetings were held with other agencies in the area. One of the first steps in the Raleigh/Durham/Chapel Hill EDP is to develop the procedures to involve local transportation agencies in the planning process. In 1992, transportation and environmental agencies in San Francisco jointly formed the "Partnership" to integrate and improve the transportation planning processes required by ISTEA, the Clean Air Act, and state legislation. A "Partnership" subcommittee will provide policy oversight and direction to the IVHS EDP. A multi-agency project advisory group was formed in Tampa to oversee the Project work.

4. How do you keep these agencies involved?

a. How often do you meet with them?

b. What are some of the topics that you discuss at your meetings?

c. What are their roles?

d. What do you feel the overall response of these agencies has been? (Do they regularly attend the meetings? Do they participate in the meetings?)

Meeting frequency ranged from as often as needed to once every three to four months. Monthly and quarterly meetings were the most common responses. Meeting topics varied. Progress reports, however, were the most frequently presented topic. The most common role of the steering committee was to provide feedback and guidance to the consultant preparing the EDP. Overall, participation from agencies involved in the EDP planning process has been very good. Additional responses to the questions discussed above are provided in Table 3.

5. Are you visiting any cities with operational IVHS technologies and how did you select them?

A number of cities were visited by the project teams conducting the IVHS EDP studies. Although they did not visit Boston, Seattle, and San Antonio, these cities were also recommended for site visits.

Visited	**Additional Cities Recommended**
• Chicago, IL	• Boston, MA
• Columbia, SC	• Seattle, WA
• Charleston, SC	• San Antonio, TX
• Minneapolis, MN	
• Orlando, FL	
· Atlanta, GA	

- Atlanta, GA
- Toronto, Canada
- Long Island, NY
- Los Angeles, CA

Although the project team for the IVHS EDP in Raleigh/Durham/Chapel Hill has not visited any sites at this time, they will be selecting sites to visit based on available literature, videos, telephone contacts, and budget constraints. The Greenville project team is selecting cities to visit based on the technologies recommended in their EDP.

6. As part of your plan, will you be prioritizing roadways/corridors for initial deployment of IVHS technologies?

7. What criteria are you using to prioritize or evaluate these roadways?

All locations, except Tampa, are prioritizing roadways for deployment of IVHS technologies. The Tampa EDP concentrated on developing an Advanced Traveler Information system. Accidents (used by four areas) and congestion levels (used by three areas) were the criteria most often used to prioritize roadways and corridors (refer to Table 4).

Table 1. IVHS EDP Status and Tasks

Area	Boston	Dallas	Denver
Status	Completed 1/94	approaching midway	completed 2/94
Tasks	• prepare project schedule • organize and conduct project management meetings • establish technical advisory committee • prepare monthly progress report • define present and projected congestion • review IVHS technologies • define evaluation methodology for IVHS components • assess benefits, costs and funding sources • develop 1994 and 2000 IVHS plans • assess environmental impact of plans • assess implementation and O&M costs • develop implementation plan • review existing State DOT organizational structure • develop final report • develop operations plan • prepare conceptual engineering for a typical corridor	• coordinate w/steering committee • assess existing TMS and potential IVHS • identify institutional issues • develop area-wide plan • develop costs, benefits, and implementation plan • define projects • facilitate implementation	• provide project organization and management • conduct IVHS information (literature) search and data collection • establish task force and conduct workshops • develop preliminary strategic plan • review and refine strategic plan • develop early action plan • develop and refine master plan • prepare implementation program • prepare final report

Table 1. (continued)

Area	Greenville	Louisville	Portland
Status	anticipate completing 1st seven tasks 8/94	anticipate completion 6/94	completed 10/93
Tasks	• perform inventory and data collection • identify alternate routes and incident management strategies • develop conceptual ATMS system • evaluate driver information systems • develop ATMS organization • review legislation and regulations • prepare preliminary study report • prepare ATMS conceptual designs • prepare final report	• identify freeway incident management goals, objectives and data needs • collect and review existing data • perform supplemental data collection • interview incident response personnel • analyze existing and future needs • develop improvement alternatives • analyze alternatives • evaluate alternatives • refine recommendations and develop implementation plan • prepare final project report • project management and meetings	• assess area-wide corridors • assess centralized control • review detection techniques • develop ATMS system configuration • review existing incident management practices • review incident documentation • assess incident site communications • assess signs informing motorists of a central # to call-in incidents • develop incident response corridor plan • assess local ATMS institutional issues • assess local incident management institutional issues • explore inclusion of other local participants

Table 1. (continued)

Area	Raleigh	San Francisco	Tampa
Status	anticipate start 7/94	anticipate start 6/94	completed 10/93
Tasks	• organize kick-off meeting • solicit input from study area jurisdictions • develop needs statement paper • identify user service objectives • develop user service plan paper • define system functionality • screen alternative systems • develop draft regional plan • revise regional plan and submit for approval	• draft work scope, schedule, and budget • define transportation and institutional needs • maintain involvement in other complimentary activities • inventory IVHS technologies and deployment efforts • analyze costs, benefits, and implementation issues • prepare alternative regional architectures to coordinate deployment • prepare final report, exec. summary and outreach materials	• establish a project advisory group • identify and evaluate methods to collect real-time traffic information • analyze control center (location and operations) • analyze info. dissemination techniques • conduct small market research effort of user preferences for interpreting traffic condition information • prepare recommended action plan

Table 2. Summary of Agencies Involved in IVHS EDPs

Agency	Boston[a]	Dallas	Denver	Greenville	Louisville	Portland	Raleigh[b]	San Francisco	Tampa
FHWA	X				X				
State DOT/highway dept.	X	X		X	X		X	X	X
County		X	X	X		X			X
City	X	X	X	X		X	X	X	X
Transit	X	X		X			X	X	
MPO	X	X			X	X			
EMS						X			X
Fire						X			X
Police	X				X			X	X
Traffic reporters									X
UPS, taxi service									X
Media									X
Major traffic generators							X		
Telephone companies		X							
Consultant	X	X							
Environmental group	X			X					
Turnpike Authority	X								
Disaster Emergency Services					X				

a Agencies involved in Boston also included parkway, port authority, trucking association, executive office of transportation and construction, and construction project staff.
b The agencies that will be involved in the Raleigh/Durham/Chapel Hill EDP have not been finalized.

Table 3. Agency Involvement

Area	Boston[a]	Dallas	Denver
Steering Committee Meeting Frequency	quarterly	monthly	quarterly
Meeting Topics	• vehicle detection • technology compatibility • architecture for comm. center • availability of agency resources	• pvt. sector presentations • agencies' IVHS projects • progress report	• determine problems that need immediate attention
Agency Role(s)	• provide recommendations • provide guidance	• provide feedback • provide guidance	• provide feedback
Agency Response	• enthusiastic • able to build relationships that were not possible in the past	• very good • extremely helpful	• disappointed in participation to date • smaller agencies do not seem to realize benefits of IVHS • politicians seem to have their own agenda

a The steering committee in Boston met quarterly, while the technical committee met monthly

Table 3. (continued)

	Greenville	Louisville	Portland
Steering Committee Meeting Frequency	every 3 to 4 months	monthly	quarterly
Meeting Topics	• working papers on the IVHS EDP prepared by the consultant	• progress report • technologies proposed by consultant	• funding • agencies' concerns
Agency Role(s)	• make recommendations	• provide comments	• provide feedback
Agency Response	• good • major players have best response • alleviate future congestion since they are a small metropolitan area • a lot of teamwork	• wonderful • broken down jurisdictional barriers between state, county, and city • broken institutional barriers between fire, police, and EMS • a team has developed	• agencies appreciate being informed

Table 3. Agency Involvement

Area	Raleigh[b]	San Francisco	Tampa
Steering Committee Meeting Frequency	as often as needed	monthly	every 2 months
Meeting Topics	• progress report	• progress reports	• progress report/recent findings
Agency Role(s)	• provide comments • provide guidance • furnish agency‘ s plan documents describing transportation problems • supply traffic data	• provide feedback • prioritize projects	• provide feedback
Agency Response	• FHWA and local NOT have been very supportive in developing the proposal	• half are very active and deeply involved • other half are interested but overwhelmed with other responsibilities	• more private agencies desired to participate than expected

b Although a steering committee has not yet been formed for the Raleigh/Durham/Chapel Hill EDP, it is anticipated that the steering committee will meet as often as needed.

Table 4. Prioritization Criteria for Roadways/Corridors

Criteria	Boston	Dallas	Denver	Greenville	Louisville	Portland	Raleigh[a]	San Francisco[b]	Tampa[c]
Traffic volumes	X					X			
Accidents	X	X				X	X		
Congestion levels		X				X	X		
State routes	X								
Transit data		X					X		
Level-of-service							X		
Freeway bottle necks		X							
Availability of parallel routes		X							
Potential to increase capacity				X					
Proximity of parallel route to freeway, avoid conflicts with schools, pedestrians and traffic signals					X				
Air quality							X		
Convenience			X						
Delay				X					
Travel times				X					
Technical and political criteria								X	
v/c ratios				X					

a Agencies involved in Boston also included parkway, port authority, trucking association, executive office of transportation and construction, and construction project staff.
b The agencies that will be involved in the Raleigh/Durham/Chapel Hill EDP have not been finalized.

APPENDIX IB

AUSTIN AREA ITS STAKEHOLDERS

Evolving Local Agency List

Transportation Infrastructure Providers
- **Texas Department of transportation—Austin District**[1,2]
- **City of Austin—Transportation Division**[1,2]
- **Travis County**[1]
- **Austin Transportation Study**[3]
- **Lower Colorado River Authority**

Transportation Service Providers
- **Capital Metro**[1,2,3]
- **Taxis**
- **Towing Companies**
- **Amtrak**

Emergency Responders
- **Department of Public Safety**[1,2,3]
- **Travis County Sheriff**[1,2]
- **Austin Police Department**[1,2,3]
- **Austin Fire Department**[1,2,3]
- **EMS**[1,2,3]
- **911**[1,2,3]

Information Providers
- **Metro Traffic**[1,2,3]
- **Texas Cable TV Association**[1,2,3]
- **KASE/KVET—radio**
- **KLBJ—radio**[1,2,3]
- **KTBC—TV**[1]
- **KVUE—TV**[1]
- **KXAN—TV**[1,2,3]
- **American Statesman**[1,2]
- **Chamber of Commerce**
- **Austin Convention and Visitors Bureau**[1,2,3]

Freight Carriers
- **Central Freight**
- **Texas Motor Transportation Assoc.**[1]
- **United Postal Service**
- **Postal Service Postmaster**[1,2]
- **Federal Express**
- **Airborne**
- **Austin and Northwestern R&R**
- **Georgetown R&R**
- **Austin Transportation Club**[1,2,2,3]

University of Texas
- **Business Affairs/Police**[1,2]
- **Center for Trans. Research**

Airport1

Telephone
- **Southwestern Bell**[1]
- **AT&T**
- **GTE**

Bicycle
- **Texas Bicycle Coalition**[1]

School Districts
- **Austin1,2**
- **Eanes1,2**

Technology Providers/Traffic Generators
- **MCC**
- **IBM**
- **3M**
- **Motorola**
- **Lockheed**
- **Texas Instruments1**
- **Trimble**
- **Arrowsmith**

Area Cities
- **Bee Cave**
- **Briarcliff**
- **Buda**
- **Cedar Park**
- **Creedmoor**
- **Hays**
- **Jonestown**
- **Lago Vista**
- **Lakeway**
- **Leander**
- **Manor**
- **Mustang Ridge**
- **Pflugerville**
- **Rollingwood**
- **Round Rock1,2,3**
- **San Leanna**
- **Sunset Valley**
- **West Lake Hills**

Area Counties
- **Hays**
- **Williamson1,2**

Environmental Groups
- **Texas Natural Resource and Conservation Commission**
- **Sierra Club**
- **Earth First**

Political Representatives
- **U.S. Representative Jake Pickle**
- **State Senator Gonzalo Barrientos**
- **County Commissioner Bill Aleshire**

Austin Hotel and Motel Association

Elderly Associations
- **CAMLU**

Disabled Associations

Hospital Associations

Pedestrians Associations
- **Walk Austin1**

Legend
- **1=sent survey (31)**
- **2=returned survey (22)**
- **3= met (14)**

Local Agency	Met	Sent Survey	Returned Survey
Transportation Infrastructure Providers			
Texas Department of Transportation—Austin District		X	X
City of Austin—Transportation Division		X	X
Travis County		X	
Austin Transportation Study	X		
Lower Colorado River Authority			
Transportation Service Providers			
Capital Metro	X	X	X
Taxis			
Towing Companies			
Amtrak			
Emergency Service Providers			
Department of Public Safety	X	X	X
Travis County Sheriff		X	X
Austin Police Department	X	X	X
Austin Fire Department	X	X	X
EMS	X	X	X
911	X	X	
Information Providers			
Metro Traffic	X	X	X
Texas Cable TV Association	X	X	X
KASE/KVET—radio			
KLBJ—radio[a]		X	X
KTBC—TV		X	
KVUE—TV		X	
KXAN—TV	X	X	X
American Statesman		X	X
Chamber of Commerce			
Austin Convention and Visitors Bureau	X	X	X

[a] **One survey was completed by the same person that works for both the Austin Police Department and KLBJ radio.**

Local Agency	Met	Sent Survey	Returned Survey
Freight Carriers			
Central Freight			
Texas Motor Transportation Assoc.		X	
United Postal Service			
Postal Service Postmaster		X	X
Federal Express			
Airborne			
Austin and Northwestern R&R			
Georgetown R&R			
Austin Transportation Club[b]	X	XX	XX
University of Texas			
Business Affairs/Police		X	X
Center for Trans. Research			
Airport		X	
Telephone			
Southwestern Bell		X	
AT&T			
GTE			
Bicycle			
Texas Bicycle Association		X	
School Districts			
AISD		X	X
Eanes		X	X

[b]Two members of the Austin Transportation Club responded to the survey.

Local Agency	Met	Sent Survey	Returned Survey
Technology Providers/Traffic Generators			
MCC			
IBM			
3M			
Motorola			
Lockheed			
Texas Instruments		X	
Trimble			
Arrowsmith			
Area Cities			
Bee Cave			
Briarcliff			
Buda			
Cedar Park			
Creedmoor			
Hays			
Jonestown			
Lago Vista			
Lakeway			
Leander			
Manor			
Mustang Ridge			
Pflugerville			
Rollingwood			
Round Rock	X	X	X
San Leanna			
Sunset Valley			
West Lake Hills			
Area Counties			
Hays			
Williamson		X	X

Local Agency	Met	Sent Survey	Returned Survey
Environmental Groups			
Sierra Club			
Earth First			
TNRCC			
Political Representatives			
Senator Gonzalo Barrientos			
Representative Jake Pickle			
Judge Bill Aleshire			
Austin Hotel and Motel Association [c]			
CAMLU—elderly			
Disabled			
Hospital			
Pedestrians			
Walk Austin		X	

[c]Austin Hotel and Motel Association felt it would be appropriate for the Austin Convention and Visitors Bureau to respond on their behalf to the survey.

Intelligent Vehicle Highway System User Services and Austin Area Users																												
	Congestion Management System								Public Transportation Management Syste				Intermodal Management System							Safety Management System								
	Travel and Traffic Management								Public Transportation Management				EPS	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems						
User	PI	EDI	TSI	RG	RMR	IM	TDM	TC	ETI	PTM	PPT	PTS	EPS	CVEC	ARSI	CVAP	OSM	CFM	HMIN	EVM	ENPS	LCA	LCA	ICA	VECA	SR	PRD	AVO
TxDoT William Garbade 832-7000						X		X						X														
City f Austin David Gerard 499-7022						X	X	X																				
Travis County Raymond Reed 472-7483						X		X																				
Capital Metro Mike Ouimet 389-7448	X	X			X				X	X	X	X	X									X	X					
Airport Peter Rieck 495-7594	X	X																										
DPS Capt E.C. Sherman 873-3100						X													X	X	X							
APD Lt John Stewart 480-5208						X													X	X	X							
Sheriff Lt. Mike Miller 473-9770						X													X	X	X							
AFD Peter Sybesma 477-5784																			X	X	X							
Austin EMS Michale Morris 469-2050																			X	X	X							

Intelligent Vehicle Highway System User Services and Austin Area Users																												
	Congestion Management System								Public Transportation Management Syste				Intermodal Management System							Safety Management System								
	Travel and Traffic Management								Public Transportation Management				EPS	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems						
User	PI	EDI	TSI	RG	RMR	IM	TDM	TC	ETI	PTM	PPT	PTS	EPS	CVEC	ARSI	CVAP	OSM	CFM	HMIN	EVM	ENPS	LCA	LCA	ICA	VECA	SR	PRD	AVO
Austin 911 Lt. Looney 480-5190																			X	X	X							
ATS Michael Aulik 499-5441							X																					
Taxi (CoA) Joyce Frederick 479-6037	X		X		X								X															
Tx Cale TV Assn. Inc. Bill Arnold 474-2082																												
KLBJ Radio Sam Cox 480-5201	X	X																										
KASE/KVET David Anderson 422-2855	X																											
KTBC-TV Michael Schneider 476-7777	X																											
KVUE-TV Carole Kneeland 459-2064	X																											
KXAN-TV Jim McNabb 476-3636	X																											
Austin American Statesman David Lowry 445-3662	X																											

Intelligent Vehicle Highway System User Services and Austin Area Users

User	Congestion Management System								Public Transportation Management Syste				Intermodal Management System							Safety Management System								
	Travel and Traffic Management								Public Transportation Management				EPS	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems						
	PI	EDI	TSI	RG	RMR	IM	TDM	TC	ETI	PTM	PPT	PTS	EPS	CVEC	ARSI	CVAP	OSM	CFM	HMIN	EVM	ENPS	LCA	LCA	ICA	VECA	SR	PRD	AVO
Metro Traffic Bill Kim 459-7375	X	X		X																								
TxBicycle Coalition Glenn Gadbois 476-7433	X	X	X	X																								
Walk Austin																												
Austin Hotel & Motel Assn Pat Miller 259-2165	X		X		X																							
Austin Trans-portation Club Jan Weest 250-3565																												
TxMotor Trans. Assn. Robert Floyd														X	X	X	X	X			X	X						
Central Freight 928-7335														X	X	X	X	X										
Federal Express 1-800-238-5355																												
Airborne 476-6933																												
UPS 1-800-292-7129																												
Amtrak 1-800-672-7245	X					X		X					X															

Intelligent Vehicle Highway System User Services and Austin Area Users																												
	Congestion Management System								Public Transportation Management Syste				Intermodal Management System							Safety Management System								
	Travel and Traffic Management								Public Transportation Management				EPS	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems						
User	PI	EDI	TSI	RG	RMR	IM	TDM	TC	ETI	PTM	PPT	PTS	EPS	CVEC	ARSI	CVAP	OSM	CFM	HMIN	EVM	ENPS	LCA	LCA	ICA	VECA	SR	PRD	AVO
Georgetown Railroad 255-2410																												
Austin & Northwestrn Railroad 458-6700																												
IBM 1-800-426-3333	X				X																							
3M 984-1800	X				X																							
Motorola 928-6000	X				X																							
Lockheed 386-0000	X				X																							
Texas Instuments 250-7111	X				X																							
MCC 343-0978																												
CTR Michael Walton 471-1414																												
UT Jerry De Camp 471-4411	X				X																							
Towing (APD) Sgt Bowers 280-5121					X													X										
Hospital	X		X																									

Intelligent Vehicle Highway System User Services and Austin Area Users																												
	Congestion Management System								Public Transportation Management Syste				Intermodal Management System							Safety Management System								
	Travel and Traffic Management								Public Transportation Management				EPS	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems						
User	PI	EDI	TSI	RG	RMR	IM	TDM	TC	ETI	PTM	PPT	PTS	EPS	CVEC	ARSI	CVAP	OSM	CFM	HMIN	EVM	ENPS	LCA	LCA	ICA	VECA	SR	PRD	AVO
Postal Service Postmaster 929-1283			X										X	X	X	X	X											
Sierra Club 860-2993																			X									
Earth First																			X									
AT&T																												
SW Bell 870-6150													X	X	X	X	X	X										
AISD Dan Roberts 926-7940	X																											
Eanes ISD Bill Wheeless 329-3623	X																											
TNRCC 908-1015																												
Lower Colorado River Authority 473-3235																												
Greater Austin Chamber of Commerce Sandy Dochan 322-5638																												
Handicap																												
Tx Sanator Gonzalo Barrientos 463-0114																												

Intelligent Vehicle Highway System User Services and Austin Area Users																												
	Congestion Management System								Public Transportation Management Syste				Intermodal Management System							Safety Management System								
	Travel and Traffic Management								Public Transportation Management				EPS	Commercial Vehicle Operations						Emergency Management		Advanced Vehicle Safety Systems						
User	PI	EDI	TSI	RG	RMR	IM	TDM	TC	ETI	PTM	PPT	PTS	EPS	CVEC	ARSI	CVAP	OSM	CFM	HMIN	EVM	ENPS	LCA	LCA	ICA	VECA	SR	PRD	AVO
US Senator Jack Pickle 482-5921																												
CAMLU	X				X						X																	
Bee Cave																												
Briar Cliff																												
Creedmoor																												
Jonestown																												
Lago Vista																												
Lakeway																												
Manor																												
Mustang Ridge																												
Pflugerville																												
Rollingwood																												
San Leanna																												
Sunset Valley																												
West Lake Hills																												
Williamson County																												
Cedar Park																												
Leander																												

Intelligent Vehicle Highway System User Services and Austin Area Users																												
	Congestion Management System								Public Transportation Management Syste				Intermodal Management System								Safety Management System							
	Travel and Traffic Management								Public Transportation Management				EPS	Commercial Vehicle Operations							Emergency Management		Advanced Vehicle Safety Systems							
User	PI	EDI	TSI	RG	RMR	IM	TDM	TC	ETI	PTM	PPT	PTS	EPS	CVEC	ARSI	CVAP	OSM	CFM	HMIN	EVM	ENPS	LCA	LCA	ICA	VECA	SR	PRD	AVO
								X																				

APPENDIX IC

TRANSPORTATION SURVEY TALLY

IVHS EARLY DEPLOYMENT STUDY

Transportation Survey

Name: Survey Summary

Agency: 32 sent and 21 received

Address: Some surveys received were incomplete

Phone #: ____________________________ **FAX #:** ______________________

1. Does your agency or business use information on traffic accidents, congestion, or other conditions to improve its performance?

