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**Federal Transit
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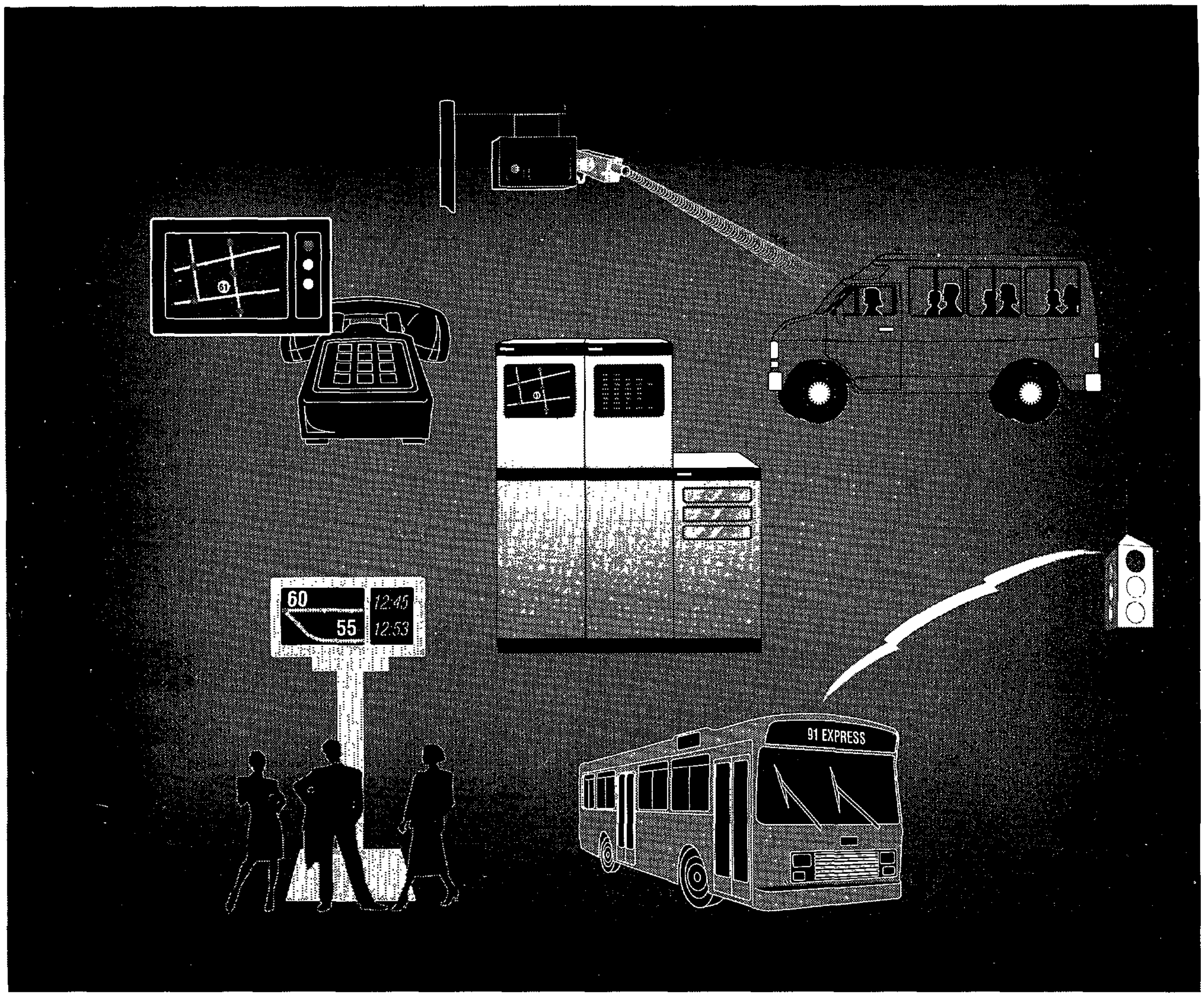
ITI TOOLBOX

Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers

July 1994



ADVANCED PUBLIC TRANSPORTATION SYSTEMS PROGRAM
A Component of the Departmental IVHS Initiative

Office of Technical Assistance and Safety

Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers

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Final Report
July 1994

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LIST OF ACRONYMS AND ABBREVIATIONS

ABRS	Alternate Bus Routing System
APTS	Advanced Public Transportation Systems
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management Systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
AVM	Automatic Vehicle Monitoring
AVMAM	Automated Vehicle Monitoring and Management
caltrans	California Department of Transportation
CCTV	Closed-circuit Television
CDOT	Colorado Department of Transportation
ConnDOT	Connecticut Department of Transportation
CRT	Cathode Ray Tube
CSP	Colorado State Patrol
CTA	Chicago Transit Authority
CTMS	Computerized Transportation Management System
DOT	Department of Transportation
EPS	Emergency Priority System
ETTM	Electronic Toll and Traffic Management
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
FTM	Freeway Traffic Management
GHTMC	Greater Houston Traffic Management Center
GIS	Geographic Information System
GPS	Global Positioning System
HAR	Highway Advisory Radio
HOV	High Occupancy Vehicle
IDOT	Illinois DOT
INFORM	Information For Motorists
IVHS	Intelligent Vehicle-Highway System
LRT	Light Rail Transit
MARTA	Metropolitan Atlanta Rapid Transit Authority
MBTA	Massachusetts Bay Transportation Authority
MCT	Milwaukee County Transit
Mn/DOT	Minnesota DOT
MONITOR	Milwaukee Area Freeways Organizational Network Information on Traffic Operations and Response
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transit Commission
o c c	Operations Control Center
OCTA	Orange County Transportation Authority
PATH	Port Authority Trans-Hudson

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PCD	Personal Communications Device
RTD	Regional Transportation District
SC&C	Surveillance, Communications, and Control
SCS	Signal Coordination System
SRS	SmartRoute Systems
TCC	Transportation Control Center
TDM	Transportation Demand Management
TMC	Transportation Management Center
TOC	Traffic Operations Center
TRANSCOM	Transportation Operations Coordinating Committee
TRANSMIT	TRANSCOM's System for Managing Incidents and Traffic
TSC	Traffic Systems Center
TSMC	Traffic Systems Management Center
TTI	Texas Transportation Institute
UTCS	Urban Traffic Control System
VIDS	Video Imaging Detection System
VMS	Variable Message Signs
VRC	Vehicle to Roadside Communication
WisDOT	Wisconsin DOT
WMATA	Washington Metropolitan Area Transit Authority

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SECTION 1. INTRODUCTION

The advent of intelligent vehicle-highway system (IVHS) technologies has fostered the development and implementation of automated systems that control traffic and provide traffic information to drivers. However, one very important element of traffic has been overlooked in the past - public transportation. Traditionally, the impact of public transportation on traffic flow and volumes has not been factored into these automated systems. Also, providing transit information along with traffic information to travelers (rather than just drivers) has not been done in the past. The recognition that multi-modal information can influence a traveler's decision on route(s) selection and mode(s) is not recent, but the provision of transit and traffic information has not been done until very recently.

Thus, there are two key issues that could be addressed by today's IVHS technologies - the coordination of transit and traffic operations and the dissemination of transit and traffic information to the public. The basic objective of the study described in this report was to address these two issues by reviewing existing "transportation management centers" (TMCs) and those under development. This review determined the extent to which transit has been or will be integrated into TMCs.

This study was conducted by the Research and Special Programs Administration/Volpe National Transportation Systems Center of the United States Department of Transportation, under the sponsorship of the Advanced Public Transportation Systems (APTS) Program, Federal Transit Administration (FTA) and the guidance of Mr. Ronald J. Fisher, P.E., director of the Office of Training, Research, and Rural Transportation, FTA.

1.1 STUDY OBJECTIVES

This study was prompted by a concern on the part of the transit community that TMCs may not be adequately addressing and considering transit. A need was identified for a guidelines document whose objective is to ensure that transit will be considered in TMCs However, prior to producing such a guidelines document, several steps were needed to identify the scope of TMCs in the United States and the extent to which transit has been or is being integrated into TMCs.

Thus, the objectives of this study were to:

- Conduct a review of existing TMCs and those under development;
- Assess their status and the extent to which transit is being integrated;
- Identify major issues associated with TMC development and operation; and
- Prepare a preliminary guidelines document that discusses the issues associated with integrating transit into TMCs, and suggests the next steps to develop integration approaches.

1.2 TECHNICAL APPROACH TO STUDY

The study began by identifying existing TMCs or TMCs under development. Next, key TMCs to be addressed in the study were selected based on their current status and progress, and the amount of information available on TMC operations and transit involvement (see Section 2.2).

Once the final list of TMCs was selected, a set of structured questions was developed to facilitate information gathering. A draft set of questions was applied to one of the TMCs in order to "test" the questions and to solicit comments about the questions. Once the final set of questions was developed, the TMCs were contacted either by site visits and/or telephone interviews to collect the data and any other information pertinent to the study.

After the data was collected, it was assimilated and analyzed in order to determine transit's involvement in TMCs and to identify issues that might be addressed by a guidelines document for integrating transit into TMCs This analysis was used to develop this working paper on review and assessment of TMCs, and on preliminary guidelines for incorporating transit into TMCs Issues that will be addressed in this preliminary guidelines document include:

- Institutional and technology integration issues;
- Data exchange between transit and highway (e.g., transit vehicles as probes); and
- Capabilities for comprehensive traveler information.

1.3 REPORT ORGANIZATION

This report is organized as follows. Section 2 defines the term "transportation management center," and identifies the TMCs that are included as part of this study. Section 3 describes each TMC organization, and discusses the coordination of TMC roles and responsibilities. Section 4 identifies the technologies employed in each TMC for collecting and disseminating transit and traffic information. Section 5 describes the capabilities of traveler information systems in terms of the technologies employed in the TMCs Section 6 presents the conclusions of the study, discusses preliminary guidelines for integrating transit into TMCs, and provides an annotated outline of the final guidelines document. Section 7 presents recommendations for FTA in preparing a final guidelines document.