   • **(19) Yes** • **No** (2 no answer)

2. What information does your agency or business use?

(13) Travel time	(2) Airline arrival\departure
(20) Accident locations	(1) Railroad arrival\departure
(15) Weather	(2) Transit schedule
(15) Construction	(2) Delivery information
(16) Congestion	(8) Traffic counts
(7) Route guidance	(0) Not applicable
(1) Other: key map___	(0) Other:______________

3. How does your agency or business receive this information?

(18) Radio	(8) Newspaper	(7) TV	(13) Phone
(8) Computer	(0) Not applicable	(2) Other: Fax__	(3) Other: Counter___

4. Is this information reliable?

(5) Always	**(16) Sometimes**	(0) Never	(0) Not applicable

Fax completed survey to Brian Burk at 832-7148
Note: #/#.## = # of responses/average value of responses

IVHS EARLY DEPLOYMENT STUDY

Transportation Survey

5. Is this information timely?

(3) Always **(18) Sometimes** (0) Never (0) Not applicable

6. In your opinion, list the actions that could be taken to improve the reliability and timeliness of this information?

(13) Direct link to live freeway traffic information
(11) Direct link to live city street traffic information
(2) Direct link to live transit information
(1) Direct link to live airline information
(0) Direct link to live railroad information
(15) Direct link to live centralized information (freeway, city street, ...)
(1) Not applicable
(1) Other: Direct link to Travis County traffic information-

7. Would your agency or business like to have information on (see below) conditions?

Traffic (i.e. congestion, accidents)	(20) Yes	(0) No
Transit (i.e. schedule, stops)	(4) Yes	(7) No
Airline (i.e. arrival/depart)	(1) Yes	(9) No
Railroad (i.e. arrival/depart)	(1) Yes	(9) No

8. What five items of information on traffic conditions would your agency like to have access to? (List in order of priority--# 1 = most important)? {see footnote}

7/2.14 - Time of accident	10/3.40 - Length of traffic backup
16/1.31- Location of accident	**14/3.86 - Projected delay due to an accident**
10/2.90 - Type of Accident	4/5.00 - Travel time to your destination
11/2.55 - Alternate route to avoid delays	3/3.00 - Shortest route
3/3.00 - Shortest travel time	4/4.25 - Traffic speeds in area of accident
13/3.46 - Location of road construction	l/5.00 - Transit schedule
0/0.00 - Other:_____________________	0/0.00 - Other:__________________

Fax completed survey to Brian Burk at 832-7148
Note: #/#.## = # of responses/average value of responses

IVHS EARLY DEPLOYMENT STUDY

Transportation Survey

9. How would your agency or business like to have access to this information? (List 3 items in order of priority--# 1 = most important) {see footnote)

1/1.00 - Portable TV
1/1.00 - Newspaper
13/1.46 - **Computer in office**
0/0.00 - Pager
0/0.00 - Monitor at home
6/2.33 - Changeable message sign on side of roadway
8/2.38 - Radio
6/2.00 - Phone
7/1.86 - Computer in vehicle
2/2.50 - TV monitor in lobby of office
1/1.00 - Other: remote hook up

10. What times of the day would your agency or business like to receive this information?
(List in order of priority--#1 = most important) {see footnote}

5/1.00 - 24-hours per day
3/2.67 - 4:00 p.m. to 6:00 p.m.
1/1.00 - Other: not specified___
4/l -75 - 7:00 a.m. to 9:00 a.m.
2/4.00 - 11:00 a.m. to 1:00 p.m.
1/1.00- Other: 7 a.m. - 7 p.m.

11. What days of the week would your agency or business like this information to be available?

_10_ Monday through Friday
__0_Weekends
_11_ **Every Day**
__0_ Other: ________

12. How frequently would your agency or business like this information updated?

__4_ Every 5 minutes
__5_ Every 15 minutes
__3_ Every 10 minutes
_10_ **Continuous**

13. If your agency or business operates a fleet of vehicles, would it be beneficial to automatically locate these vehicles on the roadway?

(12) Yes (5) No (4) Not applicable

Fax completed survey to Brian Burk at 832-7148
Note: #/#.## = # of responses/average value of responses

IVHS EARLY DEPLOYMENT STUDY

Transportation Survey

14. What five routes are most important to the performance of your agency or business?
(Indicate in order of priority--# 1 = most important) {see footnote}

17/1.53 - **IH 35**	**15/2.53 - Mopac/Loop 1**	7/4.43 - Loop 360
1412.79 - US 183	3/3.00 - Congress Avenue	3/3.33 - US 290 East
6/3.33 - Lamar Boulevard	1/5.00 - South 1st Street	1/4.00 - Manchaca Road
9/3.67 - US 290/Ben White/SH 71	3/12.0 - RM 2222/Koenig Ln	3/l 3.0 - Burnet Road
l/3.00 - Other: RM 620______	l/1.00 - Other: RM 2244_	0/0.00 - Other:______

15. Please list five problems that are regularly encountered on these routes that affect the performance of your agency or business?
(Indicate in order of priority--# 1 = most important) {see footnote}

20/1.20 - Congestion	**20/2.35 – Accidents**	4/3.75 - Trucks
5/3.80 - Potholes	0/0.00 – Pedestrians	1/5.00 - Driveways
11/3.45 - Signal delay	**6/3.50 – Speeding**	**17/3.06-Const. delay**
1/5.00 - Other: Buses_____	0/0.00 - Other:_________	0/0.00 - Other:______

16. In your opinion, list at least three actions on these routes mat would improve the performance of your agency or business?
(Indicate in order of priority--# 1 = most important) {see footnote}

17/1.47 - Widen road way	4/2.50 - More police presence	**5/1.80 - Restrict some vehicles**
6/2.17 - Meter ramps	1/3.00 - Close ramps	3/2.67 - Restrict driveways
5/2.80 - Install signals	**15/2.13 - Retime signals**	0/0.00 - Other:__________
1/1.00 - Other: Opticom	0/0.00 - Other:__________	0/0.00 - Other:__________

17. Who should be responsible for making the improvements?

_13_ City	_7_ County	_5_ Private enterprise
_15_ State	_10_ Federal	_1_ Other:

Fax completed survey to Brian Burk at 832-7148
Note: #/#.## = # of responses/average value of responses

APPENDIX ID

LOCAL AGENCY MEETING NOTES

Local Agency Meeting Notes

Capital Metro

Contact: Mike Ouimet

Interests

- **Signal preemption for buses**
- **AVL system for buses**
  Would like to have one standard AVL system for use by all agencies interested in AVL, like EMS, Fire, and APD. The same standard AVL system used by each agency would reduce costs, facilitate the sharing of a single roadway network database, and provide a number of people in Austin that could assist each other in solving problems with the system.

Additional Information

- **Huston-Tillotson University has contracted with Capital Metro to research GPS technologies.**
  Funds have been budgeted for AVL installation in 1996.
- **Bus drivers and supervisors report traffic incidents to their dispatcher. Dispatcher will in turn dispatch information to other bus drivers. Drivers will skip stops if incident will significantly delay the bus' schedule.**

Department of Public Safety

Contact: Captain E.C. Sherman

Interests

- **800 trunk line**
  An 800 trunk line would provide communication between different agencies responding to the same emergency. At this time, for DPS to communicate with APD, a DPS unit has to contact his dispatcher, DPS dispatcher then has to contact APD dispatcher, APD dispatcher then contacts APD unit. 800 trunk line will allow DPS and APD units to talk directly to each other.
- **Any systems that would reduce the number of collisions between motorists.**
- **Vehicle ignition shut-down**
  Any technology that could turn a vehicle's engine off to avoid high speed pursuits. When a DPS unit is in high speed pursuit of another vehicle, the DPS officer has to make a decision regarding what is in the best interest of public safety. Which action increases public safety more: (1) apprehending the fleeing suspect or (2) risking the possibility of an accident due to the high-speed

nature of the pursuit. A number of times the DPS officer discontinues the pursuit in the interest of public safety. If criminals realize officers will no longer pursue them in a high-speed chase, the deterrent for committing the crime is reduced.

- **Representation within a traffic management center**

Additional Information

- **Units are assigned to patrol a specific geographical area.**
- **Do not have a CAD system. Keep track of vehicles by voice communications or county dispatch.**
- **At this time, funding is unavailable for an 800 trunk line.**
- **DPS performs before and after studies for seat belt violations.**
- **Although DPS may be the first responder to an emergency that is outside their jurisdiction, they allow agency with jurisdiction to take over while they provide any assistance that is needed.**
- **Limited resources make it difficult to envision GPS technology in the near future.**
- **Surveillance cameras would probably not benefit DPS since they mainly patrol rural areas. Cost would be too expensive.**
- **Currently, 25 percent of DPS units have video cameras. They are in the process of installing more cameras on units. The areas with DWI generators are receiving first priority for deploying the cameras. Some counties buy video cameras and, in some cases, radios for DPS vehicles. Officer's discretion to turn on camera.**
- **DPS is responsible for responding to all traffic accidents in counties and rural areas. Sheriffs are responsible for responding to all criminal activities in these areas.**

Austin Police Department

Contacts: Lieutenant John Stewart and Sergeant Sam Cox

Interests

- **800 trunk line**
- **Incident management training course**

  An incident management course would educate cadets and supervisors about techniques to better mange incidents.
- **Signal preemption for emergency vehicles responding to emergency calls.**

  Concerned that preemption could be abused.
- **AVL system**

  Concerned with security of the system. Would not want "Bad Guys" to have access to the system.
- **Traffic management center**

Additional Information

- **Units are assigned to patrol a geographic area.**
- **Incident data is stored up to 90 days after incident occurs. Information could be used to establish a baseline that documents the duration of each stage of an incident: detection, verification, response, removal, traffic management. Depending on the detail of the information, it could also be used to determine overall incident duration, number of lanes blocked, severity, and amount of resources and personnel responding to the incident. This information could then be used to evaluate the effectiveness of recommendations that are implemented.**
- **I-net system does pass by their building.**

Austin Fire Department

Contacts: Peter Sybesma and Steve Collier

Interests

- **Signal preemption**
- **Surveillance cameras**

  Access to live video could be used to determine the number of vehicles to respond.

  Access to live video would allow staff to assess a tanker spill without being exposed to hazardous chemicals.
- **Speed data**

  Speed data could be used to determine travel times. Travel times could then be used to plan the location of future fire stations to maintain adequate response time.
- **Computerized tracking of hazardous materials**
- **Street closure information**
- **Fire hydrant closure locations**
- **AVL system**

Additional Information

- **Try to maintain a 3 I/2 minute average response time. 30 seconds for scramble time and 3 minutes for travel time at 30 mph.**
- **Receive 50 to 85 calls per day. Approximately half are first responder calls for EMS. In other words, the Fire Department is closer than EMS to the scene of a life threatening emergency. Therefore, the Fire Department responds first and provides the necessary services until EMS arrives.**
- **Need to reduce the time that the signal preemption system takes to recognize an approaching vehicle.**
- **Typical fire station has a 1 l/2 mile radius service area (approx. 4 l/2 sq. mi.)**
- **Drivers responsible for knowing shortest route to emergency. They try to stay off**

high volume streets.

- **Computer dispatches nearest fire station to the emergency.**
- **No direct link with 911 system. Dispatcher re-enters data to determine which fire station is closest to emergency.**

Austin Emergency Medical Services

Contact: Michael Morris

Interests

- **Signal preemption**
- **AVL system**

  Would like to link the AVL system to real-time traffic information to better determine which ambulance could respond in the shortest amount of time.
- **800 trunk line**
- **Relocating communication center**

  Would like to relocate communications center, which houses 911, EMS, Fire, and APD dispatchers, from APD headquarters to a more secure location. Concerned if a hazardous chemical is spilt on I-35, the communications center may need to be evacuated due to its close proximity to I-35.

  A potential site was the new airport but SAC base contaminated with asbestos.
- **Surveillance cameras**

Additional Information

- **Already have a method to track the location of ambulances. Dispatchers know where the ambulance is dispatched from, if the ambulance is in the process of responding to an emergency, when the ambulance driver enters the information acknowledging they have arrived at the scene, and the route the ambulance takes from the hospital back to their facility. Therefore, they always have an idea where the ambulance is.**
- **Drivers are pleased with the performance of the existing signal preemption system.**
- **Discussions are underway for relocating the communication center.**
- **3 tier response system: (1) basic life support, 65 percent of calls, (2) advance life support--trauma, gun shot, and (3) star flight helicopter. Cost increases with each tier.**

911

Contact: Darlene Blackburn

Interests

- **One phone number for reporting traffic incidents**

The current list of phone numbers for TxDOT is too lengthy to look through and decide which phone number to call during an emergency.

Additional Information

- **Common theme between all dispatchers is that they are extremely busy.**
- **911 handles calls from call boxes. Majority of calls are for service, not emergencies. During one week they received 14 calls from the call boxes. During another week, they received 6 calls. Very, very few have been calls that need Fire, EMS, or APD to respond. Demand on 911 and communications staff could be reduced if one number was available to the public to call to report traffic accidents or minor breakdowns that do not require emergency assistance.**
- **When 911 receives a phone call, the address of incoming call is automatically displayed on a computer screen. This is not the case when 911 receives a cellular phone call. Cellular phone calls require 911 operators to take more time to enter information. Additionally, the location of the emergency may not be accurate.**

Metro Traffic

Contact: Bill Kim

Interests

- **Direct access to traffic information**
- **Any system that can assist in providing timely and accurate traffic information**
- **Concerned about competitive edge should centralized management center use radio.**

Additional Information

- **They are in the business of providing information to the public.**
- **Once they receive information about a traffic incident, it takes 2 to 4 minutes to get that information out to the radio stations.**
- **Detect incidents through police scanner, aircraft, and spotters (people who work in businesses near major travel ways) located around town.**
- **Verify through spotters and by calling APD.**
- **Hours of operation 5 a.m. to 8 p.m.**
- **First broadcast around 6 a.m. Primarily provide information to radio stations between 6 a.m. and 9 a.m. and 3 p.m. and 7 p.m. If needed, will broadcast information outside those times (e.g., ice storm). Between 9 a.m. and 3 p.m. only 3 radio stations take information on traffic conditions. The radio stations decide whether or not to provide this information to their listeners.**
- **Typical broadcast frequency is 10 minutes during the peak drive times.**
- **Different stations want different types of information.**
- **Some stations want traffic report at same time as other stations.**

- **Have 24-hour contract with airplane to provide surveillance information. Camera mounted on airplane to provide live video (?).**
- **They provide traffic information to about 60 to 70 percent of the radio listeners in Austin.**
- **Not always notified of maintenance activities.**
- **Has staff, some broadcast in Spanish.**
- **No longer reports delay. Delay no always meaningful.**

Texas Cable TV Association

Contact: W.D. Arnold

Interests

- **Unidentified**

Additional Information

- **Cable companies using coaxial cable for communication.**
- **Cable companies use one-way amplifiers since they do not need information back from the termination point. If information from the termination point is desired, need two-way amplifiers.**
- **There has been a study in Austin to operate traffic signals over cable company's system.**
- **Aerosmith Technologies is a local provider of AVL systems for fleet management.**
- **No standards to facilitate integration between companies.**
- **Existing standards MPEG l&2, PCN, PLS.**
- **Many local cable companies can not add channels (channel lock). Capacity of co-ax has been reached.**

KXAN-TV

Contact: Alyce Dorsey

Interests

- **Live video from the scene of an incident**
- **Road closures, under water locations, and construction information**
- **Single point of contact for information about traffic conditions**

Additional Information

- **Currently, traffic information is broadcasted at 6:30 a.m., 7:25 a.m., 7:55 a.m., 8:25 a.m., and 8:55 a.m.**

- **Providing video and information to the public is their business.**
- **Sergeant Sam Cox with KLBJ provides them with traffic information.**
- **Maps are used with an "X" to mark the location of an incident.**
- **Survey viewers once a year. Took it for granted that they wanted traffic information.**
- **Broadcast news information every hour on the hour, 24 hours per day.**
- **Video among stations is linked by common satellite carrier.**
- **Depending on severity of incident, they could broadcast information at the bottom of the television screen.**
- **They will interrupt their normal broadcasting schedule to report an incident. The example given was the airplane landing on Airport Boulevard.**

Austin Transportation Club

Contact: Genieve Weest

Interests

- **Local traffic information**
- **Intercity traffic Information (e.g., between Austin and San Antonio)**

Additional Information

- **Board of Directors meet first Wednesday of each month.**
- **They distribute a newsletter monthly.**
- **No rail unloading facility in Austin. All commodities are trucked.**

City of Round Rock

Contact: Joe Vining

Interests

- **Intercity traffic information between Round Rock and Austin**
  A changeable message sign would be an appropriate means of communicating downstream traffic information to motorists commuting to Austin.

Additional Information

- **Residential and business growth is increasing demand on surface streets.**
- **55 percent of residents work in Austin. Remaining 45 percent work in Round Rock.**
- **About 10 years away from having own signal system.**
- **Still waiting for roadway network to be completed.**

- **City Departments perform annual drills to be prepared for major emergencies (e.g., tanker spill, terrorist).**

Austin Convention and Visitors Bureau

Contact: Charles A. Stephens

Interests

- **Directional signing along IH-35 and city streets for points of interest.**

Additional Information

- **At airport and downtown locations, they receive information through phone calls on accidents and construction in order to develop alternate routes for visitors.**
- **Through Capital Metro they have a "Hotel Hopper" service. However, since it is funded through the federal government it must operate on a fixed route.**
- **In the discussion stages with the City of Austin on designating two parking spaces on 6th street to run hotel shuttles. They need to develop schedules to post at the hotels and on 6th street.**

Austin Transportation Study

Contact: Mike Aulick, Rick Lakatta

Interests

- **How will IVHS relate to ISTEA management systems.**

Additional Information

- **They are responsible for developing congestion management system for Austin area.**

APPENDIX IE

TxDOT ADVISORY COMMITTEES

AUSTIN ITS STEERING COMMITTEE
ROLES and RESPONSIBILITIES

The roles and responsibilities of the Austin ITS steering committee are to advise and make recommendations to the working committees and the Austin ITS study team for the planning and deployment of ITS user services.

Rules:

The Texas Legislature enacted Senate Bill 383 in 1993. This legislation requires a state agency that is advised by an advisory committee to adopt rules that state the purpose of the committee, describe its task, and the manner in which it reports to the agency. The Texas Transportation Commission identified ITS steering committees as meeting the criteria of this legislation through Minute Order 103067 on December 22, 1993. The rules established through this minute order areminimum.

- No more than 24 members
- Private sector must be represented
- Must meet once a calendar year
- Must have a quorum to vote
- Must elect a chair and vice chair by a majority vote

The Austin ITS steering committee is free to adopt rules that are not in conflict with those established by the minute order.

Officers:

The Vice Chair will be responsible for the day-to-day administrative duties.

- Call the meeting
- Create the minutes
- Provide copies to members

The Chair will bring issues and make recommendations for the Austin ITS steering committee to consider. The Chair will also be responsible for the creation of the working committees and the communication between those working committees.

TEXAS TRANSPORTATION COMMISSION

Various County MINUTE ORDER

District Various

WHEREAS, the Texas Transportation Commission (the "Commission") is empowered by Texas Civil Statutes, Article 6666, to promulgate rules for the conduct of the work of the Texas Department of Transportation the 'Department"); and

WHEREAS, the Commission has previously adopted rules relating to Advisory Committees, codified under Title 43, Texas Administrative Code, Chapter 1, Sections l-80-1.84; and

WHEREAS, Senate Bill 383, 73rd Legislature, 1993, requires the Department to adopt rules that: (1) state the purpose of each of its advisory committees and describe each committee's task and the manner in which it will report to the agency; and (2) establish a date on which each committee will automatically be abolished unless continued in existence by affirmative vote of the Commission; and

WHEREAS, in order to comply with the mandates of Senate Bill 383, which became effective on September 1, 1993, to provide for flexibility in the process for statutory advisory committee review of Department rules, to clarify existing provisions, and to assure that critical roles of the advisory committees continue without interruption, thereby protecting the vital interests, safety and welfare of the taxpayers and the travelling public, the Commission, by Minute Order No. 102795, dated September 28, 1993, adopted on an emergency basis and simultaneously proposed for permanent adoption the repeal of existing Section 1.83, new Sections 1.83 and 1.85, and amendments to Sections 1.80, 1.81, 1.82, and 1.84, the provisions of which are explained in Exhibit "A" to this Order; and

WHEREAS, the emergency and proposed sections were published in the October 15, 1993, issue of the Texas Register (18 TexReg 7142); and a public hearing was held on October 25, 1993, pursuant to the Government Code, Chapter 2001, to receive data, comments, views, and/or testimony concerning the proposed sections, and no comments were received; and

WHEREAS, in keeping with the rulemaking process, the Commission has determined it necessary to adopt on a permanent basis the repeal of Section 1.83, new Sections 1.83 and 1.85, and the amendments to Sections 1.80, 1.81, 1.82, and 1.84; and

WHEREAS, the repeal, new and amended sections have been examined by legal counsel and found to be a valid exercise of the Commission's authority to adopt;

NOW, THEREFORE, IT IS ORDERED that the Commission hereby adopts on a permanent basis the repeal of existing Section 1.83, as shown in Exhibit "B" to this Order, new Sections 1.63 and 1.85, as shown in Exhibit "C" to this Order, and amendments to existing Sections 1.80, 1.81, 1.82, and 1.84, as shown in Exhibit Yl" to this Order; and the Executive Director is directed to take the necessary steps to implement the actions as ordered herein, pursuant to the requirements of the Government Code, Chapter 2001.

Submitted by: Examined and recommended by:

General Counsel Approved Director of Staff Services

Executive Director

Minute Number 103067

Date Passed Dec 22 93

OUTLINE

§1.80. PURPOSE (amended)

- amends the purpose of the undesignated head so that it also applies to advisory committees created by the department

§1.81. DEFINITIONS (amended)

- repeals redundant definitions of individual statutory advisory committees

- adds definitions of department advisory committee, district engineer, and statutory advisory committee

§1.82. STATUTORY ADVISORY COMMITTEE OPERATIONS AND PROCEDURES (amended)

(a) Applicability

- added to clarify that section only applies to statutory advisory committees

(b) Membership

- removes requirement that commission designate chair of Aviation and Bicycle Rules Committees

- provides for each committee to elect chair and vice-chair

(c) Meetings

- removes provisions concerning frequency meetings which was moved to later section

- lowers advance notice of meetings from 14 to 10 days

(d) Reimbursement (no change)

(e) Conflict of interest (no change)

(f) Administrative support (no change)

(g) Advisory committee recommendations (no change)

(h) Manner of Reporting

requires department to report advice of statutory advisory committee to commission and to invite committee chair to appear

§1.83. STATUTORY ADVISORY COMMITTEES (replaces existing §1.83)

(a) Bicycle Rules Advisory Committee

- created pursuant to V.T.C.S., Article 6673h
- advises commission on adoption of bicycle road use rules
- meets annually and as required to advise on rules
- to be abolished upon adoption of rules

(b) Environmental Advisory Committee

- created pursuant to V.T.C.S., Article 6673g
- advises commission on rules of department that may affect the environment
- meets not more than once each month
- to be abolished in 1997 unless continued

(c) Aviation Advisory Committee

- created pursuant to V.T.C.S., Article 46c-3
- advises commission on method for prioritizing projects and on capital improvement, aviation facilities development, and multi-year aviation facilities capital improvement programs
- meets annually and as requested by Director of Aviation
- to be abolished in 1997 unless continued

(d) Public Transportation Advisory Committee

- created pursuant to V.T.C.S., Article 666323
- advises commission on needs and problems of public transportation providers and comments on rules involving public transportation
- meets not more than once each month
- to be abolished in 1997 unless continued

§1.84. RULEMAKING (amended)

(a) Purpose (no change)

(b) Preliminary review (no substantive change)

(c) Final review (no substantive change)

(d) Comment (no change)

(e) Emergency rules

- authorizes department to submit emergency rules to commission without prior review by advisory committee

(f) Waiver

- authorizes committee to waive preliminary or final review of draft rules

(g) Deferral

- authorizes committee to defer review of rules until the public comment period

<u>1.85. DEPARTMENT ADVISORY COMMITTEES (new)</u>

(a) Creation

- creates the following committees and states their purpose, duties, and to whom they report

  (1) Quality Assurance/Quality Assurance Specification Development Committee

  (2) Specialist Certification Advisory Committee

  (3) Consulting Engineering Advisory Committee

  (4) Project advisory committees

  (5) Statewide Transportation Plan External Advisory Panel

  (6) Transit Operators' Advisory Committee

  (7) Transit Vehicle Specification Committee

  (8) Ad hoc transit advisory panels

  (9) Registration and Title Liaison Committee and Dealer System Advisory Board

  (10) County Tax Assessor-Collector Review Team

  (11) TxDOT - TNRCC - Tax Assessor-Collector Working Group

(12) Rulemaking advisory committees

(13) Hydraulics and Erosion Control Laboratory Industry Advisory Committee

(14) Traffic Records Council

(15) FHWA Electronic Data Sharing Task Force

(16) IVHS steering committees

(b) Operating procedures

(1) Membership

- limits committees to no more than 24 members
- requires, if applicable to purpose and duties of committee, balanced representation between consumers and industry

(2) Meetings

- requires committees to meet at least annually
- requires a majority vote of membership for formal committee action

(3) Officers

- requires each committee to elect a chair and vice-chair by majority vote of the members of the committee

(c) Duration

- except otherwise specified in subsection (a), abolishes committees September 1, 1995 unless continued in existence

§1.83. Advisory Committee Responsibilities.

(a) Advisory committees created by the commission. The responsibilities of advisory committees that are created by the commission will be prescribed by order of the commission.

(b) Public Transportation Advisory Committee. The responsibilities of the Public Transportation Advisory Committee will include:

(1) advising the commission on the needs and problems of the state's public transportation providers, including recommending methods for allocating state public transportation funds if the allocation methodology is not specified by statute;

(2) commenting on proposed rules or rule changes involving public transportation matters during their development and prior to their final adoption unless an emergency requires immediate action by the commission; and

(3) performing other duties as determined by order of the commission.

(c) Bicycle Rules Advisory Committee. The responsibilities of the Bicycle Rules Advisory Committee will include:

(1) advising the commission on the adoption of rules regarding bicycle road use on the state highway system; and

(2) performing other duties as determined by order of the commission.

(d) Environmental Advisory Committee. The responsibilities of the Environmental Advisory Committee will include:

(1) advising the commission on rules of the department that may affect the environment; and

(2) performing other duties as determined by order of the commission.

(e) Aviation Advisory Committee. The responsibilities of the Aviation Advisory Committee will include:

(1) periodically reviewing the adopted capital improvement program;

(2) advising the commission on the preparation and adoption of an aviation facilities development program;

(3) advising the commission on the establishment and maintenance of a method for determining priorities among locations and projects to receive state financial assistance for aviation facility development;

(4) advising the commission on the preparation and update of a multi-year aviation facilities capital improvement program; and

(5) performing other duties as determined by order of the commission.

§1.83. Statutory Advisory Committees

(a) Bicycle Rules Advisory Committee.

(1) Purpose. Created pursuant to Texas Civil Statutes, Article 6673h, the Bicycle Rules Advisory Committee seeks to provide the commission with insight from the perspective of bicyclists. The primary mission of the committee is to advise the commission on the development of rules for bicyclists use of the state highway system. By involving representatives of the public and of bicyclists, the department helps ensure effective communication with the bicycle community, and that the bicyclist's perspective will be fully considered in the development of bicycles road use rules,

(2) Duties. The committee shall:

(A) advise the commission on the adoption of rules regarding bicycle road use on the state highway system; and

(B) perform other duties as determined by order of the commission.

(3) Meetings, The committee shall meet annually and as required by §1.84 of this title (relating to Rulemaking).

(4) Duration. The committee shall be abolished upon final adoption of bicycle road use rules by the commission.

(b) Environmental Advisory Committee.

(1) Purpose. Created pursuant to Texas Civil Statutes, Article 6673g, the Environmental Advisory Committee provides a forum for the exchange of information between the department, the

commission and committee members representing the general public and the environmental community. Advice and recommendations expressed by the committee provide the department and the commission with greater insight with regard to environmental issues; thus, facilitating the department's and the commission's goal of ensuring that environmental considerations are fully integrated into department and commission rules and policies.

(2) Duties. The committee shall:

(A) advise the commission on rules of the department that may affect the environment;

(B) become informed and knowledgeable of the department's environmental activities, and the environmental policies, and rules which govern the department's operations;

(C) communicate to the department any views or recommendations of the committee regarding the department's environmental policies, rules, and procedures;

(D) communicate the roles, mission, and environmental policies of the department in order to promote a better understanding of the department throughout the general public and environmental community; and

(E) perform other duties as determined by order of the commission.

(3) Meetings. The committee shall meet:

(A) as necessary, at the call of its chair, but not exceeding once each month;

(B) at the request by the commission; and

(C) as required by §1.84 of this title (relating to Rulemaking).

(4) Duration. The committee is abolished September 1, 1997, unless continued in existence by affirmative vote of the commission.

(c) Aviation Advisory Committee.

(1) Purpose. Created pursuant to Texas Civil Statutes, Article 46c-3, the Aviation Advisory Committee provides a direct link for general aviation users' input into the Texas Airport System. The committee provides a forum for exchange of information concerning the users' view of the needs and requirements for the economic development of the aviation system. The members of the committee are an avenue for interested parties to utilize to voice their concerns and have that data conveyed for action for system improvement. Additionally, committee members are representatives of the department and its Aviation Division, able to furnish data on resources available to the Texas aviation users.

(2) Duties. The committee shall:

(A) periodically review the adopted capital improvement program;

(B) advise the commission on the preparation and adoption of an aviation facilities development program;

(C) advise the commission on the establishment and maintenance of a method for determining priorities among locations and projects to receive state financial assistance for aviation facility development;

(D) advise the commission on the preparation and update of a multi-year aviation facilities capital improvement program; and

(E) perform other duties as determined by order of the commission.

(3) Meetings. The committee shall meet once a calendar year and such other times as requested by the Aviation Division Director.

(4) Duration. The committee is abolished September 1, 1997, unless continued in existence by affirmative vote of the commission,

(d) Public Transportation Advisory Committee.

(1) Purpose. Created pursuant to Texas Civil Statutes, Article 6663b, the Public Transportation Advisory Committee provides a forum for the exchange of information between the department, the commission, and committee members representing the transit industry and the general public. Advice and recommendations expressed by the committee provide the department and the commission with a broader perspective regarding public transportation matters that will be considered in formulating department policies.

(2) Duties. The committee shall:

(A) advise the commission on the needs and problems of the state's public transportation providers, including recommending methods for allocating state public transportation funds if the allocation methodology is not specified by statute;

(B) comment on proposed rules or rule changes involving public transportation matters during their development and prior to final adoption unless an emergency requires immediate action by the commission; and

(C) perform other duties as determined by order of the commission.

(3) Meetings. The committee shall meet:

(A) as necessary, at the call of its chair, but not exceeding once each month;

(B) at the request of the commission; and

(C) as required by §1.84 of this title (relating to Rulemaking).

(4) Duration. The committee is abolished September 1, 1997, unless continued in existence by affirmative vote of the commission.

§1.85. Department Advisory Committees.

(a) Creation. The following committees are established as department advisory committees.

(1) Quality Control/Quality Assurance Specification Development Committee.

(A) Purpose. The Quality Control/Quality Assurance Specification Development Committee is created for the purpose of developing a quality control/quality assurance specification for hot-mix asphaltic concrete pavement. Through a formalized review process, the committee provides a forum for the exchange of information through a committee composed of the department engineering staff, highway industry material suppliers, and contractor representatives. Advice and recommendations expressed by the committee provide the department and the commission with increased insight in material and construction methods for quality control and quality assurance; thus, aiding the department and the commission's goals of ensuring industry input into design standards and practices.

(B) Duties. The committee shall advise the department and the commission concerning the development of a quality control/quality assurance hot-mix asphaltic concrete pavement specification.

(C) Manner of reporting. The committee shall report its advice and recommendations to the Pavement Engineer of the Design Division.

(D) Duration. Upon completion of the quality control/quality assurance hot-mix asphaltic concrete specification, the committee is abolished.

(2) Specialist Certification Advisory Committee.

(A) Purpose. The purpose of the Specialist

Certification Advisory Committee is to review the Specialist Certification Program and to maintain a forum for the exchange of information between the department and the paving industry. Advice and recommendations expressed by the committee provide the department and the commission greater insight into pavement technology, testing, and specialist training; thus, facilitating the department's and the commission's goals of ensuring safe, efficient, and economical pavement design, construction, and maintenance practices for increased pavement life and performance.

(B) Duties. The committee shall provide advice and recommendations concerning:

(i) modifications and improvements to the training program curriculum and operations;

(ii) decertification claims;

(iii) recertification refresher courses; and

(iv) other matters as required to successfully implement and continue the Specialist Certification Program.

(C) Manner of reporting. The committee shall report its advice and recommendations to the Assistant Executive Director for Field Operations.

(3) Consultant Engineering Advisory Committee.

(A) Purpose. The purpose of the Consultant Engineering Advisory Committee is to coordinate and facilitate the use of the consultant engineering community in department operations.

(B) Duties. The committee shall review, discuss, and recommend items of mutual concern between the department and the consultant engineering community.

(C) Manner of Reporting. The committee shall report its advice and recommendations to the Deputy Executive Director for Transportation Planning and Development.

(4) Project advisory committees.

(A) Purpose. The executive director may authorize a district engineer to create, by written order, an ad hoc project advisory committee composed of the following members as may be deemed appropriate by the district engineer: department staff; affected property owners and business establishments; technical experts; professional consultants representing the department; and representatives of local governmental entities, the general public, chambers of commerce, and the environmental community. A project advisory committee shall serve the purpose of facilitating, evaluating, and achieving support and consensus from the affected community and governmental entities in the initial stages of a highway improvement project. Advice and recommendations of a committee provide the department with an enhanced understanding of public, business, and private concerns about a project from the development phase through the implementation phase; thus, facilitating the department's communications and traffic management objectives, resulting in a greater cooperation between the department and all affected parties during project development and construction.

(B) Duties. A project advisory committee shall:

(i) maintain community and local government communication; and

(ii) respond in a timely fashion to affected parties' concerns about project development and construction.

(C) Manner of reporting. A project advisory committee shall report its advice and recommendations to the district engineer.

(D) Duration. A project advisory committee may be abolished at any stage of project development, but in no event may a committee continue beyond completion of the project.

(5) Statewide Transportation Plan External Advisory Panel.

(A) Purpose, Texas Civil Statutes, Article 6663(f) and 23 U.S.C. Section 135 require the department to develop a statewide multimodal transportation plan that encompasses all modes of transportation. The panel, appointed by the Deputy Executive Director for Transportation Planning and Development and composed of representatives of other governmental agencies concerned with transportation and private transportation providers, thereby ensuring multimodal input as required by federal law, is created to advise the department on its statewide transportation plan. The panel provides a forum for identifying issues to be addressed by the planning process and provides input into the department's planning process. The panel members represent a constituency of interests and in this way broadens input into the process.

(B) Duties. The panel shall:

(i) review and comment on white papers prepared as part of developing recommended goals for Texas' transportation system;

(ii) review and comment on the draft statewide transportation plan; and

(iii) provide logistical assistance such as furnishing data and existing planning materials.

(C) Manner of reporting. The panel shall report its advice and recommendations to the department's Multimodal Planning Team.

(6) Transit Operators' Advisory Committee.

(A) Purpose. Through an open communication process the Transit Operators' Advisory Committee provides a forum for the exchange of information between transit operators and the Public Transportation Division.

(B) Duties. The committee shall:

(i) provide input to the Public Transportation Division on procedures that are developed for the routine management of grant programs;

(ii) provide input to the Public Transportation Division in the development of the Rural Transit Assistance Program as recommended in the Federal Transit Administration's

Circular 9040.1C, which stipulates that operators should be given maximum opportunity to participate in the development process; and

(iii) perform other duties as determined by the Public Transportation Division Director.

(C) Manner of reporting. The committee shall report its advice and recommendations to the Public Transportation Division Director.

(7) Transit Vehicle Specification Committee.

(A) Purpose. To provide a forum for the exchange of information with the Public Transportation Division on the availability of certain vehicles and vehicle components to be used in the field of public transportation in Texas and more specifically the Federal Transit Act, Sections 16 and 18 programs.

(B) Duties. The committee shall periodically review and recommend updates of vehicles' specifications used in the Federal Transit Act, Section 16 and 18 grant programs.