SECTION 2. TRANSPORTATION MANAGEMENT CENTERS

2.1 DEFINITION OF TRANSPORTATION MANAGEMENT CENTERS

The term “transportation management center” (TMC) has been used to describe multi-modal centers with some level of automation that provide transportation information, and control both traffic and transit. Unfortunately, the use of this term has been limited in existing centers - most existing centers are still called traffic management centers, primarily because they do not include transit. A related term, advanced traffic management systems (ATMS), uses the word *traffic* instead of *transportation.*

For this study, a definition of TMC was developed to define the scope of organizations that would be contacted to collect data. The definition is as follows:

A transportation management center employs advanced technologies to provide transportation information and/or to manage and control transportation networks.

This term greatly broadens the term traffic management center or ATMS, which is defined by IVHS America as follows: “ATMS employ innovative technologies and integrate new and existing traffic management and control systems in order to be responsive to dynamic traffic conditions while servicing all modes of transportation. “[1]

1 Reference 14, p. III-9.

2.2 TRANSPORTATION MANAGEMENT CENTERS CONTACTED

A list of potential TMCs to contact was developed from the available literature (see List of References in Appendix C) and from contacts at the FTA and the Federal Highway Administration (FHWA). The original list is shown in Table 1.

TABLE 1. INITIAL LIST OF TMCs

LOCATION	NAME
Anaheim, CA	Anaheim Traffic Management Center
Atlanta, GA	Atlanta Transportation Management Center (TMC)
Boston, MA	SmartRoute Systems (SRS)
Chicago, IL	Illinois DOT (IDOT) Traffic Systems Center (TSC)
Connecticut	Connecticut Department of Transportation (ConnDOT)
Denver, CO	Denver Traffic Operations Center (TOC)
Detroit, MI	Detroit Transportation Center
Houston, TX	Greater Houston Traffic Management Center (GHTMC)
Long Island, NY	Information For Motorists (INFORM)
Los Angeles, CA	Transportation Operations Center
Milwaukee, WI	Milwaukee Area Freeways Organizational Network Information on Traffic Operations and Response (MONITOR) Traffic Operations Center
Minneapolis/St. Paul, MN	Minnesota DOT (Mn/DOT) Traffic Management Center/Travlink Project
Montgomery County, MD	Montgomery County DOT TMC
Metropolitan New York/New Jersey/ Connecticut	Transportation Operations Coordinating Committee (TRANSCOM)

LOCATION	NAME
Norfolk, VA	Reversible Roadway Bus/High Occupancy Vehicle (HOV) Lanes Traffic Control Svstem
Phoenix, AZ	Traffic Operations Center
San Antonio, TX	IVHS Operations Control Center (OCC)
Seattle, WA	Traffic Systems Management Center (TSMC)

Initial contact was made with almost all of these TMCs After collecting some basic information on each TMC, a decision was made to narrow down the list of TMCs for data collection purposes. The final list of TMCs is shown in Table 2[2]. Transit participation in the majority of these TMCs involves only one transit agency. In only two cases, the Illinois Department of Transportation (IDOT) Traffic Systems Center (TSC) and the Transportation Operations Coordinating Committee (TRANSCOM), there is involvement by multiple transit agencies.

As described in Section 1.2, a detailed list of questions was developed and tested on one TMC. The TMC in Montgomery County, Maryland was chosen for the following reasons:

- Montgomery County DOT has an active traffic management program that incorporates transit in its day-to-day operations;
- Montgomery County DOT is developing and implementing an Advanced Transportation Management System, which includes the use of many advanced technologies; and
- Montgomery County DOT is coordinating its activities with the Maryland State Highway Administration, and the County's Transit System, Ride-On, coordinates its services with the Washington Metropolitan Area Transit Authority (WMATA) Metrorail and Metrobus service, and with Maryland's Mass Transit Administration MARC commuter rail service.

2 The Transportation Operations Center in Los Angeles, CA was not contacted due to complications after the January 17, 1994 earthquake.

TABLE 2. FINAL LIST OF TMCs

LOCATION	NAME
Anaheim, CA	Anaheim Traffic Management Center
Atlanta, GA	Atlanta TMC
Boston, MA	SRS
Chicago, IL	IDOT TSC
Connecticut	ConnDOT
Denver, CO	Denver TOC
Houston, TX	GHTMC
Milwaukee, WI	MONITOR Traffic Operations Center
Minneapolis/St. Paul, MN	Mn/DOT Traffic Management Center/Travlink Project
Montgomery County, MD	Montgomery County DOT TMC
Metropolitan New York/New Jersey/ Connecticut	TRANSCOM
San Antonio, TX	IVHS occ
Seattle, WA	TSMC

A meeting was held with Mr. Gordon Aoyagi, Chief, Division of Transit Services for Montgomery County DOT and Mr. Gene Donaldson, Engineer and IVHS Project Development Coordinator, Division of Traffic Engineering, Montgomery County DOT to collect the information requested in the draft list of interview questions. During this meeting, several suggestions were made to modify the list of interview questions. These suggestions were incorporated into the final list of interview questions, which is shown in Appendix A.

SECTION 3. INSTITUTIONAL AND ORGANIZATIONAL ISSUES

Inherent in the coordination and integration of transit and traffic operations are institutional and organizational issues that can result in the success or failure of those operations. Since transit and traffic operations have totally different goals and objectives, coordination and integration can be very challenging. Thus, the first set of questions asked of the TMCs addressed the basic organizational structure of the TMC and the degree to which transit is or will be involved.

3.1 TRANSIT PARTICIPATION IN TMCS

The first four questions that were asked of the TMCs provided a framework to assess the degree to which transit has been or will be integrated into TMCs These questions asked for:

- The type of TMC:

  Information only;
  Traffic control and management; or
  Both information and control;

- The organizations that participate or will be participating in the operation of the TMC;
- Whether or not transit operations were included in the TMC; and
- Whether or not transit operations were co-located with traffic operations in the TMC.

As shown in Table 3, out of the 13 TMCs contacted, seven have included transit in some aspect of their operation. However, of these seven, only two have transit operations co-located with traffic operations (Montgomery County and Houston), and one will have transit operations co-located with traffic operations (San Antonio). The other TMCs do not have

TABLE 3. TRANSIT PARTICIPATION IN TMCs

LOCATION	NAME	TYPE	TRANSIT INCLUDED?	PARTICIPATING ORGANIZATIONS[3]
Anaheim, CA	Anaheim Traffic Management Center	IC[4]	Y in the future	**City of Anaheim** Anaheim Police Department
Atlanta, GA	Atlanta TMC	C[5]	Y, information only	City of Atlanta **Georgia DOT** Georgia State Patrol Georgia Department of Administrative Services Georgia Department of Natural Resources Georgia Emergency Management Agency Metropolitan Atlanta Rapid Transit Authority Cobb Community Transit Dome Authority Fulton, Dekalb, Cobb, Gwinnett and Clayton Counties

3 Those organizations in bold oversee the TMC operations.

4 IC = Both information and control; C = Control only; I = Information only

5 It will be IC in the future.

LOCATION	NAME	TYPE	TRANSIT INCLUDED?	PARTICIPATING ORGANIZATIONS
Boston, MA	SRS	I	Y	Boston Transportation Department **Massachusetts Highway Department** **Executive Office of Transportation and Construction** Massachusetts Bay Transportation Authority Massachusetts Port Authority (MASSPORT) Massachusetts Turnpike Authority Massachusetts State Police
Chicago, IL	IDOT TSC	IC	N	**IDOT**
Connecticut	ConnDOT	IC	N	**ConnDOT** Connecticut State Police (future)
Denver, CO	Denver TOC (under development)	IC	Y, but not on-site	City and County of Denver Colorado DOT (CDOT) Colorado State Patrol (CSP)
Houston, TX	GHTMC	IC	Y	**City of Houston** **Metropolitan Transit Authority** **Texas DOT** **Harris County**
Milwaukee, WI	MONITOR Traffic Operations Center	IC	N	**Wisconsin DOT, District 2** Milwaukee County Sheriff Department or Department of Public Works

LOCATION	NAME	TYPE	TRANSIT INCLUDED?	PARTICIPATING ORGANIZATIONS
Minneapolis/St. Paul, MN	Mn/DOT Traffic Management Center/Travlink Project	IC	N	Cities of Minneapolis, St. Paul, Bloomington and others Metropolitan Transit Commission **Mn/DOT** State Patrol Several counties in the region
Montgomery County, MD	Montgomery County DOT TMC	IC	Y	Montgomery County DOT **Division of Transit Services** **Division of Traffic Engineering** Maryland State Highway Administration City of Rockville
Metropolitan New York/ New Jersey/Connecticut	**TRANSCOM**[6]	I	Y	New York State Thruway Authority Metropolitan Transportation Authority New Jersey DOT New Jersey Highway Authority New Jersey State Police New Jersey Transit New Jersey Turnpike Authority New York City DOT New York State DOT New York State Police Palisades Interstate Park Commission Port Authority of New York and New Jersey Port Authority Trans-Hudson (PATH) MTA Bridges and Tunnels ConnDOT

6 Over 100 agencies participate in TRANSCOM. TRANSCOM exists through an inter-agency memorandum of understanding among its 15 members. TRANSCOM is administratively part of the Port Authority of New York and New Jersey.

LOCATION	NAME	TYPE	TRANSIT INCLUDED?	PARTICIPATING ORGANIZATIONS
San Antonio, TX	IVHS OCC	IC	Y	San Antonio Police Department **Texas DOT** VIA Metropolitan Transit Authority Texas Transportation Institute (TTI)
Seattle, WA	TSMC	IC	N	**Washington State DOT**

transit involvement on-site since the transit agencies have separate control centers and dispatch facilities.

The majority of the other TMCs have or will have communications links between traffic and transit. In four cases (Anaheim, Chicago, Denver and TRANSCOM), there is or will be a two-way communication link which enables traffic and transit to transmit and receive information. In four other cases (Atlanta, Minneapolis/St. Paul, SmartRoute Systems (Boston), and Seattle), there is or will be only a one-way link between transit and traffic. In three of these four cases, transit will receive traffic data. The other one, SmartRoute Systems in Boston, receives information from the Massachusetts Bay Transportation Authority (MBTA).

The TMCs realize that the information needed for transit operations differs significantly from information needed for traffic operations. However, they also realize that there is information common and critical to both. The primary benefit of transit and traffic having the ability to communicate and to exchange data is that:

- Transit can dynamically adjust its operations (e.g., re-routing around an incident) based on traffic information received from the TMC; and
- Traffic operations can be notified in real-time of incidents and traffic problems encountered by transit. They can also be notified of transit service delays and schedule changes that will have an impact on traffic flow and volume.