(C) Manner of reporting. The committee shall report its advice and recommendations to the Public Transportation Division Director.

(8) Ad hoc transit advisory panels.

(A) Purpose. In order to provide for effective and timely input from affected public transportation providers and riders, the commission, by minute order, may create an ad hoc transit advisory panel.

(B) Duties. An ad hoc advisory panel shall advise the Public Transportation Division on a single issue or program that only affects a specific segment of the public transportation industry or of the public. An example of an ad hoc panel would be a committee created to advise the division on the funding allocation rules for a particular grant program.

(C) Manner of reporting. An ad hoc advisory panel shall report its advice and recommendations to the Public Transportation Division Director.

(D) Duration. An ad hoc advisory panel shall be abolished no later that 90 days after its creation.

(9) Registration and Title System (RTS) Liaison Committee and Dealer System Advisory Board.

(A) Purpose. The Registration and Title System (RTS) Liaison Committee and Dealer System Advisory Board provide forums to aid in the implementation of the RTS. The purpose of the committee and board is to obtain feedback from the primary users of the system, and to seek solutions to potential impediments before the system is put in daily use.

(B) Duties. The committee and board shall:

(i) identify RTS user requirements;

(ii) convey system status information to the users and obtain the input of users; and

(iii) obtain system acceptance approval from the users.

(C) Manner of reporting. The committee and board shall report their advice and recommendations to the Vehicle Titles and Registration Division Director.

(10) County Tax Assessor-Collector Review Team.

(A) The County Tax Assessor-Collector Review Team provides a forum for the review of proposed motor vehicle title and registration related policies and procedures prior to implementation. The review team advises the department of the potential impact of such policies and procedures on the offices of Texas' County Tax Assessor-Collectors, who are the department's statutorily designated agents for motor vehicle title and registration matters. By establishing formal two-way communication, the review team provides an opportunity for partnering; thus, allowing for the smoothest possible operation of Texas' motor vehicle title and registration system.

(B) Duties. The team shall:

(i) advise the department of the potential impact of proposed policies and procedures; and

(ii) suggest changes or improvements to the department's title and registration operations.

(C) Manner of reporting. The team shall report its advice and recommendations to the Vehicle Titles and Registration Division Director.

(11) Texas Department of Transportation - Texas Natural

Resources Conservation Council - Tax Assessor-Collector Working Group.

(A) Purpose. The working group provides a forum for the implementation of the Federal Clean Air Act and House Bill 1969, 73rd Legislature, 1993, provisions concerning a motor vehicle inspection and maintenance program. By partnering in this effort, the three entities will make the implementation of the program as smooth as possible,

(B) Duties. The working group shall provide advice with respect to:

(i) strategies for the complete implementation of the program;

(ii) the design and modifications of necessary forms;

(iii) establishing methods for the collection of fees prescribed by House Bill 1969; and

(iv) public awareness programs.

(C) Manner of reporting. The working group shall report its advice and recommendations to the Vehicle Titles and Registration Division Director.

(12) Rulemaking advisory committees.

(A) Purpose. The commission, by order, may create ad hoc rulemaking advisory committees pursuant to the Government Code, Chapter 2001, Section 2001.031 for the purpose of receiving advice from experts, interested persons, or the general public with respect to contemplated rulemaking.

(B) Duties. A rulemaking advisory committee shall provide advice and recommendations with respect to a specific contemplated rulemaking.

(C) Manner of reporting. A rulemaking advisory committee shall report its advice and recommendations to the division responsible for the development of the rules.

(D) Duration. A rulemaking committee shall be abolished upon final adoption of rules by the commission.

(13) Hydraulics and Erosion Control Laboratory Industry Advisory Committee (IAC).

(A) Purpose. The IAC provides a forum through which affected industry groups and personnel may comment on and participate in the formal evaluation program for erosion control products undertaken by the Texas Department of Transportation/ Texas Transportation Institute Hydraulic and Erosion Control Laboratory. Through the IAC, the department is assured that open lines of communication with affected industries are maintained. In this way, the department assures product evaluation takes place with substantive industry comment and that any erosion control materials used by the department will be of the highest possible quality.

(B) Duties. The IAC shall provide advice and recommendations concerning the:

(i) results of the current product evaluation cycle; and

(ii) product evaluation procedures for the next available evaluation cycle.

(C) Manner of reporting. The IAC shall report its advice and recommendations to the Assistant Executive Director for Field Operations.

(14) Traffic Records Council (TRC).

(A) Purpose. The TRC coordinates and guides the planning and implementation of various Texas traffic records systems. The overall goal of the TRC is to share information regarding the various state data bases related to traffic records, establish a mutual understanding of the overall state goal of increasing the safety and efficiency of the roadway system, and to develop strategies for continued cooperation among all state and local participants with an interest in the traffic records process.

(B) Duties. The TRC shall:

(i) assist the department in the coordination and guidance of the planning and implementation of the various Texas traffic records systems to improve information quality and quantity;

(ii) provide recommendations concerning the implementation of a strategic plan for the improvement of the state's record systems;

(iii) help transfer related information on technology and systems through meetings and forums; and

(iv) provide recommendations to the various agencies on system enhancements and linkages.

(C) Manner of reporting. The TRC shall report its advice and recommendations to the various participating agencies, including the department and its Traffic Operations Division.

(15) Federal Highway Administration (FHWA) Electronic Data Sharing Task Force.

(A) Purpose. In cooperation with the Federal Highway Administration, the FHWA Electronic Data Sharing Task Force is created to address opportunities for information sharing. Information sharing is a crucial aspect of the Federal-aid Highway and Motor Carrier programs for both parties, and an increasing amount of information is now being exchanged electronically.

(B) Duties. The task force shall:

(i) identify opportunities for information sharing between the organization;

(ii) enhance electronic communication; and

(iii) streamline reporting processes.

(C) Manner of reporting. The task force shall report its advice and recommendations to the department's Information Resource Manager.

(16) Local IVHS steering committees.

(A) Purpose. Federal law encourages the expenditure of federal transportation funds to achieve improvements in the efficiency of transportation operations. A portion of these funds are specifically designated for the planning and testing of Intelligent Vehicle Highway Systems (IVHS) technologies. As part of the development and implementation of these projects, a district engineer, in conjunction with local officials, may create a steering committee to provide support for IVHS activities. Advice and recommendations expressed by a committee will foster the coordination of state and local benefit in the design, maintenance, and operation of IVHS facilities.

(B) Duties. A committee shall provide advice and recommendations with respect to:

(i) IVHS project priorities;

(ii) the approval of projects;

(iii) seeking project funding;

(iv) coordinating public and private ventures; and

(v) promoting IVHS at local, state, and national levels.

(C) Manner of reporting. A committee shall report its advice and recommendations to the local district engineer, or his or her designee.

(b) Operating procedures.

(1) Membership. An advisory committee shall be composed of not more than 24 members to be appointed by the office or official to whom the committee is to report. When applicable to the purpose and duties of the committee, the membership shall

provide a balanced representation between:

(A) industries or occupations regulated or directly affected by the department; and

(B) consumers of services provided either by the department or by industries or occupations regulated by the department.

(2) Meetings.

(A) An advisory committee shall meet once a calendar year and such other times as requested by the office to which it reports.

(B) A majority of the membership of an advisory committee constitutes a quorum, A committee may take formal action only by majority vote of its membership.

(3) Officers. Each committee shall elect a chair and vice-chair by majority vote of the members of the committee,

(c) Duration. Except as otherwise specified in this subsection, a committee created under this section is abolished September 1, 1995 unless continued in existence by affirmative vote of the commission.

Advisory Committees

§1.80. Scope and Purpose. The sections under this undesignated head prescribe the uniform procedures governing the operation of committees created to advise the Texas Transportation Commission or the Texas Department of Transportation.

§l.81. Definitions.

The following words and terms, when used in this undesignated head, shall have the following meanings, unless the context clearly indicates otherwise.

Commission - The Texas Transportation Commission.

Department - The Texas Department of Transportation

Department advisory committee - Any committee created by the department or the commission for the purpose of providing advice or recommendations in a purely advisory manner regarding certain matters within the jurisdiction of the department or the commission.

District engineer - The chief administrative officer in charge of a district of the department.

Executive director - The chief executive officer of the Texas Department of Transportation.

Statutory advisory committee - A committee expressly created by statute for the purpose of providing advice or recommendations in a purely advisory manner regarding certain matters within the jurisdiction of the commission.

§1.82. Statutory Advisory Committee Operations and Procedures.

(a) Applicability. This section applies to statutory advisory committees.

(b) Membership.

(1) Except as provided in paragraphs (2) and (3) of this subsection, the commission will:

(A) appoint advisory committee members for a two-year term, and will designate one member to serve as chair; and

(B) appoint members to serve the balance of any term upon the occurrence of a vacancy.

(2) Members of the Environmental and Public Transportation Advisory Committees shall be appointed and shall serve pursuant to Texas Civil Statutes, Article 6663b and Texas Civil Statutes, Article 6673g, respectively.

(3) Members of the Bicycle Rules Advisory Committee shall serve until the committee is abolished as provided by Texas Civil Statutes, Article 6673h.

(4) Each committee shall elect a chair and vice-chair by majority vote of the members of the committee.

(c) Meetings.

(1) Open meeting requirements. Advisory committees shall post and hold all meetings in accordance with the provisions applicable to meetings of the commission under the Texas Open Meetings Act, the Government Code, Chapter 551. Filing of notice of open meetings with the Secretary of State shall be coordinated

through the department's General Counsel.

(2) Regular meetings. The chair of the committee shall provide notice of time, date, place, and purpose of regular meetings to the members and the executive director, by mail or telephone or both, at least 10 calendar days in advance of each meeting.

(3) Quorum. A majority of the membership of an advisory committee constitutes a quorum. The committee may act only by majority vote of its membership.

(4) Attendance. A record of attendance at each meeting shall be made. If a member of a committee appointed by the commission misses two consecutive meetings, written notice shall be given to the member. A third consecutive absence from a regular meeting will be sufficient grounds for removal of that member by the commission.

(5) Parliamentary procedure. Parliamentary procedures for all committee meetings shall be in accordance with the latest edition of Roberts Rules of Order, 'except that the chair may vote on any action as any other member of the committee.

(6) Record. Minutes of all committee meetings shall be prepared and filed with the commission. The complete proceedings of all committee meetings must also be recorded by electronic means.

(7) Open records. All minutes, transcripts, and other records of the advisory committees are records of the commission

and as such are subject to disclosure under the provisions of the Government Code, Chapter 552.

(d) Reimbursement. Advisory committee members are not entitled to receive compensation for serving as members, but will be reimbursed for reasonable and necessary expenses for performing their duties. Current rules and laws governing reimbursement of expenses for state employees shall govern reimbursement for expenses of advisory committee members.

(e) Conflict of interest. Advisory committee members are subject to the same laws and policies governing ethical standards of conduct as those for commission members and employees of the department.

(f) Administrative support. For each advisory committee, the executive director will designate an office of the department that will be responsible for providing any necessary administrative support essential to the functions of the committee.

(g) Advisory committee recommendations. In developing department policies, the commission will consider the recommendations submitted by advisory committees.

(h) Manner of reporting.

(1) The office designated under subsection (f) of this section shall, in writing, report to the commission an official action of a statutory advisory committee, including any advice and recommendations, prior to commission action on the issue.

The chair of the advisory committee or his or her designee will also be invited by the department to appear before the commission prior to commission action on a posted agenda item to present the committee's advice and recommendations.

(2,) In the event a written report cannot be furnished to the commission prior to commission action, the report may be given orally, provided that a written report is furnished within 10 days of commission action.

§1.84. Rulemaking.

(a) Purpose. This section governs the role of a statutory advisory committee in the adoption of new or amended rules pursuant to the Administrative Procedure Act, the Government Code, Chapter 2001.

(b) Preliminary review. When the department determines that it is necessary or desirable for the commission to adopt new or amended rules, the department will:

(1) notify the relevant advisory committee, if any of the nature of the rulemaking, including the reasons for the rules and the general subjects to be covered: and

(2) request the chair of the committee to call a meeting of the relevant advisory committee for the purpose of providing advice and recommendations prior to completing the final draft of the proposed rules.

(c) Final Review. Upon completing a final draft of proposed rules that are subject to this section and prior to submitting the draft to the commission for proposed adoption, the department will request the chair to call a meeting of the relevant advisory committee to review and comment on the rules as drafted.

(d) Comment. Prior to commission adoption of rules that are subject to this section, the commission will provide the advisory committee and department staff an opportunity to appear before it for the purpose of advising the commission of its recommendations regarding the proposed rules.

(e) Emergency rules. If the department submits to the commission emergency rules under the Government Code, Chapter 2001, Section 2001.034, it is not required to comply with subsections (b) and (c) of this section. The members of the committee shall be so notified in writing within 10 days of commission action.

(f) Waiver. A committee may elect to waive preliminary or final review of rules presented under this section.

(g) Deferral. A committee may elect to defer review of rules under this section until the public comment period.

Appendix II-A

City of Garland
1992 Staffing Survey

STAFFING LEVEL SURVEY

FIGURE OF INTEREST	AVERAGE			
	POPULATION		AREA	
	100,000 OR LESS	OVER 100,000	50 SQ MILES OR LESS	OVER 50 SQ MILES
POPULATION	58,978	364,181	63,603	379,761
SQUARE MILES	30.5	188.0	28.2	194.4
OFFICE PERSONNEL	3.4	12.6	4.0	12.6
REGISTERED ENGINEERS	1.6	3.1	1.6	3.1
ENGINEERING ASST./DRAFTERS	0.9	6.1	1.1	6.0
OTHER	1.5	3.5	1.6	5.9
SIGNAL TECHNICIANS	4.3	17.7	4.3	16.8
SIGNS/MARKINGS TECHNICIANS	4.4	15.2	3.9	15.5
TOTAL SIGNALS	70.6	410.0	67.6	411.2
FIXED TIME SIGNALS	22.8	148.0	22.3	148.0
ACTUATED SIGNALS	47.8	262.0	45.3	263.2
COORDINATED SIGNALS	52.8	278.7	50.5	271.0
SCHOOL FLASHERS	35.3	120.7	37.5	119.8
SIGNALS PER TECHNICIAN	17.1	23.6	16.1	24.0
SIGNALS PER SQUARE MILE	2.5	2.0	2.5	2.0
SIGNALS PER 1000 POPULATION	1.1	1.0	1.0	1.0
SIGNALS PER OFFICE STAFF	23.3	30.6	20.9	29.9
SIGNALS & FLASHERS PER TECH	25.3	34.0	25.3	32.3
AVG TROUBLE CALLS/SIGNAL/MONTH	1.2	1.0	1.5	1.0
NUMBER OF CITIES SURVEYED	8	21	8	21

SOURCE: Survey of Various Texas Cities, Oklahoma City and New Orleans
Conducted by City of Garland, Department of Transportation, June 1992
For further information, contact Larry Cervenka,
City of Garland

STAFFING LEVEL SURVEY

FIGURE OF INTEREST	AVERAGE POPULATION 100,000 OR LESS	AVERAGE POPULATION 100,000-250,000	AVERAGE POPULATION OVER 250,000
POPULATION	58,978	135,988	651,212
SQUARE MILES	30.5	76.8	329.1
OFFICE PERSONNEL	3.4	6.1	19.8
REGISTERED ENGINEERS	1.6	1.4	5.2
ENGINEERING ASST./DRAFTERS	0.9	2.6	9.4
OTHER	1.5	2.0	5.2
SIGNAL TECHNICIANS	4.3	7.0	30.0
SIGNS/MARKINGS TECHNICIANS	4.4	7.4	24.5
TOTAL SIGNALS	70.6	134.0	711.0
FIXED TIME SIGNALS	22.8	54.7	253.8
ACTUATED SIGNALS	47.8	79.4	457.1
COORDINATED SIGNALS	52.8	64.4	493.5
SCHOOL FLASHERS	35.3	43.5	205.0
SIGNALS PER TECHNICIAN	17.1	22.6	24.3
SIGNALS PER SQUARE MILE	2.5	1.7	2.2
SIGNALS PER 1000 POPULATION	1.1	1.0	1.0
SIGNALS PER OFFICE STAFF	23.3	25.0	36.6
SIGNALS & FLASHERS PER TECH	25.3	29.9	34.1
AVG TROUBLE CALLS/SIGNAL/MONTH	1.2	1.0	1.0
NUMBER OF CITIES SURVEYED	8	11	10

SOURCE: Survey of Various Texas Cities, Oklahoma City and New Orleans
Conducted by City of Garland, Department of Transportation, June 1992
For further information, contact Larry Cervenka,
City of Garland

STAFFING LEVEL SURVEY

DATE: 06 / 4 / 92

CITY:	ABILENE	ARLINGTON	AUSTIN	CARROLTON	DALLAS **	FARMERS BRANCH **	FORT WORTH	GARLAND	GRAND PRARIE **	IRVING **	MESQUITE **	PLANO	AVERAGE
POPULATION:	106,000	260,000	465,222	81,000	1,000,000	26,000	450,000	153,270	102,677	165,000	104,000	134,000	292,545
SQUARE MILES:	110	96	225	35	377	12.5	293	57	80	68	42	70	161.10
OFFICE PERSONNEL:	2.5	15	34	7	17	2	12	9	4	8	3	7	10.26
REGISTERED ENGINEERS:	1	6	5	4	13	2	5	2	1	2	1	2	2.69
ENGINEERING ASST/DRAFTSMEN:	1	6	18	1	0	0	6	3	2	3	1	4	4.82
OTHER:	0.5	3	11	3	4	0	1	4	1	3	1	1	2.95
SIGNAL TECHNICIANS:	4	19	19	6	56	2	27	6	6	9	3	6	14.00
SIGN/MARKING TECHS:	8	15	15	8	24	N/A	23	7	7	8	4	11	12.45
SIGNALS:	150	225	562	62	1132	47	565	126	90	145	45	90	316.45
													0.00
FIXED TIME:	109	0	338	0	388	5	30	56	9	14	6	3	113.46
ACTUATED:	41	225	224	62	744	42	535	68	61	131	39	87	203.00
													0.00
SCHOOL FLASHERS:	25	70	349	56	800	36	50	54	70	34	28	82	97.10
COORDINATED:	94	179	444	38	926	26	245	69	10	54	9	80	210.79
# SIGNAL SYSTEMS:	8	2	0	7	71	3	2	13	1	6	2	14	13.24
SIGNALS/TECHNICIAN:	37.50	11.84	29.58	7.75	20.21	23.50	20.93	25.20	15.00	16.11	15.00	11.25	21.63
SIGNALS/SQ MILES:	1.36	2.30	2.50	1.77	3.00	3.78	1.93	2.21	1.13	2.13	1.07	1.29	2.12
SIGNALS/1000 POPULATION:	1.42	0.87	1.21	0.77	1.13	1.88	1.26	9.59	0.68	0.68	0.43	0.67	1.06
SIGNALS/OFFICE STAFF:	60.00	15.00	18.53	8.86	68.59	23.50	47.06	14.00	22.50	18.13	15.00	12.66	26.79
SIGNALS, FLASHERS/TECHS:	43.75	15.53	47.95	14.75	34.50	41.50	22.78	36.00	26.67	19.89	24.33	21.50	30.26
AVG. TROUBLE CALLS/SIG:	2.06	0.48	0.62	2	1.43	2.7	N/A	1	1.6	N/A	2.3	0.33	1.06

*** PLANNING & OPERATIONS**
****FROM PREVIOUS SURVEY**
SURVEY.WK1

STAFFING LEVEL SURVEY

DATE: 06 / 4 / 92

CITY:	BEAUMONT	DENTON	NEW ORLEANS	LUBBOCK **	ODESSA	CORPUS CHRISTI	AMARILLO	HURST	RICHARDSON	HOUSTON	WACO **	TYLER **	AVERAGE
POPULATION:	113,000	67,000	500,000	194,148	89,699	286,000	160,772	32,000	75,500	1,630,000	107,000	78,000	292,645
SQUARE MILES:	79	61	368	104	35.03	124	87	9.1	28	561	90.68	44	161.10
OFFICE PERSONNEL:	8	2	9	9	3	9	9	1	8	41	6	4	10.26
REGISTERED ENGINEERS:	1	1	1	1	0	2	1	1	3	9	0	1	2.89
ENGINEERING ASST/DRAFTSMEN:	1	0	8	7	0	5	6	0	3	18	4	1	4.82
OTHER:	6	1	0	1	3	2	2	0	2	14	1	2	2.95
SIGNAL TECHNICIANS:	12	3	10	6	5	12	5	2	6	61	6	5	14.00
SIGN/MARKING TECHS:	9	3	18	5	7	15	14	2	8	55	6	6	12.45
SIGNALS:	168	69	433	164	169	305	234	26	84	2000	162	106	316.45
													0.00
FIXED TIME:	96	10	251	5	83	80	89	0	1	1000	85	81	113.46
ACTUATED:	72	59	182	161	86	225	145	26	63	1000	77	25	203.00
													0.00
SCHOOL FLASHERS:	51	10	368	50	24	151	16	9	57	0	23	85	97.10
COORDINATED:	57	27	400	N/A	162	134	154	14	80	1600	123	73	210.79
# SIGNAL SYSTEMS:	1	2	30	1	3	18	6	2	1	140	19	9	13.24
SIGNALS/TECHNICIAN:	14.00	23.00	43.30	20.50	33.80	25.42	48.8	13.00	14.00	32.79	20.25	21.20	21.83
SIGNALS/SQ MILES:	2.13	1.13	1.18	1.58	4.82	2.46	2.69	2.86	3.00	3.44	1.79	2.41	2.12
SIGNALS/1000 POPULATION:	1.49	1.03	0.87	0.84	1.88	1.07	1.48	0.81	1.11	1.23	1.51	1.36	1.06
SIGNALS/OFFICE STAFF:	21.00	N/A	N/A	18.22	56.33	33.89	26.00	26.00	10.50	48.78	27.00	26.50	26.79
SIGNALS, FLASHERS/TECHS:	18.25	26.33	80.10	26.75	38.60	38.00	50.00	17.50	23.50	32.79	23.13	38.20	30.28
AVG. TROUBLE CALLS/SIG:	1.2	0.3	2.9	0.5	0.8	0.63	0.6	0.5	1.06	0.6	0.8	1.04	1.06

*** PLANNING & OPERATIONS**
****FROM PREVIOUS SURVEY**
SURVEY.WK1

STAFFING LEVEL SURVEY

DATE: 06 / 4 / 92

	PASADENA **	OK CITY **	ORANGE **	SAN ANTONIO	EL PASO	AVERAGE:
POPULATION:	130,000	450,000	23,628	955,400	515,500	292,545
SQUARE MILES:	58.59	635	20	344	248	151.10
OFFICE PERSONNEL:	3	17	4	26	18	10.26
REGISTERED ENGINEERS:	1	2	1	5	4	2.69
ENGINEERING ASSISTANTS/DRAFTERS:	1	6	2	16	9	4.62
OTHER:	1	9	1	3	6	2.95
SIGNAL TECHNICIANS:	4	23	3	44	29	14.00
SIGNS/MARKINGS TECHNICIANS:	2	25	1	35	20	12.45
SIGNALS:	126	500	2	940	448	316.45
FIXED TIME:	97	10	2	397	44	113.46
ACTUATED:	31	490	0	542	404	202.55
						0.00
SCHOOL FLASHERS:	40	207	5	1	56	97.10
COORDINATED:	106	168	0	549	292	210.79
# SIGNAL SYSTEMS:	2	4	0	N/A	13	13.24
SIGNALS/TECHNICIAN:	32.00	21.74	0.67	21.36	15.45	21.83
SIGNALS/SQ. MILES:	2.18	0.79	0.10	2.73	1.81	2.12
SIGNALS/1000 POPULATION:	0.96	1.11	0.06	0.96	0.87	1.06
SIGNALS/OFFICE STAFF:	42.67	29.41	0.50	26.15	24.89	25.79
SIGNALS/FLASHERS/TECHS:	42.00	30.74	2.33	21.39	17.34	30.29
AVG. TROUBLE CALLS/SIG.	0.6	0.53	1.5	1.92	1.16	1.08

STAFFING LEVEL SURVEY
(UNDER 100,000 POPULATION)

DATE: 07 / 17 / 92

CITY:	ODESSA	CARROLTON	HURST	FARMERS BRANCH **	RICHARDSON	DENTON	TYLER **	ORANGE **	AVERAGE
POPULATION:	89,699	81,000	32,000	26,000	75,500	67,000	78,000	23,628	58,978
SQUARE MILES:	35.03	35	9.1	12.5	28	61	44	20	30.56
OFFICE PERSONNEL:	3	7	1	2	8	2	4	4	3.66
REGISTERED ENGINEERS:	0	4	1	2	3	1	1	1	1.63
ENGINEERING ASSISTANTS/DRAFTSMEN:	0	1	0	0	3	0	1	2	0.86
OTHER:	3	3	0	0	2	1	2	1	1.50
SIGNAL TECHNICIANS:	5	6	2	2	6	3	5	3	4.25
SIGN/MARKING TECHS:	7	8	2	N/A	8	3	6	1	4.38
SIGNALS:	169	62	26	47	84	69	106	2	70.63
FIXED TIME:	83	0	0	5	1	10	81	2	22.75
ACTUATED:	86	62	26	42	63	59	25	0	47.86
SCHOOL FLASHERS:	24	56	9	36	57	10	85	5	35.25
COORDINATED:	162	38	14	26	80	27	73	0	52.75
# SIGNAL SYSTEMS:	3	7	2	3	1	2	9	0	3.25
SIGNALS/TECHNICIAN:	33.80	7.75	13.00	23.50	14.00	23.00	21.20	0.67	17.11
SIGNALS/SQ MILES:	4.82	1.77	2.86	3.78	3.00	1.13	2.41	0.10	2.48
SIGNALS/1000 POPULATION:	1.88	0.77	0.81	1.88	1.11	1.03	1.36	0.06	1.12
SIGNALS/OFFICE STAFF:	56.33	8.86	26.00	23.50	10.50	N/A	26.50	0.50	23.34
SIGNALS, FLASHERS/TECHS:	38.60	14.75	17.50	41.50	23.50	26.33	38.20	2.33	25.34
AVG. TROUBLE CALLS/SIG:	11	N/A	0.5	2.7	2.5	2.3	1.04	1.5	2.69

*** PLANNING & OPERATIONS**
****FROM PREVIOUS SURVEY**
SURVEY.WK1

STAFFING LEVEL SURVEY
(100,000 TO 250,000 POPULATION)

DATE: 07 / 17 / 92

CITY:	ABILENE	LUBBOCK **	GARLAND	GRAND PRARIE **	IRVING **	MESQUITE **	PLANO	WACO **	PASADENA	BEAUMONT	AMARILLO	AVERAGE
POPULATION:	106,000	194,148	153,270	102,677	165,000	104,000	130,000	107,000	130,000	113,000	160,772	135,986
SQUARE MILES:	110	104	57	80	68	42	70	90.68	58.59	79	87	78.77
OFFICE PERSONNEL:	2.5	9	9	4	8	3	7	6	3	8	9	8.14
REGISTERED ENGINEERS:	1	1	2	1	2	1	2	0	1	1	1	1.36
ENGINEERING ASSISTANTS/DRAFTSMEN:	1	7	3	2	3	1	4	4	1	1	6	2.64
OTHER:	0.5	1	4	1	3	1	1	1	1	6	2	1.95
SIGNAL TECHNICIANS:	4	6	6	6	9	3	6	6	4	12	5	7.00
SIGN/MARKING TECHS:	8	5	7	7	8	4	11	6	2	9	14	7.36
SIGNALS:	150	164	126	90	145	45	90	162	128	168	234	134.09
FIXED TIME:	109	5	56	9	14	6	3	85	97	96	89	54.73
ACTUATED:	41	161	68	61	131	39	87	77	31	72	145	796.36
SCHOOL FLASHERS:	25	50	54	70	34	28	82	23	40	51	16	43.45
COORDINATED:	94	N/A	69	10	54	9	80	123	106	57	154	64.45
# SIGNAL SYSTEMS:	8	1	13	1	6	2	14	19	2	1	6	5.82
SIGNALS/TECHNICIAN:	37.50	20.50	25.20	15.00	16.11	15.00	11.25	20.25	32.00	14.00	48.8	22.79
SIGNALS/SQ MILES:	1.36	1.58	2.21	1.13	2.13	1.07	1.29	1.79	2.18	2.13	2.69	1.74
SIGNALS/1000 POPULATION:	1.42	0.84	9.59	0.68	0.68	0.43	0.67	1.51	0.98	1.49	1.48	1.01
SIGNALS/OFFICE STAFF:	60.00	18.22	14.00	22.50	18.13	15.00	12.66	27.00	42.67	21.00	26.00	25.06
SIGNALS, FLASHERS/TECHS:	43.75	26.75	36.00	26.67	19.89	24.33	21.50	23.13	42.00	18.25	50.00	29.90
AVG. TROUBLE CALLS/SIG:	2.06	0.5	1	1.6	N/A	2.3	0.6	0.8	0.6	1.2	0.6	1.02

****FROM PREVIOUS SURVEY**
SURVEY.WK1

STAFFING LEVEL SURVEY
(OVER 250,000 POPULATION)

DATE: 07 / 17 / 92

CITY:	ARLINGTON	AUSTIN	NEW ORLEANS	DALLAS **	CORPUS CHRISTI	FORT WORTH	HOUSTON	OK CITY **	SAN ANTONIO	EL PASO	AVERAGE
POPULATION:	260,000	465,222	500,000	1,000,000	286,000	450,000	1,630,000	450,000	955,400	515,500	651,212
SQUARE MILES:	96	225	368	377	124	293	561	636	344	248	329.10
OFFICE PERSONNEL:	15	34	9	17	9	12	41	17	26	18	19.80
REGISTERED ENGINEERS:	6	5	1	13	2	5	9	2	5	4	5.20
ENGINEERING ASSISTANTS/DRAFTSMEN:	6	18	8	0	5	6	18	6	18	9	9.40
OTHER:	3	11	0	4	2	1	14	9	3	5	5.20
SIGNAL TECHNICIANS:	19	19	10	56	12	27	61	23	44	29	30.00
SIGN/MARKING TECHS:	15	15	18	24	15	23	55	25	35	20	24.50
SIGNALS:	225	562	433	1132	305	565	2000	500	940	448	711.00
FIXED TIME:	0	338	251	388	80	30	1000	10	397	44	253.80
ACTUATED:	225	224	182	744	225	535	1000	490	542	404	457.10
SCHOOL FLASHERS:	70	349	368	800	151	50	0	207	1	55	205.10
COORDINATED:	179	444	400	926	134	245	1600	166	549	292	493.50
# SIGNAL SYSTEMS:	2	0	30	71	18	2	140	4	N/A	13	26.00
SIGNALS/TECHNICIAN:	11.84	29.58	43.30	20.21	25.42	20.93	32.79	21.74	21.36	15.45	24.26
SIGNALS/SQ MILES:	2.30	2.50	1.18	3.00	2.46	1.93	3.44	0.79	2.73	1.61	2.21
SIGNALS/1000 POPULATION:	0.87	1.21	0.87	1.13	1.07	1.26	1.23	1.11	0.96	0.87	1.06
SIGNALS/OFFICE STAFF:	15.00	18.53	N/A	68.59	33.89	47.06	48.78	29.41	36.15	24.89	36.64
SIGNALS, FLASHERS/TECHS:	15.53	47.95	80.10	34.50	38.00	22.78	32.79	30.74	21.39	17.34	34.11
AVG. TROUBLE CALLS/SIG:	0.5	0.62	2.9	1.43	N/A	1.03	0.63	0.53	1.92	1.16	1.07

****FROM PREVIOUS SURVEY**
SURVEY.WK1

TRANSPORTATION DEPARTMENT
STAFFING LEVEL COMPARISON (92)

CITIES	ARLINGTON (817) 275-3271	CARROLLTON 466-3050	DALLAS 670-3715	*FT WORTH (817) 870-8055	GARLAND 205-2439	*GRAND PRAIRIE 660-8132	*IRVING 721-2646	*MESQUITE 216-6215	PLANO 424-6531	RICHARDSON 238-4243
Population	260,000	87,000	1,000,000	450,000	183,270	102,677	165,000	104,000	149,188	75,500
Square Miles	98	35	377	293	57	80	68	42	70	28
Miles of Street	N/A	310	3427	2103	639	415	679	377	709	308
- Lane Miles	2238	774	9744	5443	1548	750	1,662.5	N/A	N/A	871
Item:										
Total Staff	42+	19	118+++	62+	23	17	25	9	26	22
- Office Staff	11	7	48+++	12	10	4	8	3	7	8
- Signal Tech.	17+, ++	5++,**	47	27++	5	6	9	3	8	6
- Signs Markings	14	7	23	23	8	7	8	3	11	8
Total Signals:	233	70	1171	565	127	90	145	45	96	86
- Fixed Time	0	0	388	30	58	9	14	6	3	1
- Actuated	233	70	783	535	69	81	131	39	93	85
- Coordinated	188	39	965	245	69	10	54	9	86	84
- School (Flashing Beacons) Signals	70	75	800	50	64	70	34	28	82	57
# Signs	29,286	N/A	N/A	N/A	33,310 (est)	N/A	N/A	N/A	N/A	11,019

TRANSPORTATION DEPARTMENT
STAFFING LEVEL COMPARISON (SUMMARY)

CITIES	ARLINGTON 275-3271	CARROLLTON 466-3050	DALLAS 670-3715	*FT WORTH (817) 870-8055	GARLAND 205-2439	*GRAND PRAIRIE 660-8132	*IRVING 721-2646	*MESQUITE 216-6215	PLANO 424-6531	RICHARDSON 238-4243
Sq. Miles/Employee	2.3	1.84	3.2	4.7	2.47	4.7	2.7	4.7	2.7	1.3
1000 Population Per Employee	6.2	4.6	8.49	7.2	7.9	6.0	6.6	11.5	5.7	3.4
Miles of Street Per Employee	N/A	16.3	29.0	33.9	27.78	24.4	27.2	41.8	27.3	14.0
Signals Per Signal Technician	13.72+, ++	14++	24.92	20.93++	25.4	15.00	16.11	15.00	12	14.33
Signals/Flashers Per Signal Tech	17.82	29	41.94	22.78	38.2	26.67	19.89	24.33	22.25	23.83
Avg. Trouble Calls/Sig./Mo	0.48	2	1.33	N/A	1	1.6	N/A	2.3	0.33	1.08
Miles of Street Sign/Mark Tech	N/A	44.2	149.0	91.4	79.8	59.2	84.9	125.7	64.5	38.5
Lane Miles Per Signs/Mark Tech	160	111	424	237	194	107	208	125	N/A	109
# Signs Per Sign/Mark Tech	2092	N/A	N/A	N/A	4164	N/A	N/A	N/A	N/A	1377

• From Previous Survey
+ Also Responsible for Street Lighting
++ Responsible for Signal Construction
+++ Not Including Airport or Parking Regulation Functions
** Responsible for Freeway Median Lights
+++ Not Including Airport or Parking Regulation Personnel
** Maintains Highway Median Lighting

TRANSPORTATION DEPARTMENT
ADJUSTED STAFFING LEVEL COMPARISON

CITIES	ARLINGTON	CARROLLTON	DALLAS	*FT WORTH	GARLAND Actual	*GRAND PRAIRIE	*IRVING	*MESQUITE	PLANO	RICHARDSON
1000 Population Per Employee	30	40	22	25	23	31	28	16	32	54
Miles of Street Per Employee	* N/A	39	22	19	23	26	23	15	23	46
Signals Per Signal Technician	9+, ++	9	5	6	5	8	8	8	11	9
Signals/Flashers Per Signal Tech	11	7	5	8	5	7	10	8	9	8
Miles of Street Sign/Mark Tech	* N/A	14	4	7	8	11	8	5	10	17
Lane Miles Per Signs/Mark Tech	10	14	4	7	8	14	7	N/A	N/A	14
# Signs Per Sign/Mark Tech	16	N/A	N/A	N/A	8	N/A	N/A	N/A	N/A	24

• From Previous Survey
+ Also Responsible for Street Lighting
++ Also Responsible for Signal Construction

This table shows the number of employees that would be required for the City of Garland to match the given ration in the comparison cities. For example, for Garland to match the per 1000 population to employee ratio in Arlington, 30 employees would be required.