3.2 COORDINATION OF TMC ROLES AND RESPONSIBILITIES

The eight questions following the first four addressed the overall coordination between traffic and transit., and how transit was or will be integrated into the TMC Specifically, each of these eight questions considered the following:

- The rationale for collocating (or not collocating) transit with traffic operations;
- The effort underway or planned to incorporate transit;

- How the integration was accomplished;
- The organization that oversees TMC operations;
- Documentation of TMC roles and responsibilities (if available);
- Coordination of transit and traffic operations in the TMC;
- TMC operations personnel responsibilities; and
- Remote operations.

Most of the thirteen TMCs are operated by only one organization, rather than by a coordinated and cooperative group of participating organizations. Because of the traffic emphasis, most TMCs are operated by the local branches of the state DOTs. However, two of the three TMCs in which transit is an integral and operational part are operated by cooperative groups. In the case of Houston, the Greater Houston Traffic Management Center (GHTMC) has an Executive Director who reports to an executive committee made up of members from each of the four participating agencies: City of Houston, Metropolitan Transit Authority, Texas DOT and Harris County. At the Montgomery County DOT TMC, there are cooperative activities that each organization (Transit Services and Traffic Engineering) participates in, but decisions on individual activities are made independently.

In order to better describe each TMC's organization and the participation by the local transit agency(ies), the following subsections summarize each TMC's structure and relationship with the local transit agency.

3.2.1 Anaheim Traffic Management Center

The City's Traffic Management Center was originally designed in November 1986 by JHK and Associates.[7] When it started, the City funded the project and it was led by the City's Traffic Engineering staff. But since then, several other City Departments, the California Department of Transportation (Caltrans), FHWA, Orange County Transportation Authority (OCTA) and other local agencies have become involved. (OCTA is not located on-site, nor

7 Ref 19.

are some of the other involved agencies.) Also, the Traffic Management Center has a two-way communication link with the Caltrans District 7 Traffic Operations Center in Los Angeles and the District 12 Office in Orange County. This link provides the City with information on freeway conditions and provides Caltrans with information on city streets.

The City has an extensive traveler information system that is accessible through cable television, remote kiosks and advisory telephone. This system focuses on the Disneyland/Convention Center/Stadium area. Eventually, the Traffic Management Center will coordinate with transit when automatic vehicle location (AVL) is installed on OCTA buses and the buses can become traffic probes. In the other direction, information on traffic conditions will be given to OCTA dispatching from the Traffic Management Center.

In 1992, JHK performed a study to define a transit IVHS project for short-term implementation in Anaheim. One of the objectives of this study was to "develop a detailed description of an operational test of an integrated transit/traffic traveler information system in Anaheim."[8] The result of this study was the design of a regional traveler information system, incorporating both transit and traffic information, and an AVL system. This effort is being led by OCTA, with support from the City of Anaheim and Caltrans. This field operational test is expected in 1994 to test AVL and integrate transit information into the existing traveler information system.

3.2.2 Atlanta Transportation Management Center (TMC)

Groundbreaking began on the new Atlanta TMC in March 1994, and it is expected to be operational in 1995. The TMC will be a real-time integrated system covering all surface transportation in the five-county greater Atlanta region. (50% of the total vehicular traffic and 44% of the state's population is in the five-county area.) Georgia DOT will oversee the TMC's operations. The TMC is one part of an advanced transportation management system,

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8 Reference 15, p. 1-1.

which also contains:

- Transportation control centers (TCCs);
- A communication network between the TMC and the TCCs;
- Integrated and interactive computerized data processing;
- Control and management software for the integration of field-deployed equipment;
- A field communications network; and
- Field equipment upgrades.

The functions of the TMC include:

- 24-hour operations;
- Data backup;
- System-wide planning coordination;
- Incident management coordination;
- Cross-jurisdictional special event coordination;
- Media coordination and cooperation; and
- System software support and maintenance.

The heart of the TMC is a geographic information system (GIS), as shown in Figure 1.

Metropolitan Atlanta Rapid Transit Authority (MARTA) dispatching will not be included in the TMC, but MARTA will have an informational presence. A MARTA representative will, however, be located at the TMC during special events. All the technology that will be utilized at the TMC is being designed with transit in mind, even though transit information may not be available through the TMC by the 1996 Olympics.

It is expected that a communications network will enable MARTA to provide real-time routes, schedules and ridership to the TMC. Also, when MARTA upgrades their AVL system to one based on global positioning system (GPS), this AVL information will be provided to the TMC.

Two field operational tests have recently been approved for Atlanta. One is an advanced traveler information system (ATIS) in which traveler information is distributed at kiosks located at welcome centers all over the state of Georgia. The other involves an en-route

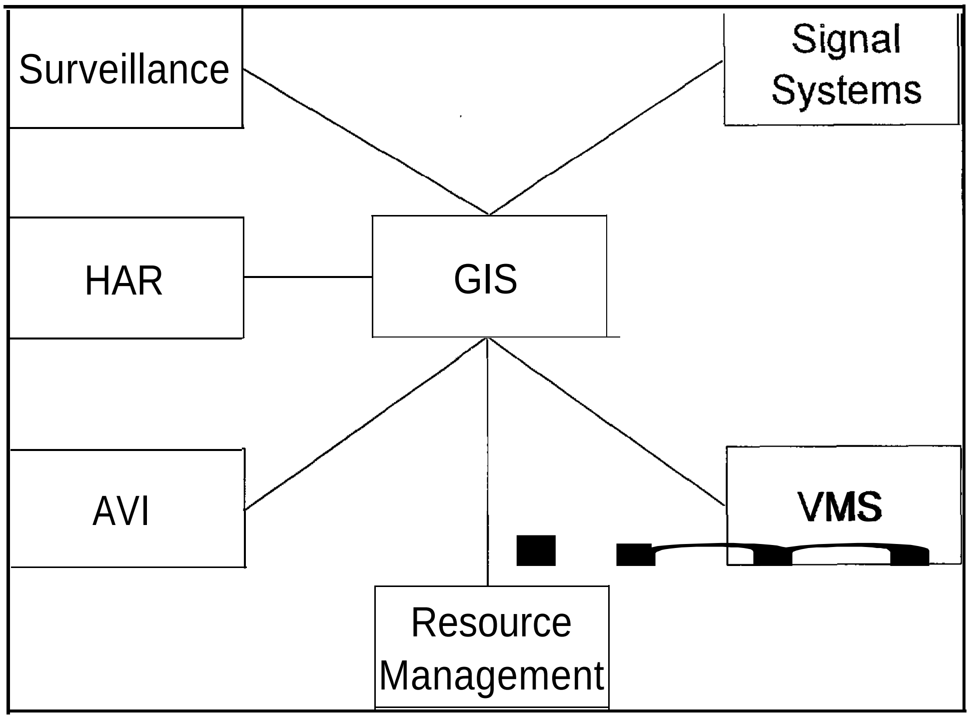

Figure 1. Atlanta TMC

traveler information system, which will include a radio link with MARTA and Cobb Community Transit.

3.2.3 SmartRoute Systems (Boston)

SmartRoute Systems (SRS) is a private company that designed and currently operates an interactive audiotex ATIS for the Boston metropolitan area and Cape Cod. This ATIS, called SmarTraveler, includes information on the MBTA's rapid rail, light rail, bus and commuter rail operations in addition to up-to-the-minute route-specific traffic information. SRS worked with MBTA management and operations officials to establish protocols for relevant information to be communicated from the MBTA operations center to SRS's operations center. This communication is via direct ring-down[9] telephone lines. Currently, SRS is working with the MBTA to improve the quality and quantity of information by connecting electronically to the MBTA's headway monitor system, which monitors delays and problems, adjusts train flow when necessary and makes announcements to passengers as to when the next train is due to arrive.

SmarTraveler is accessible by a local phone call in Greater Boston (374-1234) and is menu-driven. The menu selections are shown in Table 4.

TABLE 4. SmarTraveler MENU SELECTIONS

ROUTE/LOCATION	MENU SELECTION
Route 1	1*
Between Topsfield and Charlestown, including the Tobin Bridge	11*
Between Dedham and Wrentham	12*
Route 2	2*
Route 3	3*
Between Lowell and Burlington	31*
Between Boston and Plymouth	32*
Logan Airport, including the Callahan and Sumner tunnels	5*
Boston and Cambridge roads, including the Central Artery, Storrow and Memorial Drives, and the Jamaicaway	6*
Travel to and from Cape Cod and the Islands	7*
Route 9	9*
Subway, Rapid Transit, Bus and Commuter Rail	10*
Commuter rail	11*
Subway and rapid transit	12*
Buses	13*
Route 24	24*
Massachusetts Turnpike and I-90	90*

9 When the handset is picked up at SRS, the phone rings at MBTA dispatching.

ROUTE/LOCATION	MENU SELECTION
Route I-93	93*
Between Boston and Andover	931*
Boston and Canton, including the Southeast Expressway	932*
Route I-95	95*
Between Salisbury and Peabody	951*
Between Peabody and the Mass Turnpike	952*
Between the Mass Turnpike and Canton	953*
Between Canton and Foxboro	954*
Route 128	128*
Between the Mass Turnpike and Beverly	1281*
Between the Mass Turnpike and Braintree	1282*
Route 495	495*
Between the Mass Turnpike and Salisbury	4951*
Between the Mass Turnpike and Bourne	4952*

3.2.4 Illinois DOT Traffic Svstems Center (Chicago)

The IDOT Traffic Systems Center (TSC) provides traffic information to a variety of users on 136 miles of freeway in the Chicago metropolitan area. Although transit is not directly involved in the Center's operation, several of the local transit agencies are interactive users. The transit interactive users, METRA (commuter rail) and PACE (suburban bus), can receive traffic information and can transmit information on route changes, schedule changes and incidents. The Chicago Transit Authority (CTA) is planning to become an interactive user in the future.

The IDOT TSC provides traffic summaries, including travel times on the five major freeways in the Chicago area, every five minutes to users who include:

- Media (radio and television)[10];
- Cable television channel;
- Pager system;

[10] Most of these users have receive-only capability.