TRAFFIC SIGNAL MAINTENANCE SURVEY

DATE: 06 / 4 / 92

CITY:	ABILENE	AMARILLO	ARLINGTON	AUSTIN	CARROLTON	CORPUS CHRISTI	EL PASO	AVERAGE
POPULATION:	106,000	160,000	262,000	465,222	61,100	260,000	515,500	352,549
SQUARE MILES:	110	67	96	225	35	246	248	155.17
SIGNAL TECHNICIANS:	4	5	19	19	5	12	29	20.86
SIGNAL TECHNICIANS IN I.M.S.A.:	0	3	17	4	6	1	0	3.57
TRAFFIC SIGNALS (TOTAL):	150	234	225	562	67	305	448	367.29
FIXED TIME:	109	89	0	338	0	80	44	163.07
ACTUATED:	41	145	225	224	67	225	404	233.36
COORDINATED:	94	158	179	444	38	134	292	278.21
# SIGNAL SYSTEMS/MASTERS:	6	8	2	N/A	7	18	13	16.36
AFTER HOURS CALL OUTS:	489	N/A	400	986	N/A	762	641	301.21
SIGNAL TIMING REVISIONS:	16	N/A	20	N/A	N/A	48	203	75.29
SCHEDULED MAINTENANCE CALLS:	1690	N/A	250	120	N/A	295	50	444.36
EMERGENCY MAINTENANCE CALLS:	2233	N/A	157	N/A	N/A	3962	939	846.43
SIGNAL TROUBLE CALLS/MONTH/SIGNAL:	2.06	N/A	N/A	0.62	2	0.63	1.16	0.61
SCHOOL FLASHERS:	25	16	70	349	58	151	55	69.71
SCHOOL FLASHER MAINT. CALLS:	40	20	53	N/A	N/A	51	217	36.50

TRAFFIC SIGNAL MAINTENANCE SURVEY

DATE: 06 / 4 / 92

CITY:	FORT WORTH	GARLAND	HOUSTON	HURST	ODESSA	PLANO	RICHARDSON	SAN ANTONIO	AVERAGE
POPULATION:	450,000	153,270	1,630,000	32,000	89,699	120,000	75,500	955,400	352,549
SQUARE MILES:	293	57	561	9.1	35	69.04	28	344	155.17
SIGNAL TECHNICIANS:	27	5	126	2	4	12	6	44	20.86
SIGNAL TECHNICIANS IN I.M.S.A.:	0	4	0	1	3	6	6	0	3.57
TRAFFIC SIGNALS (TOTAL):	565	126	2000	26	169	86	84	940	387.29
FIXED TIME:	30	58	1000	0	24	3	1	397	163.07
ACTUATED:	535	68	1000	26	134	83	83	542	233.36
COORDINATED:	248	69	1600	14	163	81	80	549	278.21
# SIGNAL SYSTEMS/MASTERS:	2	13	140	2	3	14	1	N/A	18.36
AFTER HOURS CALL OUTS:	1182	N/A	52	65	N/A	342	160	128	301.21
SIGNAL TIMING REVISIONS:	47	N/A	104	3	N/A	33	630	N/A	75.29
SCHEDULED MAINTENANCE CALLS:	1807	N/A	2000	N/A	N/A	192	50	1574	444.36
EMERGENCY MAINTENANCE CALLS:	N/A	N/A	1200	87	N/A	544	163	2565	846.43
SIGNAL TROUBLE CALLS/MONTH/SIGNAL:	N/A	1	0.6	N/A	N/A	0.33	1.06	1.92	0.81
SCHOOL FLASHERS:	60	64	0	9	24	97	57	1	66.64
SCHOOL FLASHER MAINT. CALLS:	N/A	N/A	0	4	N/A	87	67	0	38.50

Appendix II-B

IH 287 Incident Management Plan

Source: Freeway Incident Management Handbook, July, 1991, U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

T R A N S C O M
Incident Management Plan

I-287, NEW YORK STATE THRUWAY
THROUGH ROCKLAND COUNTY

FROM: EXIT 15, SUFFERN

TO: TAPPAN ZEE BRIDGE, NYACK

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Incident Management Plan

Regional Highway Segment:

New York State Thruway, Interstate 287,
Rockland County
From Interchange 15, Suffern
To Tappan Zee Bridge, Nyack

Responsible Agencies:

New York State Thruway Authority
Coordinator: H. Peter Gustafson, P.E.
Director of Traffic Engineering
P.O. Box 189
Albany, New York 12201
518-436-2838

New York State Police - Troop T
Coordinator: Major Bruce Arnold
Commanding Officer
Troop T Headquarters
P.O. Box 189
Albany, New York 22201
518-436-2791

New York State Department of Transportation
Coordinator: Frederick Slade, Jr., P.E.
Supv. Traffic Operations Center
901 Bedford Road
Pleasantville, New York 10570
914-747-1118

Rockland County
Coordinator. Donald McGuire
Director, Office of Emergency Management
Fire Training Center
Firemen's Memorial Drive
Pomona, New York 10970
914-354-8259

TRANSCOM
Coordinator: John M. Ashe
Manager, Incident Management Planning
25 Journal Square
Jersey City, New Jersey 07306
201-963-4033 (Office)
l-800-TRAFFIC
(Operations Information Center)

Participating Agencies:

Bergen County Police

Clarkstown Police Department

New Jersey Highway Authority –
Garden State Parkway

New York State Department of Transportation

New York State Police - Troops F, K, T

New York State Thruway Authority

Nyack Police Department

Orangetown Police Department

Palisades Interstate Park Commission

Port Authority of New York and New Jersey
George Washington Bridge

Ramapo Police Department

Rockland County Department of Public Transportation

Rockland County Office of Emergency Management

Rockland County Sheriff's Department

Sloatsburg Police Department

South Nyack Police Department

Spring Valley Police Department

Suffern Police Department

Tarrytown Police Department

Triborough Bridge and Tunnel Authority
Bronx Whitestone Bridge
Throgs Neck Bridge
Triborough Bridge

Westchester County Department of Public Safety

Summary of Plan

This plan of coordinated management of traffic around and away from road closing incidents concerns the highway corridor of the New York State Thruway, Interstate 287, between its Interchange 15 in Suffern, and the Tappan Zee Bridge.

Projections of traffic indicate that, by the year 1995, the average daily traffic through the corridor may reach 76,000 vehicles. These projections, coupled with recent increases in the number of mad closing incidents involving tractor trailers and tankers, make it imperative to plan for the management of traffic around and away from such incidents.

Regional Diversion of Traffic

By virtue of the cooperative spirit growing amongst the consortium of transportation agencies of the region in conjunction with the formation of the Transportation Operations Coordinating Committee, TRANSCOM, it is now more easily possible to call for help in diverting traffic.

When a major incident occurs on the Thruway in Rockland County, requests will be made for the large, over the roadway, changeable message signs, now operated by the New York State Thruway at the Tappan Zee Bridge, the Port Authority at the George Washington Bridge, and the Triborough Bridge and Tunnel Authority at the Throgs Neck, Bronx Whitestone, and Triborough bridges, to warn motorists of the problem, and recommend alternate routes to be used by them.

In addition, a request may be made to the Bergen County Police for the use of their Variable Message Sign (VMS) sign trucks to be placed at appropriate locations. Depending upon the location and direction of the road closing event, the New Jersey Highway Authority, operator of the Garden State Parkway, will be requested to display messages on their portable VMS vehicles to warn motorists approaching the region what has taken place.

Local Diversion of Traffic

The traffic plan which follows sub-divides the Thruway from exit to exit. It is arranged sequentially with northbound sections followed by southbound sections. One or more alternate routes for traffic is provided.

Degrees Of Implementation

When an incident occurs which causes all lanes of the highway to be closed in a certain direction, a series of actions will take place, me extent of which will depend upon the time of day, the day of the week, and the estimate of how soon it will be before the roadway is cleared and returned to service.

When an incident occurs which causes congestion to a lesser degree than a full roadway closure, only partial implementation of this plan would be necessary. Using this plan as a basis for decisions, traffic control may be implemented by the corridor management team to as severe a degree as is warranted by the situation.

Levels of Implementation of Traffic Management Plans

A series of five levels of implementation have been established which reflect the increasing intensity of traffic management required in relation to the magnitude of the incident that has taken place. As the level of implementation gets higher, it is important that all steps in the preceding level(s) have taken place prior to, or are being accomplished concurrently.

The actions to be taken as an incident escalates are described below. An estimate of the level of operations which should be implemented, based upon the hour and day of the week, is at the end of this section.

Level 1
The Preparation

Whenever an incident takes place that has serious implications, all operation centers should be notified and an initial preparation made to handle a more serious event in case it develops.

- A message should be transmitted to appropriate agencies on the TRANSCOM network.
- Alternate Routes within the section of the corridor in which the incident has occurred are to be inspected to see that they are clear to handle the expected increase in traffic. Unless any department reports a problem such as a utility company digging up the road or other impediment, the 1st Alternate Route of the plan will be used as the Primary Alternate.

Level II
The Incident Can Be Handled at the Local Level

Traffic is light and the incident is expected to be cleared before there would be a heavy traffic demand on the roadway.

- Level I action must be taken.
- TRANSCOM notifies Shadow Traffic of the Primary Alternate Route to be used for localized traffic. Shadow is requested to recommend to commuters who normally used the I-287 corridor to switch to mass transit or to carpool for the day.
- Agencies prepare for the need for extra traffic coverage. (Who will work longer; who will be called in early?)
- Police patrols uncover any permanently mounted alternate mute markers.

Level III
Voluntary Diversion of Traffic is Necessary

There is sufficient volume of traffic so that congestion has already occurred and it would be timely for motorists to use the local alternate routes that have been set up to get past the incident.

- Level I and II actions must be taken.
- TRANSCOM notifies Shadow Traffic and recommends that trucks use Alternate mutes around the I-287 Corridor.
- Local agencies commit personnel to agreed to emergency posts to PREVENT Grid Lock.

Level IV
Mandatory Diversion of Traffic is Necessary

With assistance from regional agencies helping to divert traffic away from the corridor: At this level, sufficient congestion is affecting the surrounding highways leading toward the corridor, and the extent of the incident is such that it will be in the best interest of the motorist to spend the extra time to use the recommended regional diversion to get to the other side of the incident.

- Level I, II, and III actions must be taken.
- TRANSCOM advises Shadow Traffic of the ramp closings and local alternate routes which are now necessary.
- TRANSCOM requests the Regional agencies to set messages on their permanently installed Changeable Message signs (CMS).
- Variable Message sign (VMS) trucks am requested to take up their previously agreed to positions and display their messages.

Level V
Long Term Diversion of Traffic is Necessary

At this level, the incident is of such magnitude that the roadway will be closed for a long period of time, and one or more days of alternate operation can be expected.

- All previous levels of action must be taken.
- Special signing is prepared for long term diversion.

Action Levels of Incident/Implementation

TIME OF DAY	ESTIMATED DURATION	LANES CLOSED 1	2	3	ACTION
Midnight to 0500	1 Hour	--	--	I	CLASS "A" ACTIONS
	2 to 4 Hours	--	I	II	
	More than 4 Hours	II	II	III	
0500 to 1100 and 1400 to 2000	1 Hour	I	II	V	CLASS "B" ACTIONS
	2 to 4 Hours	III	IV	V	
	More than 4 Hours	III	IV	V	
1100 to 1400 and 2000 to Midnight	1 Hour	I	II	IV	CLASS "C" ACTIONS
	2 to 4 Hours	II	III	IV	
	More than 4 Hours	III	IV	IV	

Note: The grid above is intended for use on Monday thru Friday. For Saturday, Sunday and Holiday, Class "A" will be used from 2100 to 0800. Class "C" will be used from 0800 to 2100.

Appendix II-C

IH 287 Alternate Routing Plan

Source: Freeway Incident Management Handbook, July, 1991, U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

Alternate Routing Plan Scope Of Work

Introduction

The purpose of this project is to develop an Alternate Routing Plan so provide the framework and guidelines for responding to incidents that require closure of section(s) of the freeway system. Traffic will be re-muted onto the adjacent surface street system that parallels the freeway, and allowed to re-enter at the next appropriate interchange.

Specifically, the plan will: 1) identify alternate traffic routes between each interchange on the system: 2) establish authority and responsibility of the Department of Transportation, police agencies, and other affected agencies, and 3) document the notification process and standard procedures to be utilized for implementing the alternate route(s) and later removal following the termination of the incident period.

Project Scope

The system between__and ___ shall be covered.

Tasks

Task 1

Assemble and Index Data

Data required to develop the Alternate Routing Plan shall be assembled and indexed. This will include the following:

- Roadway maps and plans
- Location of maintenance shops
- Location of police jurisdictions
- Traffic data
- Volumes on freeway system and ramps as well as on potential alternate mutes
- Accident summary records at critical locations on alternate routes
- Existing signing on freeway and alternate routes

Task 2

Establish Alternate Route Criteria

Criteria shall be established under which alternate routes shall be selected. These include:

- Length of alternate versus freeway mute
- Jurisdiction of detour (i.e. number of traveled lanes, number of signalized intersections, number of turns, number of left turns, number of mute changes
- Accident history
- Capacity

Criteria shall be established for alternates which are:

- Long-term
- Short-term

Task 3

Identify Preliminary Alternate Routes

Assemble a set of preliminary detour routes and sketch on 8 l/2” x 11” sheets.

Task 4

Drive And Videotape Preliminary Alternate Routes

Each preliminary alternate route shall be driven and critical sections or junctions videotaped. Critical turn areas shall also be videotaped. Total distance of each route will be measured by car odometer or a distance measuring instrument as necessary, and recorded. Relevant features and characteristics shall be recorded such as structures with limited overhead clearance, and weight restrictions, or route number changes.

Task 5

Revise Preliminary Alternate Routes

Based on the data and experience of driving the preliminary alternate routes. a revised set of alternate routes will be prepared. These will be presented as simplified maps on 8 l/2” x 11” sheets with explanations and descriptions of significant features**.**

Task 6

Identify Problem Areas

A list of alternate routes shall be compiled indicating any problem sections. The problem section will be keyed to the simplified map of the detour mute. These problems will include:

- Significant delays
- Limited fuel availability (diesel and conventional)
- Overhead clearance limitations
- Structures with weight restrictions
- Residential areas
- School, hospital, church zones
- High accident zones
- Heavy pedestrian flows
- Tight turn radii
- Locations where temporary signals may be necessary will be identified.

Task 7

Identify Commercial Vehicle Restrictions

Alternate routes with vehicle restrictions shall be compiled including weight, length, height and any other restrictions.

Task 8

Determine Signing

The following aspects of signing shall be analyzed and recommendations made:

A. On Freeway

- Type (i.e. Velcro: small semi-permanent; large guide)
- Storage (stockpiling; locations of stockpiles: computerized inventory)
- Fabrication (by Agency; by contractors)
- Placement
- Erection (buck mounted; permanent folding sign, post requirements)

B. Off Freeway

- Permanent trailblazers
- Placement (location on detour routes from diversion point to the next entrance ramp)
- Temporary signing
- Storage (stockpiling locations of stockpiles; computerized inventory)
- Fabrication (by Agency, by contractors)
- Placement
- Erection (truck mounted: permanent folding sign: post requirements)

C. Trailer Mounted Variable Message Signs (VMS)

- Assess the need for trailer mounted VMS.

Task 9

Assess Highway Advisory Radio

The use of highway advisory radio (HAR) will be assessed for use in emergency alternate routing. Aspects to be explored are:

- Permanent HAR locations
- Truck mounted HAR
- Compatibility with other operations
- Construction
- Weather advisory

Included in this task will be plan to utilize a public telephone number to convey alternate route information.

Task 10

Develop Operational Procedural Guide For Termination Of Alternate Routes

An operational procedural guide shall be developed. This guide shall be targeted to enforcement and other personnel with incident traffic management responsibilities. The guide shall notify, identify and explained each affected party's duties at the specified interchange including where signs are stored and who is to erect them both on and off the freeway.

The assistance and concurrence of the involved officials shall be obtained in development of this guide. The following aspects shall be included:

- Responsible parties and duties
- Maintenance
- State police patrols
- Roadside service to disabled vehicles
- Retrieval of signs and/or temporary coveting
- Storage
- Replacement
- Restocking of maps

Task 11

Develop Notification Procedures

Notification procedures shall be developed that will allow the alternate routes to be updated on a continuous basis if affected by construction of a permanent or long-term nature, closures of surface street routes, bridge limitations or other factors.

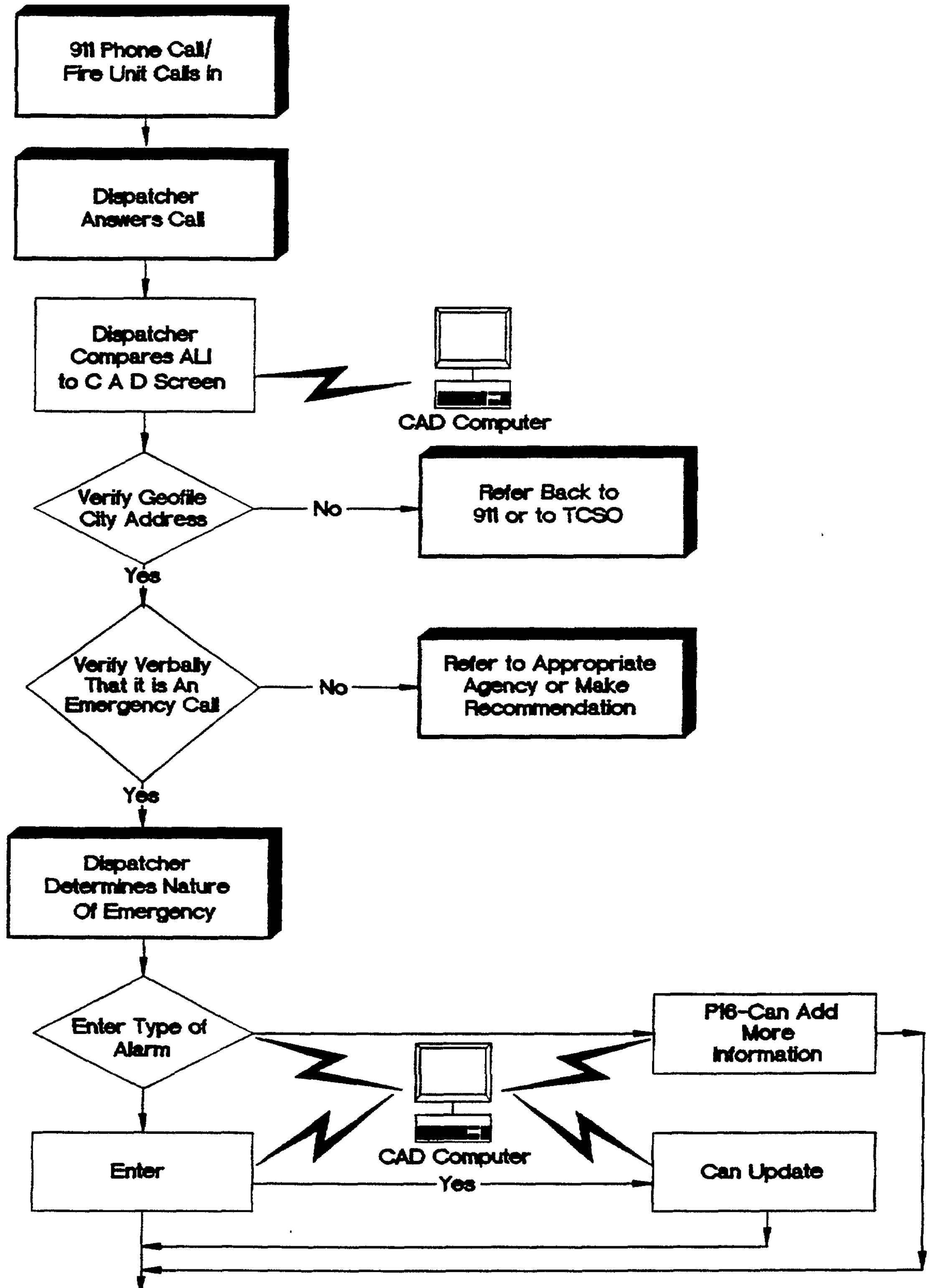
Task 12

Estimate Costs

Cost to implement the procedures, identified for alternate routing shall be estimated. These costs shall include:

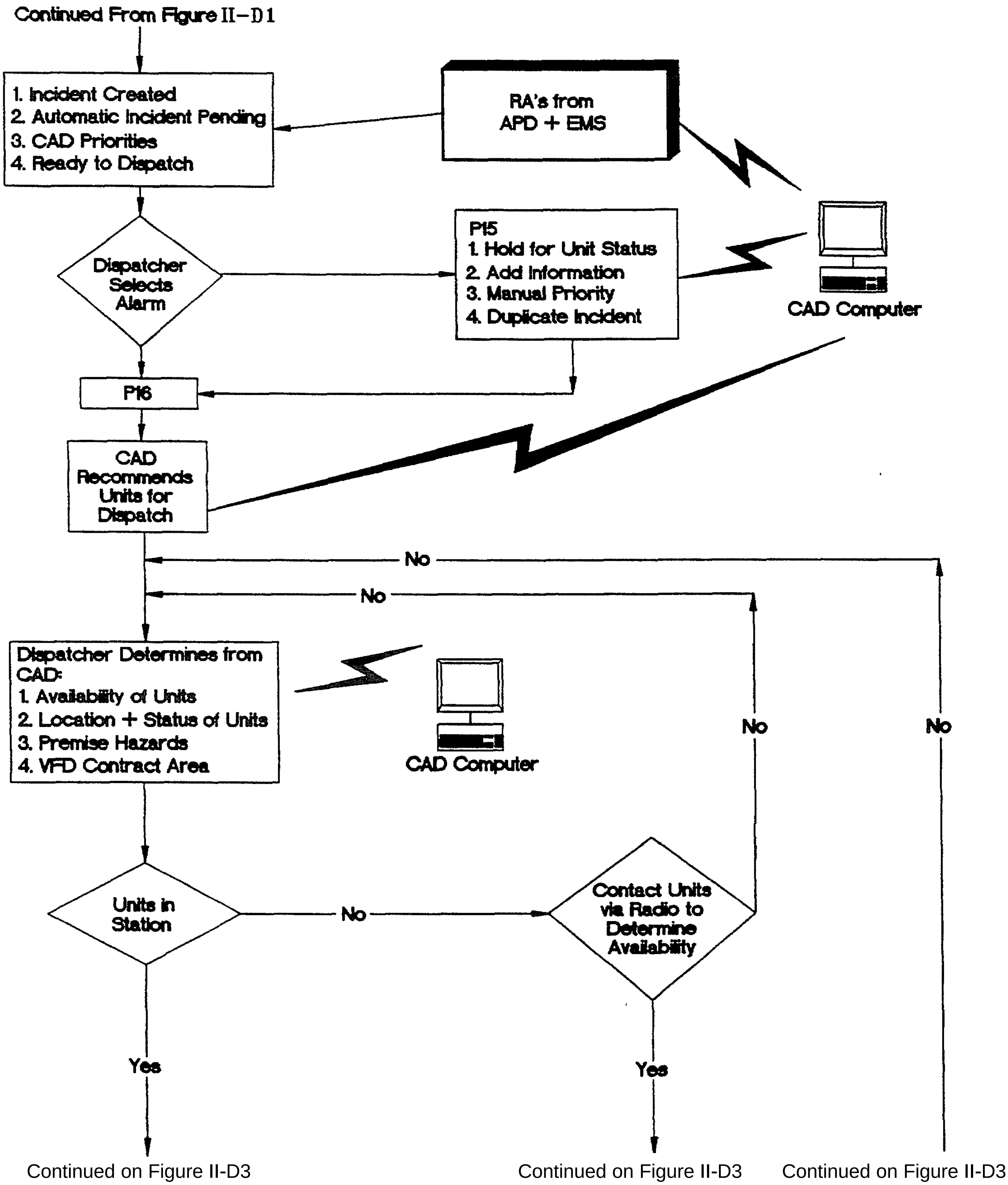
- Signs
- Printing
- Material
- Trucks
- Other equipment