- Cellular telephones;
- Traffic networks (Shadow Traffic and Metro Traffic);
- State police;
- City of Chicago;
- O'Hare Airport;
- Highway advisory radio (HAR); and
- Several local universities.

The IDOT TSC is also part of a project in the IVHS priority corridor (Gary, IN to Chicago, IL to Milwaukee, WI) to share and coordinate traffic and transit information within the corridor (see Section 3.2.8).

3.2.5 Connecticut

Connecticut's initial plans are for highway operations and incident management. They will consider incorporating transit operations, in terms of information only, in the future.

3.2.6 Denver Traffic Operations Center

The Denver Traffic Operations Center (TOC) is currently under development. The conceptual design, construction and implementation of this Center is described in Reference 10. "The TOC will be a multi-jurisdictional, multi-agency facility. Space will be provided for Colorado Department of Transportation (CDOT) and Colorado State Patrol (CSP) personnel, as well as for public/private sector staff including traffic engineers from cities and counties in the Denver Area, the media, traffic information services and enforcement and fire agencies and emergency medical response organizations."[11]

The TOC will receive input from the Regional Transportation District (RTD) (the local transit agency) in terms of RTD bus and light rail transit (LRT) schedules and status, and

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11 Reference 10, p. 1-1.

information on incidents from RTD bus drivers. RTD operations will not be located in the TOC since they recently constructed a new control center. A representative from RTD may be the liaison between the TOC and RTD. This position has been described in Reference 10, as follows: "Duties may include coordinating transit scheduling information, the RTD audiotex system and other transit project information. This position will be responsible for incorporating APTS technologies and methods into RTD's service, as well as integrating these with other regional IVHS initiatives. In addition, the position will be responsible for coordinating RTD's GPS system with the TOC so that the express bus service's AVL capabilities can be used as probes. This position will build on initial coordination efforts begun earlier in 1992 between RTD and CDOT."[12]

It is expected that workstations located at the TOC and RTD control center will facilitate the exchange of information between the TOC and RTD. The RTD workstation "could include:

- Interactive keyboard communication with the RTD system network.
- Cathode ray tubes (CRTs) for textual and graphical information displays.
- Audiotex information generation capabilities.
- Data and communication links with GPS and AVL components of the transit fleet.
- General use multi-function telephone."[13]

3.2.7 Greater Houston Traffic Management Center (GHTMC)

The GHTMC is managed by an Executive Director who reports to an Executive Committee made up of Texas DOT, Harris County, Metropolitan Transit Authority (METRO) and the City of Houston. Currently, the GHTMC is located at an interim facility while the final site is under construction. Even though METRO will not locate their dispatching operations in the GHTMC, they will have a major presence at the GHTMC in terms of HOV lane

12 Reference 10, p. 4-21.

13 Reference 10, pp. 6-6 to 6-7.

operations. For traffic incidents, alternate routing and/or scheduling strategies will be developed at the GHTMC with transit personnel, and the GHTMC will advise METRO dispatching of the alternatives. Further, when AVL is installed in the METRO's bus system, the data from the AVL system will be available at the GHTMC, particularly for incidents and special events.

METRO is unique among transit agencies since it is not only responsible for operating the bus system, but also for operating and maintaining the HOV lanes. METRO has also funded and managed "general mobility improvements," such as road reconstruction. Due to sufficient resources, METRO has a significant role in all aspects of the region's transportation. For example, METRO reconstructed the Southwest Freeway when the state of Texas did not have the money to do the reconstruction,

METRO will be involved in a public security project, in which closed-circuit television (CCTV) cameras and call boxes with two-way communication will be installed at park-and-ride lots and transit centers for security. These cameras and call boxes would be monitored from the GHTMC. Each bus stop on one major route downtown (that runs along Main Street) will also have a CCTV camera and a call box for security. These call boxes would eventually provide traveler information with static schedules initially and dynamic information in the future.

The City of Houston is installing an Emergency Priority System (EPS) which uses infrared equipment to change traffic signals for fire trucks and ambulances. This system will be available on 2,800 signals in METRO's service area. The City is providing this infrared equipment to METRO for its buses. The system for buses will not pre-empt traffic signals, but will extend the green phase. The infrared system is in compliance with the SAE J1708 standard, and will not require any intervention by the bus driver. As each bus triggers a priority, the infrared system will record the vehicle's number, vehicle type, the time that the priority was given and the direction of the vehicle.

Texas DOT has implemented an automatic vehicle identification (AVI) system consisting of cards and card readers on I-45 North, I-10 West and Route 290 West. This system will be expanded eventually to a total of 227 miles of freeway and 70 miles of HOV lanes, covering the Hardy Toll Road, I-610, Route 59 North and South, I-10 Past, the Sam Houston Tollway and I-45 South. Radio frequency antennas are mounted overhead on existing signs and bridges, scanning the HOV lanes looking for tags on vehicles that are serving as traffic probes. "The readers are spaced at one- to four-mile intervals and transmit transponder tag information at one-minute intervals. Average speeds are calculated and presented on a graphics display in 10 mph increments for use by GHTMC operators. Travel time information is placed in tabular form for use by other agencies for other applications."[14] Actual trip times are compared with expected trip time, and from that, volumes and the level of congestion is determined.[15]

"AVI technology is planned for other traffic management applications:

- Additional AVI readers will be installed on one freeway to test the use of this technology for incident detection. Spacings in the test section will vary from 0.5 to 1 .O miles.
- AVI readers will be installed within Park & Ride Facilities to monitor the arrival and departure of the transit vehicles.
- AVI readers will be temporarily installed at Park & Ride Facilities and at Bus Loading facilities to monitor special event shuttle bus operations.
- AVI readers will be installed on one arterial facility to test the use of AVI information for the operation of arterial street signal systems."[16]

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14 Reference 24.

15 Reference 29, p. 94.

16 Reference 24.

3.2.8 Milwaukee MONITOR Traffic Operations Center

Milwaukee is at the end of an IVHS priority corridor, which is defined from Gary, IN to Chicago, IL to Milwaukee, WI. Wisconsin DOT (WisDOT) operates the MOMTOR Traffic Operations Center, which will be fully implemented in the summer or fall 1994. The local transit agency, Milwaukee County Transit (MCT) does not have any personnel resident at the MONITOR Traffic Operations Center.

WisDOT is currently concentrating on the staged implementation of the MONITOR TOC. They have a long-range goal to incorporate transit into the Traffic Operations Center, but no commitments have been made by WisDOT or MCT. However, WisDOT recognizes that transit is an important element of a future traveler information system that would include pre-trip plating. This future system would also include the installation of kiosks at employment centers, and will be integrated with a corridor traveler information system.

MCT and WisDOT applied for an operational test that would have integrated MCT's GPS AVL system with the Traffic Operations Center, and would have used MCT buses as traffic probes. The test would have also provided the capability to expand the AVL system to enforcement agency vehicles. The application was turned down. However, MCT is still interested in integrating their AVL and computerized scheduling with the Traffic Operations Center.

3.2.9 Mn/DOT Traffic Management Center

The Mn/DOT Traffic Management Center manages traffic on Twin Cities metropolitan area freeways. "The Traffic Management Center is equipped with video and radio monitoring and broadcasting equipment, traffic management work stations, and staffed by 37 personnel, Its control room includes two independent operator stations, a radio announcer station, an information officer work station, computer graphics terminals, and a large screen for map display. Each operator station has 24 17-inch monitors and computer terminals with graphics capabilities to view system-wide status, control on-line ramp meters and changeable message signs. A large computer generated map displays real time traffic conditions on the metro area freeway system. The Mn/DOT Traffic Radio broadcast station currently has a bank of **128** nine-inch monitors. Information officers utilize a variety of audio communication equipment to gather and monitor additional traffic information and weather conditions. "[17]

The Mn/DOT Traffic Management Center is responsible for managing traffic on I-394, a major freeway between Wayzata and downtown Minneapolis. I-394, an 11-mile, six lane highway, was constructed to provide priority to high occupancy vehicles (HOVs) through the implementation of:

- HOV Lanes:
  - Reversible lanes (3 miles)
  - Diamond lanes (8 miles)
  - Ramp meter bypass lanes (11)
- Park-and-Ride Lots (7);
- Transit Centers (2); and
- Parking Garages/Intermodal Transfer Facilities (3).

Although the local transit agency, the Metropolitan Transit Commission (MTC), is not a part of the Traffic Management Center, it is an integral part of the Travlink project. Travlink "is an operational test that will implement and evaluate an Advanced Traveler Information System in connection with an Automatic Vehicle Location System on I-394. This project is sponsored by Minnesota Guidestar, the state's program for IVHS. "[18]

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17 Reference 25.

18 Reference 41, p.1.

One of Travlink's objectives is to "provide real-time transit schedule and traffic information for use at homes, workplaces, transit stations and other activity centers. "[19] This traffic information will be collected from the Traffic Management Center through Genesis, which is' an operational test of a personal communication device[20] (PCD) that will provide the user with real-time, route-specific information on the operating conditions of highway and mass transit systems and other personal-use types of information.

3.2.10 Montgomery County DOT TMC

Montgomery County is in the process of developing and implementing an advanced transportation management system. Even before this system is fully implemented, the County's transit system (Ride On) dispatching operation and their information center is co-located with the traffic management and control facility. This was done to improve coordination between traffic engineering and transit services, and ultimately, to ensure the efficient utilization of transportation capacity in the County.

When fully implemented, the advanced transportation management system will include the following capabilities and functions[21]:

- Advanced traffic responsive traffic signal control;
- Automated sign control system;
- 200-camera video surveillance system;
- Sophisticated electronic transportation monitoring systems;
- Time-critical GIS;
- Automated transportation information system;
- Integrated transit and traffic operations;
- GPS and other technologies based vehicle tracking system;

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19 Reference 41, p. 1.

20 PCDs identified for Genesis include alphanumeric pagers, personal digital assistants (a small hand-held unit with 2-way radio frequency communications), and notebook computers.

21 "Advanced Transportation Management System," handout available at Montgomery County DOT TMC.

- Automated incident management system;
- Aerial surveillance operations;
- Automated integration with police/fire computer-aided dispatch systems;
- Automated transportation planning support;
- Sophisticated fiberoptic-based communication system; and
- Integration with future automated highway systems.

3.2.11 TRANSCOM (Metropolitan New York/New Jersey/Connecticut)

TRANSCOM is a consortium of highway, transit and public safety agencies in the New York City metropolitan area including New York, New Jersey and Connecticut (see Table 3). TRANSCOM began operation in 1985 and in its role of coordinating these agencies to improve mobility, it has become "an almost indispensable element of the region's complex transportation network. [TRANSCOM] continuously monitors traffic conditions, construction schedules, road closings, accidents, weather-related incidents and any other event that might disrupt traffic on the estimated 6,000 miles of highway and 2,000 miles of track within the 500 square mile metropolitan area. "[22]

TRANSCOM alerts appropriate agencies when incidents interfere with traffic in the metropolitan area by telephone, alphanumeric pagers, facsimile and other technologies. Further, TRANSCOM suggests that affected agencies use existing agency-owned technologies such as variable message signs (VMS) and HAR to re-route drivers to alternate routes. TRANSCOM will have its own VMS and has already installed CCTV and HAR for Routes 4 and 17 in Bergen County, NJ.

In spring 1994, TRANSCOM will be improving their incident detection by using electronic toll and traffic management technology. This system, called TRANSCOM's System for Managing Incidents and Traffic (TRANSMIT), will place "electronic toll and traffic management (ETTM) readers along highways and selected arterials to monitor ETTM

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22 Reference 1.

'tagged' vehicles, recording travel times, identifying travel patterns and detecting incidents. The Consultant team has started the development of the necessary software to run the system and the final design of the field and communication equipment for a limited application of TRANSMIT in the Bergen County/Rockland County corridor. This 15 mile limited implementation is building upon the New York State Thruway's interim read-only EZ-PASS application at Spring Valley and Tappan Zee toll plazas, placing readers along 10 miles of the New York State Thruway and 5 miles of the Garden State Parkway."[23]

One of TRANSCOM's on-going objectives is to increase transit agency participation. This objective led to FTA granting Section 8 funds for TRANSCOM, in cooperation with local metropolitan planning organizations (MPOs), "to develop incident management plans for transit corridors."[24] For the Port Authority Trans-Hudson (PATH), TRANSCOM developed an interagency communication and operation plan for PATH Hoboken service disruptions. TRANSCOM also developed a "Framework for an Incident Management Plan and Opportunities for Interagency Communications Linkages for Long Island Rail Road Service Disruptions," in conjunction with the New York Metropolitan Transportation Council. These two plans?

- Identified linkages to external agencies that might be affected by service disruptions;
- Outlined a sequence of notification procedures;
- Assigned responsibilities when service is suspended temporarily; and
- Complemented internal operational efforts for train operations, service recovery, police/fire notifications and provision of alternate service.

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23 Reference 36 p. 15.

24 Reference 37, p. i.

25 Reference 31, p. 13-14 and Reference 38, p. 24.

Through these incident management plans, TRANSCOM is reinforcing the idea that transit agencies are an integral part of the region's total transportation picture - when there is an incident on a specific transit agency's route, it does affect traffic as well as transit, and it should be accurately reported to the traveling public along with possible alternatives.

Other projects that TRANSCOM has received Federal funding for include[26]:

- Alternate Bus Routing System (ABRS), which uses a video imaging detection system (VIDS) and vehicle to roadside communication (VRC) system, will calculate the travel times of parallel routes from Interchange 127 of the Garden State Parkway to Interchange 11 of the New Jersey Turnpike, and transmit this information to 400+ buses using this Raritan corridor;
- Regional VMS program, with VMS at 20 locations throughout the NY/NJ/CT region;
- CCTV and HAR program, in addition to the system mentioned above, four additional CCTV systems will be installed at the Tappan Zee Bridge, at interchange 16W of the NJ Turnpike, at the Triborough Bridge, and at interchange 163 of the Garden State Parkway, and one HAR system for the George Washington Bridge;
- Regional Video Linkage to connect TRANSCOM's member agencies' video feeds into TRANSCOM's Operation Information Center; and
- VIDS installed at New York State DOT's INFORM center in Hauppauge. This system is being evaluated as an alternative to induction loops, as a method for collecting traffic data (speeds, volume, vehicle classifications) and detecting incidents.

3.2.12 San Antonio IVHS OCC

The San Antonio IVHS OCC is a 51,000 square-foot facility which is currently under construction, and is expected to be completed and fully operational by September 1994. It will initially manage 24% miles of freeway and arterials with four operators. Eventually, it will manage 191 miles of roadway with 18 operators. The OCC will be overseen by Texas DOT, and will house Texas DOT, local law enforcement and VIA Metropolitan Transit.

26 Reference 36, pp. 15-16.

VIA may move their dispatching operations to the OCC, even though they have two other control rooms - one downtown and one in the new Alamo Dome. VIA built and owns the Dome, which has 65,000 seats and 2,500 parking spaces. VIA has been carrying 10% of the attendees at regular Dome events and up to 30% at special events from park-and-ride lots to the Dome.

VIA received a grant from FTA to tie into the fiberoptic network being installed as part of the OCC from their two existing control rooms. This grant will also add cameras to the surveillance network. These cameras will be installed in the park-and-ride lots for security and for determining the fill level at the lots.

3.2.13 Seattle Traffic Systems Management Center

The Seattle Traffic Systems Management Center (TSMC) became operational in May 1993. Washington State DOT oversees TSMC operations. Seattle Metro, the local transit agency, is not included in the TSMC. As discussed by other TMCs, since Seattle Metro's operations are very different from those of the TMC, there was no interest to locate any Metro operations at the TMC. However, Washington State DOT and Metro share information, and plan to tie their centers together with fiberoptic cable to share data and video. Currently, Metro has a remote graphics display of the freeway that indicates congestion in real-time.

Seattle Metro has an operations center in the downtown Seattle bus tunnel in addition to a separate dispatch facility. The TSMC notifies Metro's dispatch of changes in the operations of the reversible express lanes on I-5 that may affect transit operations.

The TSMC provides free telephone traffic reports that are updated every five minutes in the peak and every 30 minutes in the off-peak. The data used to construct the reports is collected from induction loops and information from Metro drivers on the condition of arterials. This data is also used by local radio and television stations. Currently, the telephone traffic reports include Metro and carp001 advertising.

SECTION 4.
TECHNOLOGIES EMPLOYED IN TMCs

The study identified specific automated technologies that are or will be employed by the TMCs. The technologies employed or to be employed by each TMC are shown in Table 5.

The two technologies that are directly related to transit, adaptive signal control and AVL, will be used in the future by most of the TMCs that provide both traffic control and information. For most that said they would employ adaptive signal control in the future, they also said that they would be using data from transit AVL systems in the future when these systems are fully operational. Specific descriptions of transit and traffic data that is currently or will be collected and disseminated is given in Sections 4.1 and 4.2, respectively.

4.1 TECHNOLOGIES TO COLLECT AND DISSEMINATE TRANSIT INFORMATION

There is very little transit information that is collected and disseminated through the TMCs, as shown in Tables 6 and 7. Most transit agencies have their own mechanisms for collecting and distributing information, and with the exception of a few TMCs, this information is not even available at the TMC. The following subsections describe what transit information is or will be collected, and how it is or will be collected

4.1.1 Anaheim Traffic Management Center

In the future, the Anaheim Traffic Management Center plans to collect real-time data on vehicle location, routes and schedules. At this point in time, they have not decided the rate

TABLE 5. ADVANCED TECHNOLOGIES CURRENTLY EMPLOYED IN THE TMC[27]

TMC LOCATION	ADAPTIVE SIGNAL CONTROL	AVL	COMPUTERIZED SIGNAL SYSTEM	GIS	GRAPHICS-BASED DISPLAY	INCIDENT DETECTION	AUTOMATED LOGGING/ RECORDING	OTHER
Anaheim Traffic Management Center	F	F	✓		✓	F	F	
Atlanta TMC	F	F	✓	✓	F	F	F	
SRS (Boston)				F		F		CCTV,and in the future, ultrasonic detection and cellular phone probes
IDOT TSC (Chicago)			✓		✓	✓		
Connecticut			✓	F	✓	✓	F	VMS, Radar Detectors, Cameras
Denver TOC	F	F	F	F	F	F		
GHTMC	F	✓	✓	✓	✓	✓	✓	AVI, Video Surveillance, VMS. In the future, bus priority signalization, HAR, dynamic lane assignment
Milwaukee MONITOR Traffic Operations Center			F		F	F	F	

27 ✓ indicates current use, and F indicates future use.

TMC LOCATION	ADAPTIVE SIGNAL CONTROL	AVL	COMPUTERIZED SIGNAL SYSTEM	GIS	GRAPHICS-BASED DISPLAY	INCIDENT DETECTION	AUTOMATED LOGGING/ RECORDING	OTHER
Mn/DOT Traffic Management Center		F	✓	F	✓	✓		Ramp Meters, CCTV, Metro Area Radio, VMS, Cable TV Traffic Channel, Lane Control Signals
Montgomery County DOT TMC	F	✓	✓	✓	✓	✓		
TRANSCOM (Metro NY/NJ/CT)				✓	F	✓		
San Antonio IVHS OCC	F	F	F	F	F	F	F	
Seattle TSMC	F	F	✓	F	✓	✓	F	

TABLE 6. TRANSIT INFORMATION CURRENTLY DISTRIBUTED

TMC LOCATION	TIME-TABLES	REAL-TIME TIMETABLES	ROUTES	ROUTE DETAILS	FARES	BUS LOCATION	NEXT-STOP ANNOUNCE-MENTS	OTHER
Anaheim Traffic Management Center	F	F	F	F	F	F		Travel Times
Atlanta TMC	F		F	F	F			
SRS (Boston)		✓					F	
IDOT TSC (Chicago)	F	F	F	F	F	F	F	Problems, Delays, Reroutes, etc.
Connecticut								
Denver TOC								
GHTMC	F	F	F	F	F	F	F	Breakdowns and Accidents
Milwaukee MONITOR Traffic Operations Center								
Mn/DOT Traffic Management Center								Ridership data
Montgomery County DOT TMC	✓	✓	✓	✓	✓	✓	✓	Carpool/Vanpool Info and Other Transit Demand Strategies