Appendix II-D
Austin Fire Department
Alarm Dispatch of a
Multi-Company Response



Continued on Figure II-D2

WILBUR SMITH ASSOCIATES CONSULTING ENGINEERS AND PLANNERS HOUSTON, TEXAS NORTH AMERICAN CONTROLS CORPORATION ADVANCED TRAFFIC ENGINEERING KESSMAN & ASSOCIATES	AFD Alarm Dispatch of a Multi-Company Response Austin Area-Wide ITS Austin, Texas	Figure II-D1



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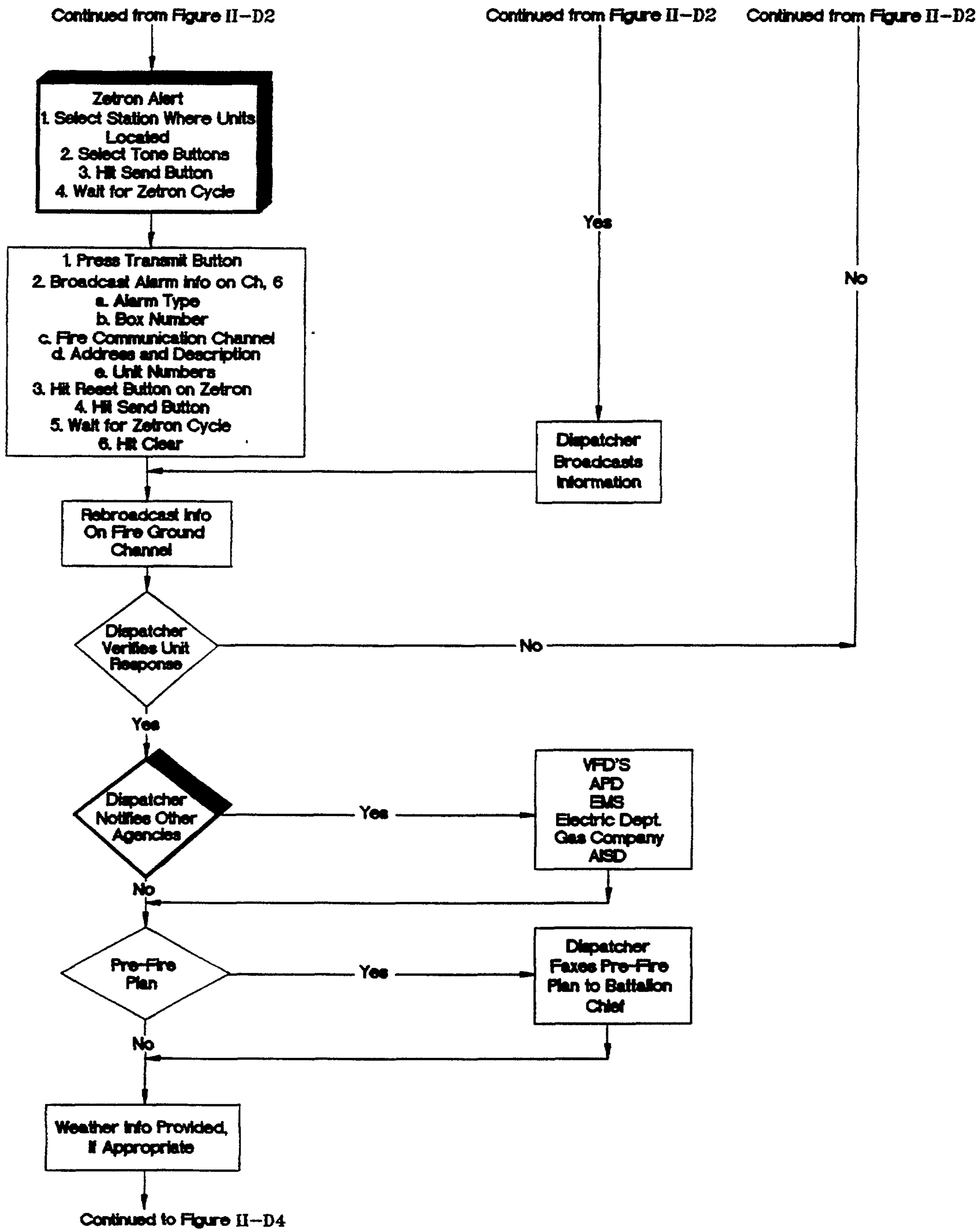
KESSMAN & ASSOCIATES

AFD Alarm Dispatch of a Multi-Company Response

Austin Area-Wide ITS
Austin, Texas

Figure II-D2



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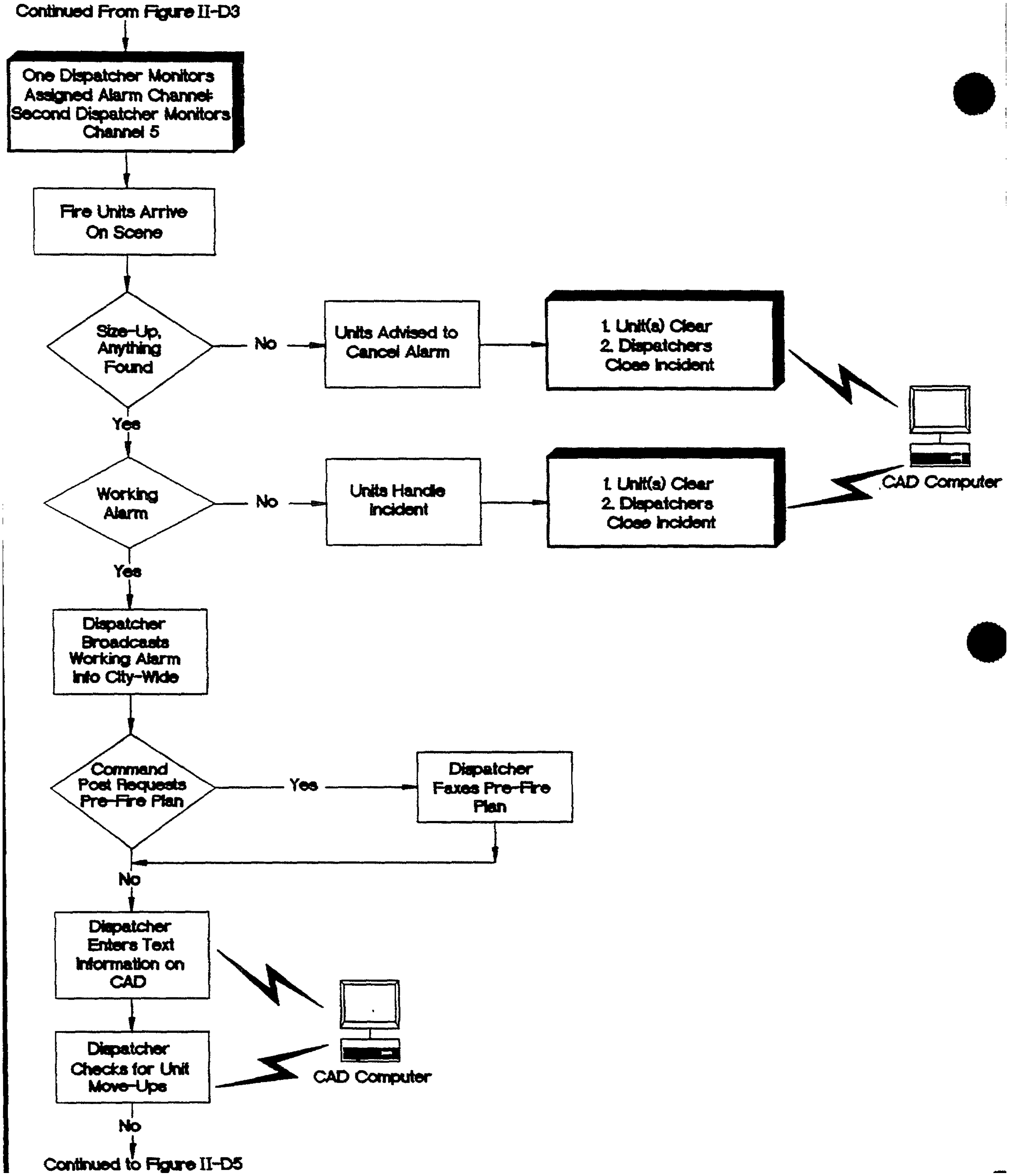
AFD Alarm Dispatch of a Multi-Company Response

Austin Area-Wide ITS
Austin, Texas

Figure II-D3



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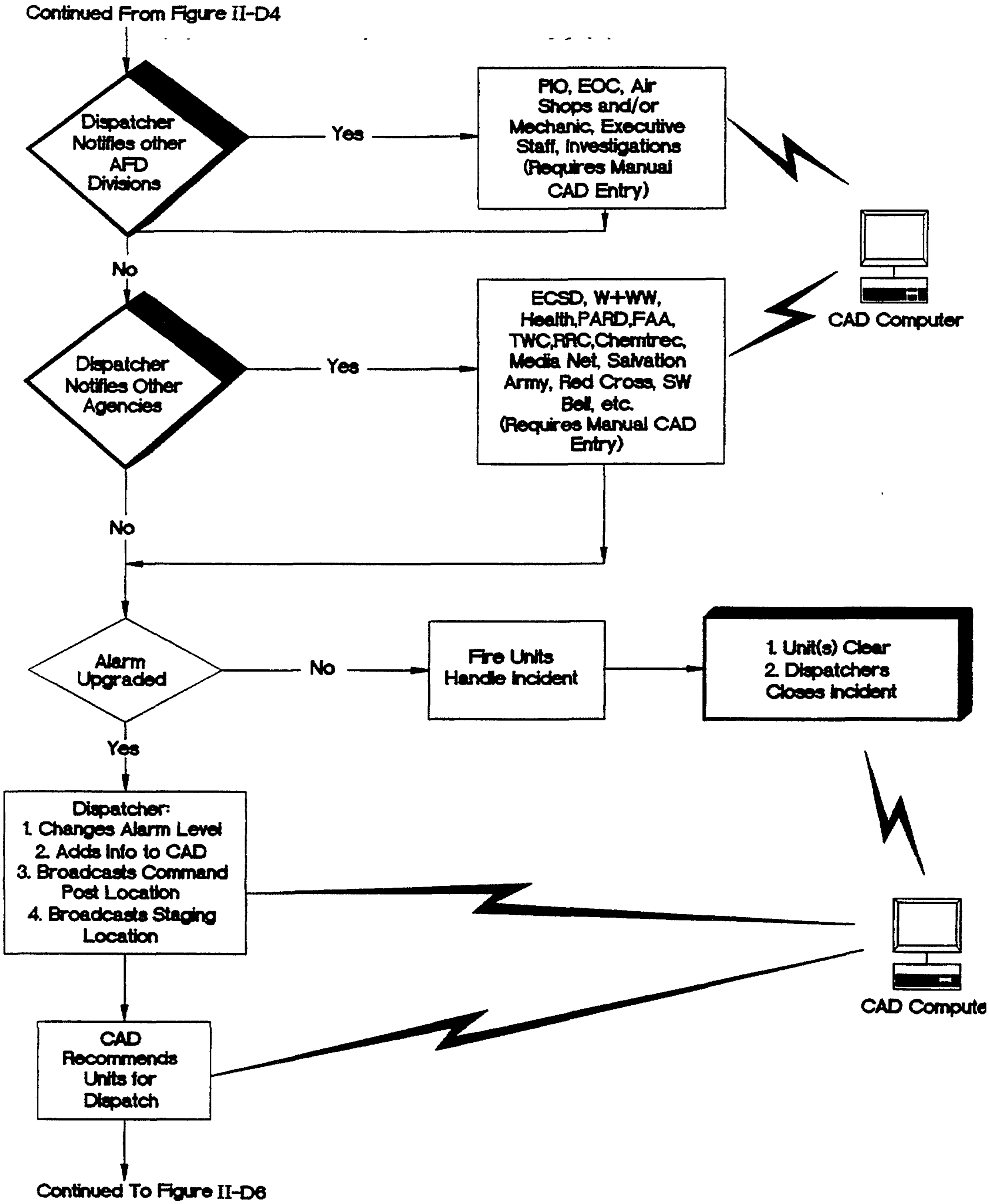
Austin, Texas

Figure II-D4



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Austin Area-Wide ITS
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Figure II-D5

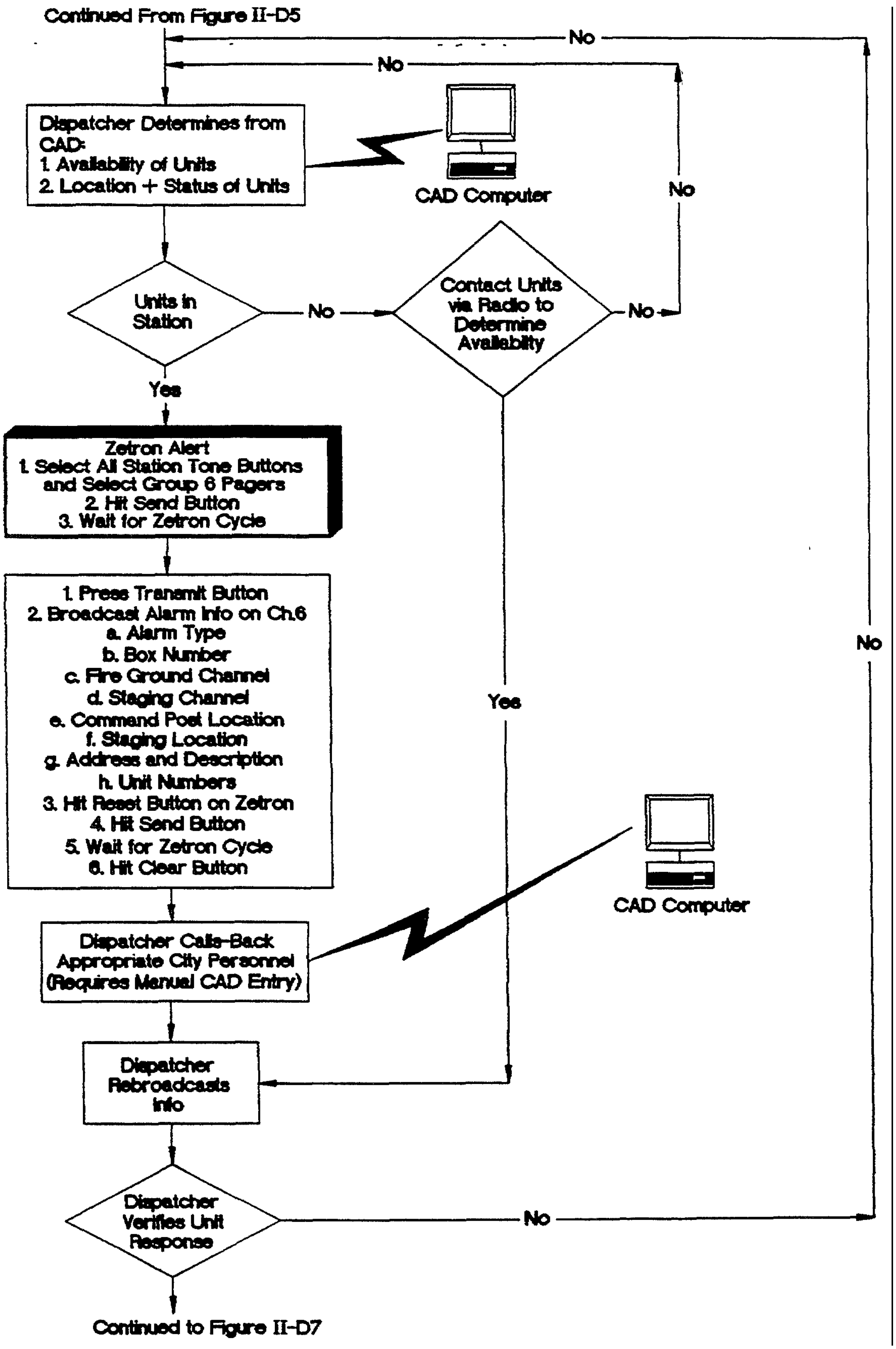

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Figure II-D6

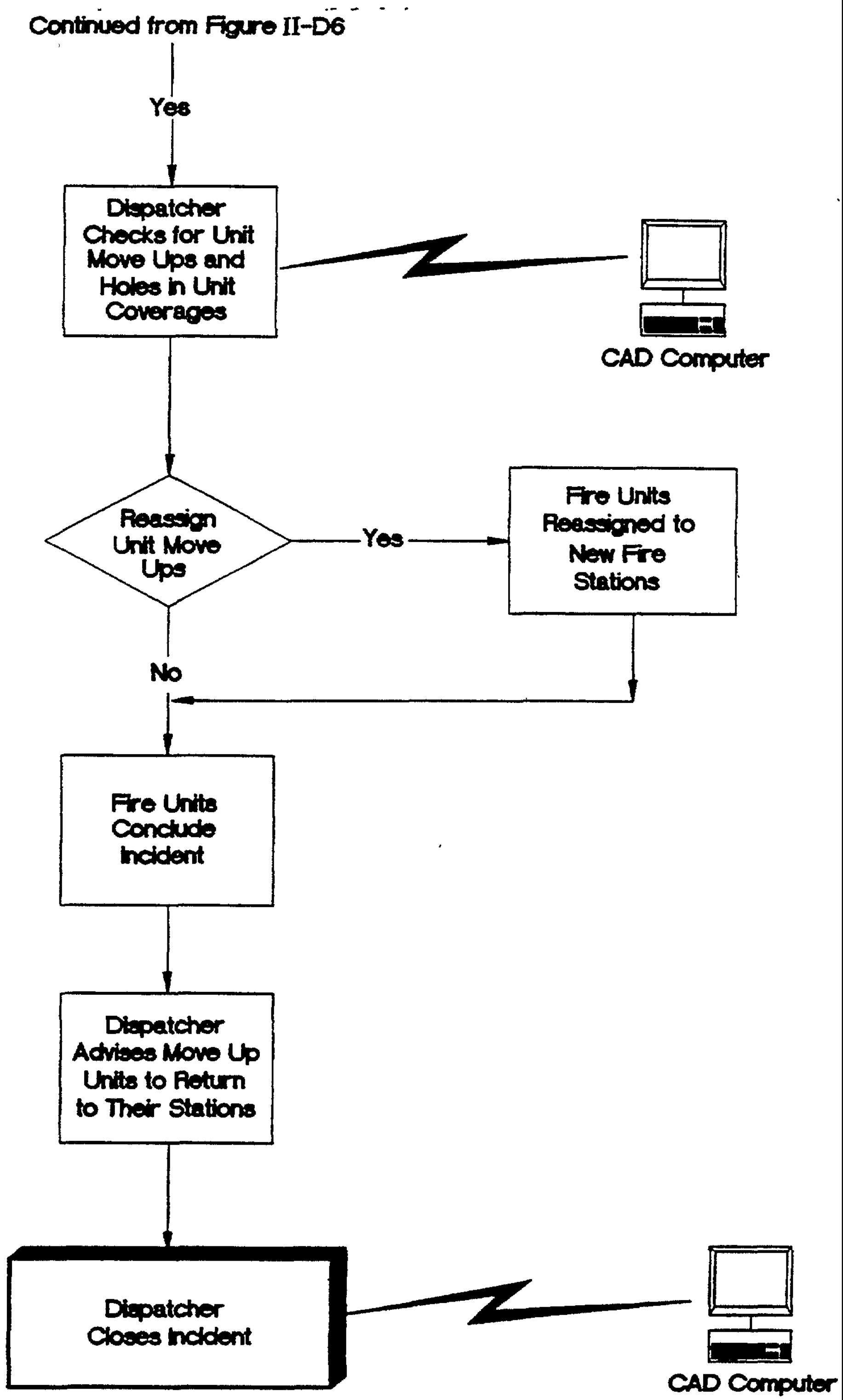

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Figure II-D7

Appendix II-E

Freight Element of
Austin Metropolitan Area Transportation Plan

4.6 FREIGHT ELEMENT

4.6.1 Introduction

Freight movement, as an impact on transportation, has received minimal consideration in past planning efforts. However, ISTEA now requires consideration of freight movement in transportation planning. The efficient movement of freight is especially significant for the Austin metropolitan area, where freight transporters and passenger vehicles generally utilize the same transportation corridors. The Freight Movement Element addresses the federal requirements (ISTEA), impacts of the North American Free Trade Agreement (NAFTA), and significant aspects of roadway freight, rail freight, and air freight in the Austin metropolitan area. Recommended policies are grouped as issues pertaining to: SH-130, Ordinances and Operational Regulations, Alternative Freight Routes, interchanges and Bridges, and Other

4.6.1.1 ISTEA Requirements

The passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 requires Metropolitan Planning Organizations (MPOs) to consider “methods to enhance the efficient movement of freight.” This legislation forces planners to look beyond the needs of passenger vehicles, and directs all modes of transportation to receive equal attention with respect to planning a future transportation network. Addressing this factor (ISTEA factor #11) will require many areas to undertake goods-movement studies.