TMC LOCATION	TIME-TABLES	REAL-TIME TIMETABLES	ROUTES	ROUTE DETAILS	FARES	BUS LOCATION	NEXT-STOP ANNOUNCE-MENTS	OTHER
TRANSCOM (Metro NY/NJ/CT)								Incidents related to delays
San Antonio IVHS OCC	F	F	F	F	F	F	F	
Seattle TSMC								

TABLE 7. CURRENT DISTRIBUTION OF TRANSIT INFORMATION

TMC LOCATION	CABLE TV	RADIO BROAD -CAST	PCI MODEM	INFO KIOSK @ BUSINESS/ SHOPPING COMPLEX	INFO KIOSK @ TRANSIT STOP/ CENTER	TELE- PHONE	DISPLAY @ BUSINESS/ SHOPPING COMPLEX	DISPLAY @ TRANSIT STOP/ CENTER	ON- BOARD TRANSIT VEHICLE	OTHER
Anaheim Traffic Management Center	F	F	F	F	F	F				
Atlanta TMC	F	F		F	F	F				
SRS (Boston)	✓	✓	F	F		✓				
IDOT TSC (Chicago)						✓				Through TSC Surveillance Computer System in Oak Park (via leased/ dial-up telephone lines)
Connecticut										
Denver TOC			F	F	F	✓	✓	✓	✓	
GHTMC	✓	✓	F	F	F	✓	✓	✓	✓	
Milwaukee MONITOR Traffic Operations Center										
Mn/DOT Traffic Management Center			F	F	F	F		F		Written reports
Montgomery County DOT TMC						✓				
TRANSCOM (Metro NY/NJ/CT)		✓	F	F	F	✓	F	F		Pager, Public address system
San Antonio IVHS OCC	F				F	✓		F	F	Trip planning info
Seattle TSMC										

at which this data will be collected. This information will be collected through a communications inter-tie from OCTA's computer to the Center's computer. The collection will be facilitated by OCTA's AVL system.

4.1.2 Atlanta Transportation Management Center (TMC)

Similarly in Atlanta, the Atlanta TMC plans to collect real-time data on routes, schedules and ridership.

4.1.3 SmartRoute Systems (Boston)

SRS collects data on and reports MBTA delays of major proportions and trains out of service. Transit data is updated six times per day currently, and it is collected by a direct ring-down telephone connection to MBTA dispatchers who selectively pass along the data. SRS is in the process of connecting electronically to the MBTA's headway monitor system (see Section 3.2.3) in order to improve the transit information they distribute through SmarTraveler.

4.1.4 Illinois DOT Traffic Systems Center (Chicago)

In Chicago, no transit data is actually collected, but any user connected to their traffic information network can view bulletins put onto the system by any interactive user, including METRA and PACE. In the future, CTA will also be an interactive user. These bulletins can be entered into the system at any time (24 hours per day, seven days per week). Also, as mentioned in Section 3.2.4, the IDOT TSC is part of a project in the Gary, IN-Chicago, IL-Milwaukee, WI corridor to share and coordinate all types of travel information including transit information.

4.1.5 Denver Traffic Operations Center

In Denver, RTD is collecting data on ridership, and boar-dings and alightings from stand checks and ride checks, respectively. Data from their automated vehicle monitoring and management (AVMAM) system will be available in the future (the AVMAM system is expected to be completely operational in June 1994). The AVMAM data will generate real-time departure data that will be provided to customers through an advanced passenger information system. This system is part of an IVHS operational test and will distribute information at selected locations. Eventually, RTD hopes to expand the system to VMS and park-and-ride counts, and to provide both display-only and interactive capabilities.

4.1.6 Greater Houston Traffic Management Center (GHTMC)

In the GHTMC, data is currently collected on HOV-lane incidents and METRO special event services. In the future, information on real-time schedules and passenger loads is expected to be collected at the GHTMC. How the data will be collected and how often is currently under development.

4.1.7 Milwaukee MONITOR Traffic Operations Center

In Milwaukee, transit information is not currently collected and distributed by the MONITOR Traffic Operations Center. Currently, data on routes, fares and bus location are distributed through a transportation demand management (TDM) promotional activity. In the future, this data would be included in a traveler information system. In addition, information on routes is currently provided at a kiosk at the Barstow Station as a promotion.

4.1.8 Mn/DOT Traffic Management Center

In Minneapolis/St. Paul, ridership data is currently collected by MTC manually every month. However, data on facility usage will be collected by MTC and made available to Mn/DOT.

This data will include:

- The number of I-394 users, carpoolers and bus riders at each transit facility; and
- A log of bus routes available at each transit facility, and bus occupancy rates.

The Travlink project will collect and distribute extensive transit and traffic data through an ATIS. The data will be collected from MTC and the Traffic Management Center. Tables 8 and 9 show the specifications for transit and traffic data collection, respectively.[28]

TABLE 8. TRAVLINK TRANSIT DATA COLLECTION SPECIFICATIONS

DATA TYPE	FREQUENCY
Transit schedules/routes with fares	Once every 3 months
Real-time transit exception reports	20% - 30% of 80 buses/minute
Predefined Transit Trips (area to area for I-394 corridor only)	Once every 3 months
Special transit informational messages	8 per day
Route maps (10 routes in the I-394 corridor only)	Once every 3 months
Elderly and Disabled / Ridesharing	Infrequently
Park-and-ride locations	Infrequently

TABLE 9. TRAVLINK TRAFFIC DATA COLLECTION SPECIFICATIONS

DATA TYPE	FREQUENCY
Traffic flow (highway link travel times)	Once every 5 minutes for all links
Traffic incidents and delays	10 per day
Construction and detours	90 per day

28 Reference 42, pp. 3-6 to 3-l.

The traveler information to be provided by Travlink will be available through four types of devices: electronic signs, display monitors, kiosks and videotex terminals. Both the kiosks and videotext terminals are interactive. Table 10 summarizes the traveler information available on each type of device.[29]

TABLE 10. TRAVLINK TRAVELER INFORMATION DISTRIBUTION

TRAVELER INFORMATION	DEVICE TYPE			
	Sign	Monitor	Kiosk	Videotex
TRANSIT				
Route Schedules			✓	✓
Route Maps			✓	✓
Fares			✓	✓
Bus Stop Schedules	✓	✓		
Real-Time Status	✓	✓		
Special Messages	✓	✓	✓	✓
Park-and-Ride Parking			✓	✓
Transit Trip Planning			✓	✓
Ridesharing			✓	✓
Elderly and Disabled			✓	✓
TRAFFIC AND ROADWAY				
Incidents			✓	✓
Construction and Detours			✓	✓
Highway Segment Information			✓	✓
MODE COMPARISONS				
Static Travel Time			✓	✓
Static Cost			✓	✓

29 Reference 41, p. 16.

Figure 2 shows the current fiberoptic cable network between the TMC and other participating organizations.[30]

4.1.9 Montgomery County DOT TMC

In Montgomery County, transit information to be collected and distributed is still under development. This data might include command and control activities of the transit system, such as bus changeouts, incidents and accidents. Also, AVL may provide information on routes, vehicle location average speed, time that vehicle was moving, and time that vehicle was stopped. Transit information, including real-time timetables and bus location, is currently distributed by telephone through Montgomery County's Transit Information Center. Also, Montgomery County currently operates an automated transit information system, which provides information on fares and fare media, holiday service schedules, service interruptions due to snow or other emergencies, Wheelchair-Accessible Ride-On, and other general information including paratransit and ridesharing services.

4.1.10 TRANSCOM (Metropolitan New York/New Jersey/Connecticut)

TRANSCOM collects data on transit incidents on varying thresholds depending on the transit agency's needs. In the future, TRANSCOM is expecting that thresholds will decrease for agencies, so that more incidents will be reported. As incidents occur, the agencies call TRANSCOM to report them.

4.1.11 San Antonio IVHS OCC

Currently, VIA collects data on ridership manually, and on vehicle location through their existing automatic vehicle monitoring (AVM) system. The AVM system, which is a signpost

30 An official local system architecture has not been developed yet. The Traffic Management Center also has extensive communications with local radio stations for traveler information.

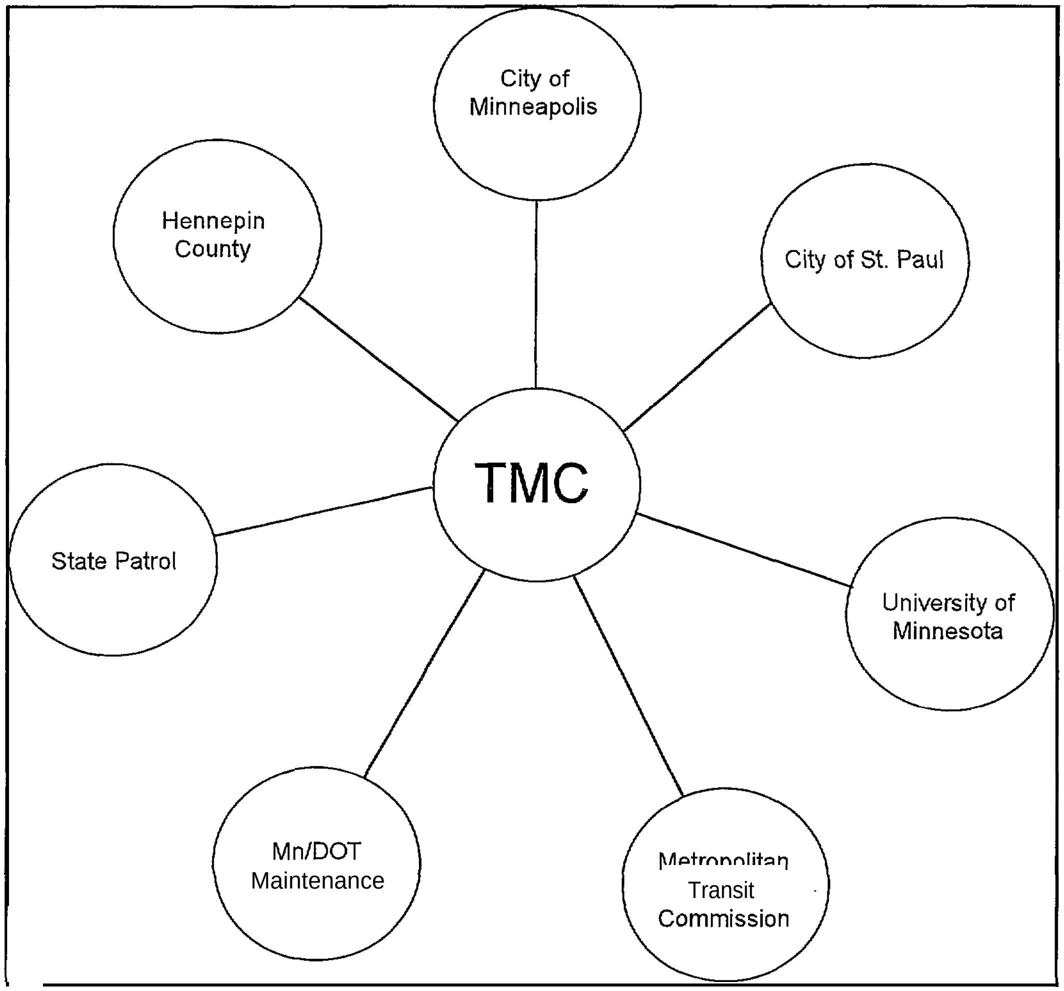

Figure 2. Current Fiberoptic Network Between Mu/DOT Traffic Management Center and Other Participating Organizations

system, will be replaced in the near future by a GPS AVL system. VIA has a computerized customer service line for those customers that know their bus stop number. This system will tell customers when the next three buses will arrive at that specific bus stop based on schedules (not actual arrival times). If a customer does not know their bus stop number, there are eleven operators on duty at peak times to answer route and schedule questions.

In the future, VIA will be located at the OCC, and will distribute information on timetables, real-time timetables, routes, route details, fares, bus location and next-stop announcements.

It is expected that this information will be distributed through cable television, information kiosks at park-and-ride lots and major transfer points, by telephone, displays at transit stops to indicate when the next bus will arrive, and signage and next-stop announcements on-board the buses.

4.1.12 Seattle Traffic Systems Management Center

The Seattle TSMC does not currently collect any transit data. They will be collecting data on bus travel times on arterials in the future.

4.2 TECHNOLOGIES TO COLLECT AND DISSEMINATE TRAFFIC INFORMATION

There is much more traffic data collected and disseminated through TMCs than transit data due to the nature of TMCs. Also, in all the TMCs, traffic data is collected in real-time and is provided free of charge. As shown in Tables 11 and 12, many of the TMCs employ sophisticated technologies to collect the data, and are using various automated means to provide traffic information. The following subsections describe the traffic data collected by each TMC and how traffic is controlled.

4.2.1 Anaheim Traffic Management Center

The Anaheim Traffic Management Center currently collects data on volume rates and occupancies. In the future, they expect to collect travel times, incidents and toll fees. The major elements of Anaheim's Traffic Management System includes[31]:

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31 Reference 19, pp. v-vii.

TABLE 11. TECHNOLOGIES USED TO COLLECT TRAFFIC INFORMATION[32]

TMC LOCATION	VIDEO SURVEIL-LANCE CAMERAS	CCTV	VIDS	INDUCTIVE LOOPS/ LOOP DETECTORS	RAMP METERS	VEHICLES AS TRAFFIC PROBES	SURVEIL-LANCE AIRCRAFT	ROADSIDE-MOUNTED RADAR DETECTORS	SATELLITE	OTHER
Anaheim Traffic Management Center	✓	✓	F	✓	✓	F				
Atlanta TMC	F		F	✓	F	F	F			
SRS (Boston)	✓	✓				✓	✓	F		Ultrasonic detection is scheduled for 2/94
IDOT TSC (Chicago)	F	F	F	✓	✓	F				Currently experimenting with acoustic sensors
Connecticut	✓	✓				F		✓		
Denver TOC	F	F	F	✓	✓	F	✓		F	
GHTMC	✓	✓	F	F[33]	F	✓	✓	F		AVI, cellular call to free traffic line
Milwaukee MONITOR Traffic Operations Center	F	F	F	✓	✓	F		F		3M's Micro-loop
Mn/DOT Traffic Management Center	✓	✓	✓	✓	✓	F	✓	F	F	

32 ✓ indicates current use, and F indicates future use.

33 These have been installed, but are not yet operational.

TMC LOCATION	VIDEO SURVEIL-LANCE CAMERAS	CCTV	VIDS	INDUCTIVE LOOPS/ LOOP DETECTORS	RAMP METERS	VEHICLES AS TRAFFIC PROBES	SURVEIL-LANCE AIRCRAFT	ROADSIDE-MOUNTED RADAR DETECTORS	SATELLITE	OTHER
Montgomery County DOT TMC	✓	✓		✓		✓	✓			
TRANSCOM (Metro NY/NJ/CT)	✓	✓	✓	✓	✓	F	✓		F	
San Antonio IVHS OCC	✓	✓	✓	✓	F	F				
Seattle TSMC	✓	✓	✓	✓	✓	F	✓[34]	F		Bus AVI and AVL systems

[34] They monitor commercial traffic reporter's planes.

TABLE 12. CURRENT DISTRIBUTION OF TRAFFIC INFORMATION

TMC LOCATION	VMS	HAR	RADIO BROAD-CAST	CABLE TV	PC/ MODEM	INFO KIOSK @ BUSINESS/ SHOPPING COMPLEX	INFO KIOSK @ OTHER LOCATION	TELE-PHONE	DISPLAY @ BUSINESS/ SHOPPING COMPLEX	DISPLAY @ OTHER LOCATION	ON-BOARD AUTO
Anaheim Traffic Management Center	✓	✓	✓	✓	F	✓	✓	F			
Atlanta TMC	F	F	F	F	F	F	F	✓			F
SRS (Boston)	F	F	✓	✓	F			✓			F
IDOT TSC (Chicago)	✓	✓	✓	✓	F	F	F	✓	F	✓	F
Connecticut	✓	F	F	F	F	F	F	F	F	F	
Denver TOC	F	✓	✓	F	F	F	F	✓			F
GHTMC	✓	F	✓[35]		F	F	F	F	F	F	F
Milwaukee MONITOR Traffic Operations Center	✓[36]	F	F	F		F		✓		✓	
Mn/DOT Traffic Management Center	✓	✓	✓	✓	F	F	F	✓	F	F	✓
Montgomery County DOT TMC	✓	✓	✓	F	F	F		F	F		
TRANSCOM (Metro NY/NJ/CT)	✓	✓	✓	✓	F	F	F	✓	✓	F	
San Antonio IVHS OCC	✓		✓	F	F	F	F	F	F	F	F
Seattle TSMC	✓	✓	✓[37]	✓	✓	✓	✓	✓	✓	✓	F

35 Done by traffic service organization.

36 Portable changeable message signs

- Traffic signal control
- CCTVs
- VMS
- HAR
- Highway advisory telephone
- Community access television
- Link with Caltrans freeway surveillance and management system, and VMS

4.2.2 Atlanta Transportation Management Center (TMC)

Even though the TMC is not operational, data is currently collected on volume, speed, occupancy (at some locations with detector stations), and some origin-destination and vehicle occupancy studies. In the future, the TMC will automate the origin-destination data collection through the use of AVI, and will collect travel time data. Currently, Atlanta has 600 signals on the Urban Traffic Control System (UTCS), which will be upgraded shortly to 1.5 Generation Control. After the Olympics in 1996, it is expected that the signal system will be upgraded to 2 Generation Control.

4.2.3 SmartRoute Systems (Boston)

Data is collected on 701 miles of roadway using a variety of detection methods. These methods include[38]:

- 38 cameras: 13 live, 24 slow-scan and one pan, zoom and tilt;
- 364 regularly-scheduled daily probe trips, communicating with the Operations Center under planned schedules and protocols via mobile phones or two-way radios;
- Routine monitoring of over 300 publicly-available and public agency radio frequencies on eight electronic scanners;

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37 Through commercial traffic reporters.

38 Reference 30, pp. 12-13.

- Two fixed-wing aircraft flying over northern and southern sections of the metropolitan area, totaling 15 hours daily;
- Direct ring-down lines to public agencies, including State Police communications center, Mass Highway Department radio room, two Amtrak dispatch facilities, and MBTA operations center; and
- Informal (but officially sanctioned) working relationships with a variety of public transportation officials, including Mass Highway district engineers, regional State Police barracks, Mass Port public safety and bridge management personnel, etc.

4.2.4 Illinois DOT Traffic Systems Center (Chicago)

The IDOT TSC currently collects data on occupancy and volume. Traffic is controlled by entrance ramp meters and VMS for on-freeway traffic advisories.

4.2.5 Connecticut

Connecticut DOT currently collects traffic data on speed and signal operation.

4.2.6 Denver Traffic Operations Center

Since the Denver Traffic Operations Center is not in operation, limited amounts of data are currently collected on speed and volume. The only traffic controls presently in use are signals and ramp meters.

4.2.7 Greater Houston Traffic Management Center (GHTMC)

Currently, the GHTMC is collecting traffic data on travel times in three corridors, and is logging motorist assistance (incidents). They have the Texas Transportation Institute (TTI) collecting the data on the following HOV lanes:

- Katy Freeway (IH-l0W);
- North Freeway (IH-45N);
- Gulf Freeway (IH-45S);
- Northwest Freeway (US 290); and
- Southwest Freeway (US 59S).

The data that is collected includes:

- Total Vehicles, Total Persons, Total Carpools and Total Carpoolers for the morning peak and afternoon peak;
- Number of Buses, Vanpools, Carpools, and Motorcycles for the morning peak, afternoon peak and total daily;
- Total Daily Vehicle Trips;
- Total Daily Person Trips; and
- Number of 40-person Buses, 60-person Buses, Vanpools, Carpools and Motorcycles inbound during the morning peak and outbound during the afternoon peak.

"As of April 1994, priority facilities were in operation in five corridors, accounting for a' total of 63.6 miles of barrier-separated HOV lanes. An additional 21 miles are under construction. Over 78,000 daily person trips are served by the Houston HOV lanes by 800 bus trips and 23,000 carpool and vanpool trips."[39]

Currently, traffic is controlled by VMS and railroad-type gates on the HOV lanes. In the future, traffic will be controlled by ramp meters and automatic closures, lane control devices, HAP, portable VMS and railroad-type gates on certain ramps.