4.6.1.2 Roadway Freight

In order to enhance freight movement, it is necessary to study the means by which freight is moved. In the Austin metropolitan area the majority of freight is moved by truck (roadway freight). Roadway freight is addressed in this document as being either through (non-stop), or local.

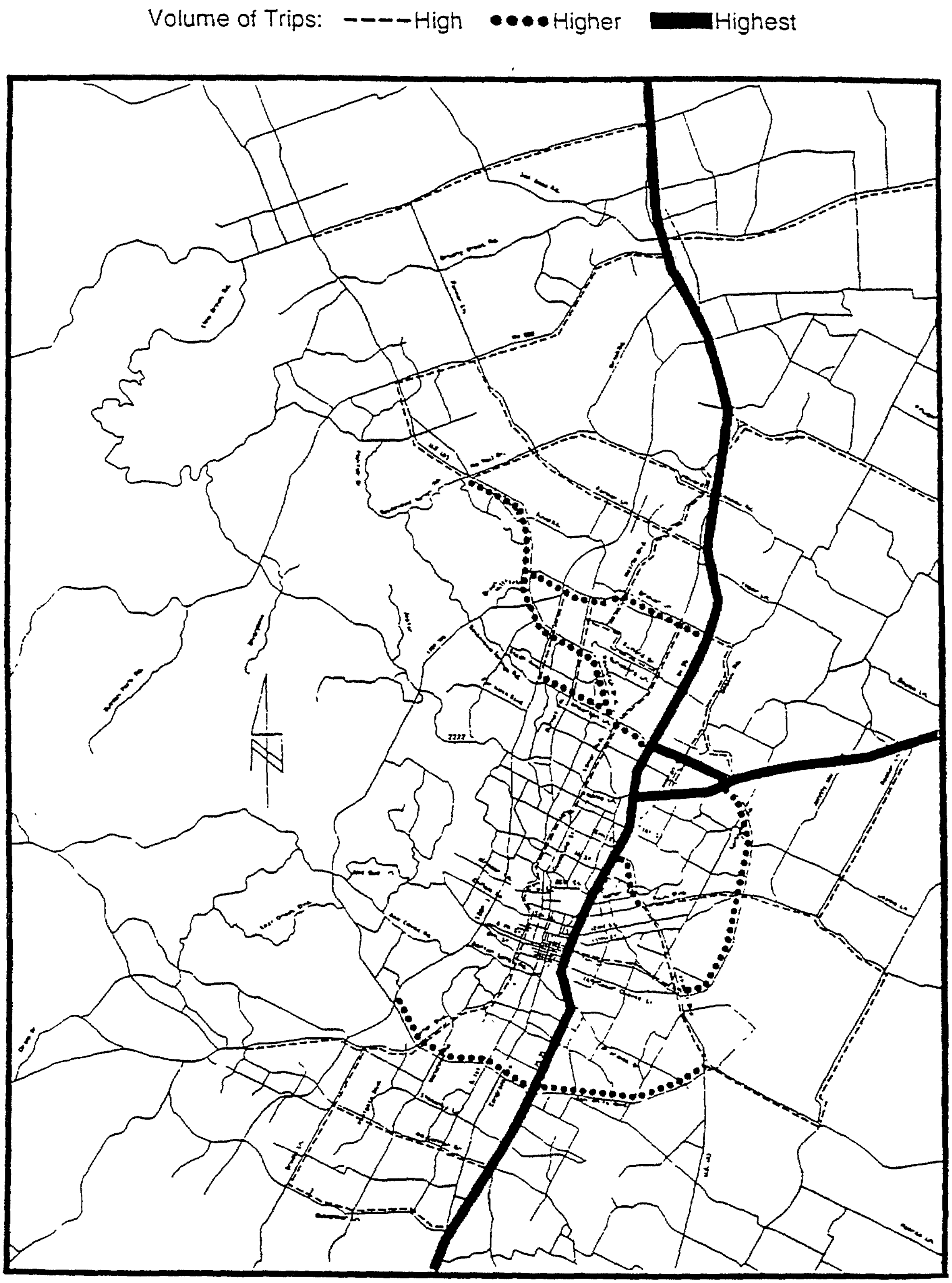
Through (non-stop) Roadway Freight

Through roadway freight pertains to trucks traveling *through* Austin, having no origin or destination inside the metropolitan area. Most of the through roadway freight traveling from Mexico (along the Laredo - San Antonio - Dallas/Fort Worth corridor) is carried on IH-35, and therefore moves directly through the center of Austin. This freight traffic places a huge burden on IH-35, which is already over capacity with commuters at peak hours. Interstates in many major cities include bypasses around the CBD; trucks hauling through freight on these Interstates can be diverted around urban traffic congestion. This is not the case for Austin, where IH-35 passes through the CBD. As stated previously, through roadway freight traffic is anticipated to increase steadily over the next few years.

Local (stop) Roadway Freight

Local roadway freight pertains to any trucks having an origin or destination(s) inside the Austin metropolitan area. Austin has a higher level of inbound roadway freight than outbound freight. This fact is explained by the nature of Austin business. The Austin metropolitan area is unique in that its highest paying jobs are in fields that produce a lower-than-average volume of outgoing freight. A large portion of the work force is characterized by young, affluent households which are huge consumers of sports and entertainment products, electronic equipment, clothes, furniture, disposable paper products, building materials, automobiles, and food and beverages. This high level of consumption generates a high volume of incoming freight trips in the Austin area (see Figure 4.6-1).

Figure 4.6-1
Roadway Freight Corridors by Volume of Trips



Preliminary findings indicate that a majority of consumable goods, especially food products, enter Austin from the south (San Antonio), while durable goods tend to come from the north (Dallas/Fort Worth). Almost all of this freight travels on IH-35. Many of these trucks have an Austin destination east of IH-35 (see Figure 4.6-2). Most commercial distribution centers (warehouses), as well as UPS, Federal Express, the General Mail Facility, and all five (5) landfills are located east of IH-35.

4.6.1.3 Rail Freight

A high level of rail freight traffic moves by train *through* Austin non-stop. These trains must decrease speed because of restrictive grades, slow speed curves, and the single-track Colorado River bridge. The Union Pacific Railroad (UPRR) currently operates about 20 *through* trains per day. The current UPRR track capacity (without significant delays) is about 25 trains. Industry forecasts suggest that the amount of rail traffic through the Austin corridor to San Antonio and Laredo will double (to 40) between 1993 and 1998. Improvements to the current Austin rail configuration may require building a modem double-track bridge, or possibly rerouting the main tracks to enhance the movement of rail freight.

The level of *local* rail freight traffic (stopping) in Austin is relatively light compared to the total volume of rail freight moving through the city. Goods carried into Austin by rail include beer, lumber, paper, plastics, and some chemicals. Goods carried out of Austin are primarily aggregates from mines and quarries in Georgetown, Austin and Marble Falls.

There are currently no facilities in the ATS service area for transferring freight from trucks onto trains. San Antonio, less than 200 miles away, currently provides this service at a reasonable price.

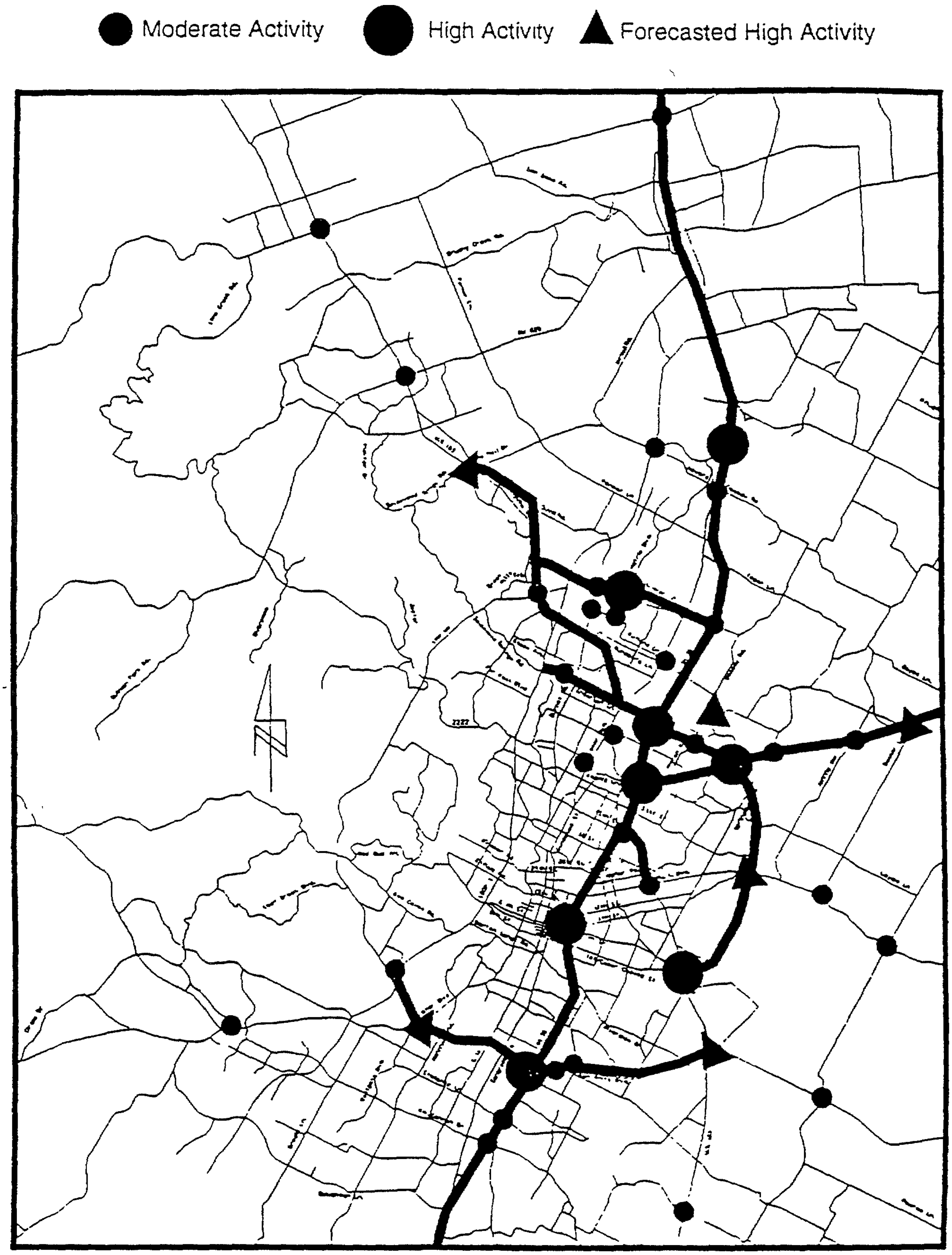
4.6.1.4 Air Freight

Austin serves as a regional air freight hub. The Austin metropolitan area sustains a very high per capita volume of air freight, due largely to its business climate (high-tech and academic). This volume of air freight is expected to continue to grow rapidly, and this growth may result in conflicts between passenger and freight traffic at and near the new airport.

4.6.1.5 Effects of NAFTA

The North American Free Trade Agreement took effect on January 1, 1994. The City of Laredo currently accounts for 60 percent of all trade between the US and Mexico. About 80 percent of that traffic moves by truck; most of the remaining 20 percent moves by rail. It is estimated that at least 30 percent of that truck traffic travels along IH-35 *through Austin* enroute to the mid-west and Canada: 80 percent of the rail traffic travels the Union Pacific Railroad (UPRR) main track *through Austin.* From October 1991 to December 1993, Austin experienced a 40 percent increase in cross-border truckloads passing through the city destined for Mexico (from 13,000 to 18,000 truck loads per month) and a 25 percent increase in truckloads coming from Mexico (from 8,500 to 10,400 per month). This traffic is anticipated to continue to increase at 20 percent per year through the year 1998, coinciding with the initial phase-in of the Agreement. It will likely level off after the year 1998, proceeding with a more normal 10 percent growth rate as experienced prior to the announcement of NAFTA.

Figure 4.6-2
Areas of Concentrated Roadway Freight Activity



4.6.2 Policies to Enhance Freight Movement

A. SH-130

Policy A-1: Accelerate feasibility study/planning of SH-130 (segments A & 6, east of IH-35, around the CBD.

- Preliminary reports from TxDOT indicate a completion date beyond the year 2020.

Policy A-2: Make the enhancement of freight movement a priority in the planning of SH-130. Design SH-130 as an express freight route away from the CBD, with interchanges and ramp exits planned to encourage through traffic. This will minimize the number of ramps, thus minimizing cost.

- If SH-130 is designed primarily to cater to the needs of passenger cars, then trucks will continue to use IH-35, as the most direct route. Increased efficiency through reduced congestion will be the main incentive for trucks to use SH-130.

Policy A-3: Study the feasibility of relocating UPRR to the east (e.g. SH-130 corridor) for rail freight movement.

- If this transportation corridor is adopted by ATS and implemented, the existing UPRR track through the center of Austin could be utilized for local/regional passenger service during the 5:00 am - 11:00 pm time frame, allowing local freight operations during the nighttime. Provision of adequate rail right of way should be addressed in the planning of SH-130, including provisions for air cargo - rail transfer of containers.

B. Ordinances and Operational Regulations

Policy B-1: Restrict large commercial trucks to the right lane(s) of IH-35, US 290, and US 183, using local ordinances or changes to state law, if necessary.

Policy B-2: Establish an adequate number of designated delivery parking spaces for commercial vehicles, especially in the CBD.

Policy B-3: Identify and enforce an alternative route for trucks transporting hazardous materials.

C. Alternative Roadway and Rail Routes

Policy C-1: Evaluate US 183 (Ed Bluestein Blvd.) as an Interim alternative freight route for through freight in order to bypass the heavy congestion on IH-35, until construction of SH-130. To connect US 183 to IH-35, consider using either FM 1327, or the Slaughter Lane extension east of IH-35, or SH 71.

- Expansion at the US 183 Montopolis bridge is incomplete. Current southbound capacity is reduced to one lane for through traffic on US 183. Northbound lanes have new bridge piers but no bridge. This bridge must be completed to full capacity in order to utilize US 183 as a freight route.

Policy C-2: Notify trucking companies, truck stops and the Department of Public Safety (DPS) of this alternative route(s) and provide incentive to trucks who use them. Also, install Route signs to inform trucks of "Truck Route"(see *Manual on Uniform Traffic Control Devices*).

Policy C-3: Study benefit of Commercial Vehicle Only lanes as part of current feasibility study for HOV lanes.

- The high level of commercial/freight activity in Austin may indicate this type of lane to be at least as beneficial as an HOV lane. Also, consider a combination of both lane types. Additionally, if Williamson County implements a transit commute plan, a new level of HOV demand will be introduced to IH-35.

Policy C-4: Examine feasible alternative rail alignments and improvements. This evaluation should include the following options: (1) building a double-track bridge at the present Colorado River bridge location, (2) double-tracking other segments of the existing fine, and (3) constructing a new rail alignment (see Policy A-3).

D. Interchanges

Policy D-1: Evaluate the Airport Blvd/IH-35 interchange for improvement as this location appears to have an increasingly high level of truck freight traffic, not necessarily related to airport cargo operations.

Policy D-2: Evaluate possible solutions to the IH-35/US 290 East interchange as this location has a high level of commuter traffic, mixing with inbound truck freight and intercity bus traffic.

Policy D-3: Evaluate current plans for IH-35/US 183 interchange to facilitate future freight movement.

- Current plans for this interchange show dedicated lanes for traffic movement westbound on US 183 only. Traffic moving eastward on US 183 from IH-35 will be required to stop at a signalized intersection. This configuration will slow down the movement of freight and will impede the northern connection of the US 183 alternate freight route.

E. Further Study

Policy E-1: Conduct a freight origin/destination study for trucks utilizing IH-35 as part of an origin/destination study that TxDOT will conduct in 1997 in the ATS area.

- Determine the percentage of inbound/outbound traffic from both the south (San Antonio and Mexico) and the north (Dallas/Fort Worth). Determine which carriers have a destination in ATS area and which are passing through.

Policy E-2: Study economic impact of traffic delays to local businesses who require freight transport/shipping or deliveries by truck.

Policy E-3: Conduct an hourly freight movement study, Hourly traffic counts that show number of trucks are necessary to improve traffic signal timing. Efficient traffic signal timing is important to enhance the movement of freight.

Policy E-4: Study current freight corridors to determine the need for and existence of dedicated left turn signals, left turn lanes, and wide-radius right turn lanes. Trucks need these features to expedite their travel through intersections.

4.6.3 List of Background Studies and Documents

4.6.3.1 Vehicle Classification Report

4.6.3.2 Impacts of NAFTA on Freight Transportation in Austin

4.6.3.3 Introduction to Freight Terminology

4.6.3.4 Traffic Volume Analysis

4.6.3.5 Characteristics of Major Freight Operations

4.6.3.6 Summary of TxDOT Major Investment Studies (SH-130 and IH-35)