"[A Computerized Transportation Management System] CTMS is a freeway corridor management system which is now being implemented throughout the Houston Area. The implementation schedule [for the planned 231-mile system] includes completion of 35 miles of corridor by the end of 1994; with an additional 50 miles by the end of 1995. CTMS is comprised of three separate, yet integrated subsystems: mainlane Freeway Traffic

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39 Reference 24.

Management (FTM), HOV Surveillance, Communications, and Control (SC&C), and frontage road Signal Coordination System (SCS). Elements of CTMS include:

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

CTMS will form the backbone for IVHS in the Houston Area with CTMS in major congested corridors to be completed by 1995. "[40]

4.2.8 Milwaukee MONITOR Traffic Operations Center

The MONITOR Traffic Operations Center will be collecting information on vehicle occupancy rates to convert into an indication of congestion, and on average speed and confiiation of incidents. Currently, entry freeway volume is controlled by on-ramp signals. In the future, on-ramp signals will adjust the entry volume onto the freeway on a system basis rather than on a local area basis.

4.2.9 Mn/DOT Traffic Management Center

Mn/DOT collects traffic data on volumes, density, speeds, accidents, incidents, vehicle occupancy, HOV information, HOV system violation, queue lengths at ramp meters, and incident duration. In the future, vehicle classification will be added.

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[40] Reference 24.

“The Traffic Management Center currently operates 354 ramp meters. By the end of 1995, a total of 400 ramp meters will be in operation. There are 142 CCTV cameras located along sections of interstate and trunk highways, covering about 60% of the Minneapolis/St. Paul metro area freeway system. An additional 28 CCTV cameras will be installed during the next two years for a total of 170 cameras by the end of 1995. Within the next five years, all cameras will be connected to the TMC via a fiberoptic communications network. Mn/DOT currently operates 46 [VMSs]. An additional ten signs will be operating by the end of 1995. Mn/DOT operates 34 HOV ramp meter bypasses. Eleven additional meter bypasses will be added by the end of 1995.

“Mn/DOT has several elements of an integrated motorist information program in place, with a number of others planned or under contract. An Advanced Motorist Information System currently integrates the Cable TV, Teletext and Audiotext motorist information elements into a single Local Area Network.

- Traffic Radio - Live traffic reports for the entire Metro Area are broadcast over Public Radio Station KBEM, 88.5 PM. Reports of two to three minutes occur every ten minutes on weekdays during peak traffic periods. During a major incident, motorist information is broadcast continuously. Drivers are alerted to tune to KBEM by flashing roadside signs. 27 strategically located Traffic Radio signs - or any one of the [VMSs] may be activated to alert drivers to tune to 88.5.
- Cable TV Traffic Channel - Includes a real-time graphics map showing traffic flow condition on all currently instrumented freeways; videotext providing lane control information and other public service announcements; and live video from on-line CCTV cameras. The audio feed is provided by KBBM radio. During peak periods it includes the Traffic Radio broadcasts. "[41]

4.2.10 Montgomery County DOT TMC

Montgomery County DOT TMC is collecting a variety of traffic data, including average speeds, volumes and incidents. Their plan to develop and implement an advanced

41 Reference 25.

transportation management system is being built upon the technologies they are currently using. These include the following:

- Computer-controlled video cameras;
- A computerized system of over 600 traffic signals;
- Vehicle detectors;
- VMS; and
- HAR

Section 3.2.10 describes the future advanced transportation management system being developed in Montgomery County.

4.2.11 TRANSCOM (Metropolitan New York/New Jersey/Connecticut)

Incidents and construction that results in delays of varying thresholds is currently collected by TRANSCOM. In the future, TRANSCOM expects to collect the same data, but with decreasing delays from the time of incident.

4.2.12 San Antonio IVHS OCC

Currently, traffic data is collected for planning purposes, but will be expanded to include speed, occupancy, volume, and incident location, type and severity. Traffic will be controlled through the use of VMS, lane control signals and arterial signal timing through the OCC. Traffic information will be provided on a real-time basis and will be free of charge.

The OCC will communicate with a sensor network of inductive-loop type vehicle detectors at 1/2-mile intervals in each lane. This network will collect traffic speed, volume and density. Surveillance and incident detection will be provided by full-motion, full-color video cameras at l-mile intervals mounted on extensions of the overhead sign structures.

OCC communications is through a fully-redundant, digital, point-to-point fiber-optic communications network. Also, there will be 50 fiber-optic VMS and 358 overhead lane control signals communicating incident mitigating information to motorists. Lane control signals will be placed at approximately one-mile intervals.

4.2.13 Seattle Traffic Svstems Management Center

The Seattle TSMC currently collects data on volume, lane occupancies, speeds and AVI data. In the future, they expect to add data on travel times and AVL data. Currently, traffic is controlled through the use of ramp meters. Traffic information is distributed on a real-time basis and is provided free of charge.

SECTION 5. CAPABILITIES FOR TRAVELER INFORMATION SYSTEMS

The purpose of this section is to identify the capabilities of traveler information systems based on the data collected by TMCs and the technologies employed by the TMCs to disseminate transit and traffic information. The study indicated that this direct relationship between TMCs and ATIS is fostering ATIS development and implementation.

Several TMCs indicated that they would be participating in the development and implementation of ATIS, which would include transit. These systems will require that transit operations and traffic management organizations cooperate and coordinate in order to provide reliable and accurate information to travelers.

Several ATISs have already been mentioned in this report. These include Anaheim, Denver, Houston and Minneapolis/St. Paul. In Anaheim, an integrated ATIS will be part of a county-wide IVHS system that has been recommended for Orange County.[42] Figure 3 shows this county-wide system. In Minneapolis/St. Paul, the Travlink project will provide a comprehensive ATIS. Figure 4 shows the interaction between MTC and the Traffic Management Center for the Travlink project. (Further information about Travlink can be found in References 33, 41 and 42.)

In Houston, another important project related to the GHTMC is the Houston *Smart Commuter* project. This project, initiated in 1990, is being funded jointly by FTA, FHWA, METRO and Texas DOT. This "Operational Test will evaluate the potential for gaining more efficient use of major travel corridors through greater utilization of high-occupancy commute modes, shifts in travel routes and changes in time of travel through the applications

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42 Ref. 13, pp. 12-13.

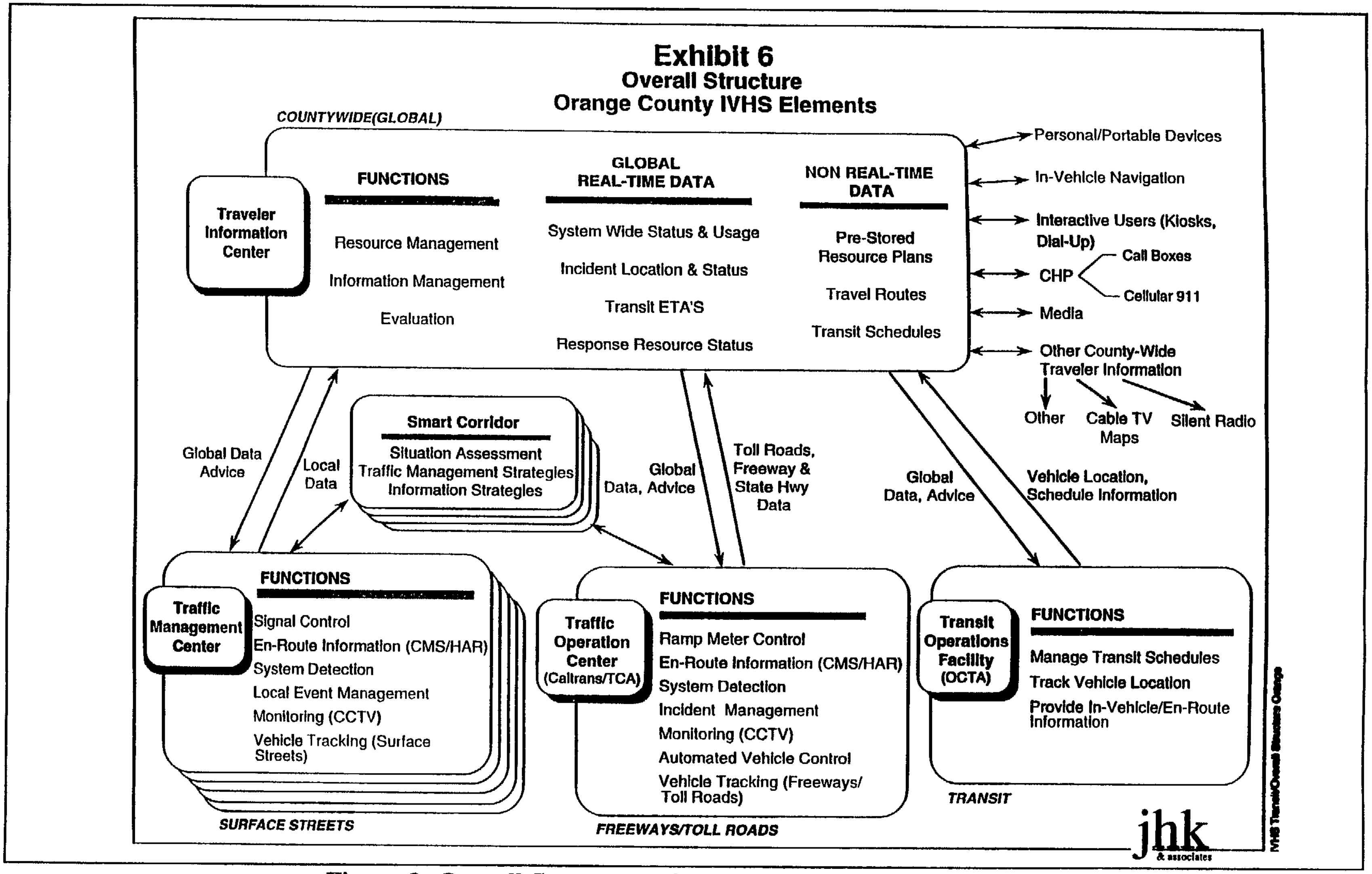

Figure 3. Overall Structure - Orange County IVHS Elements

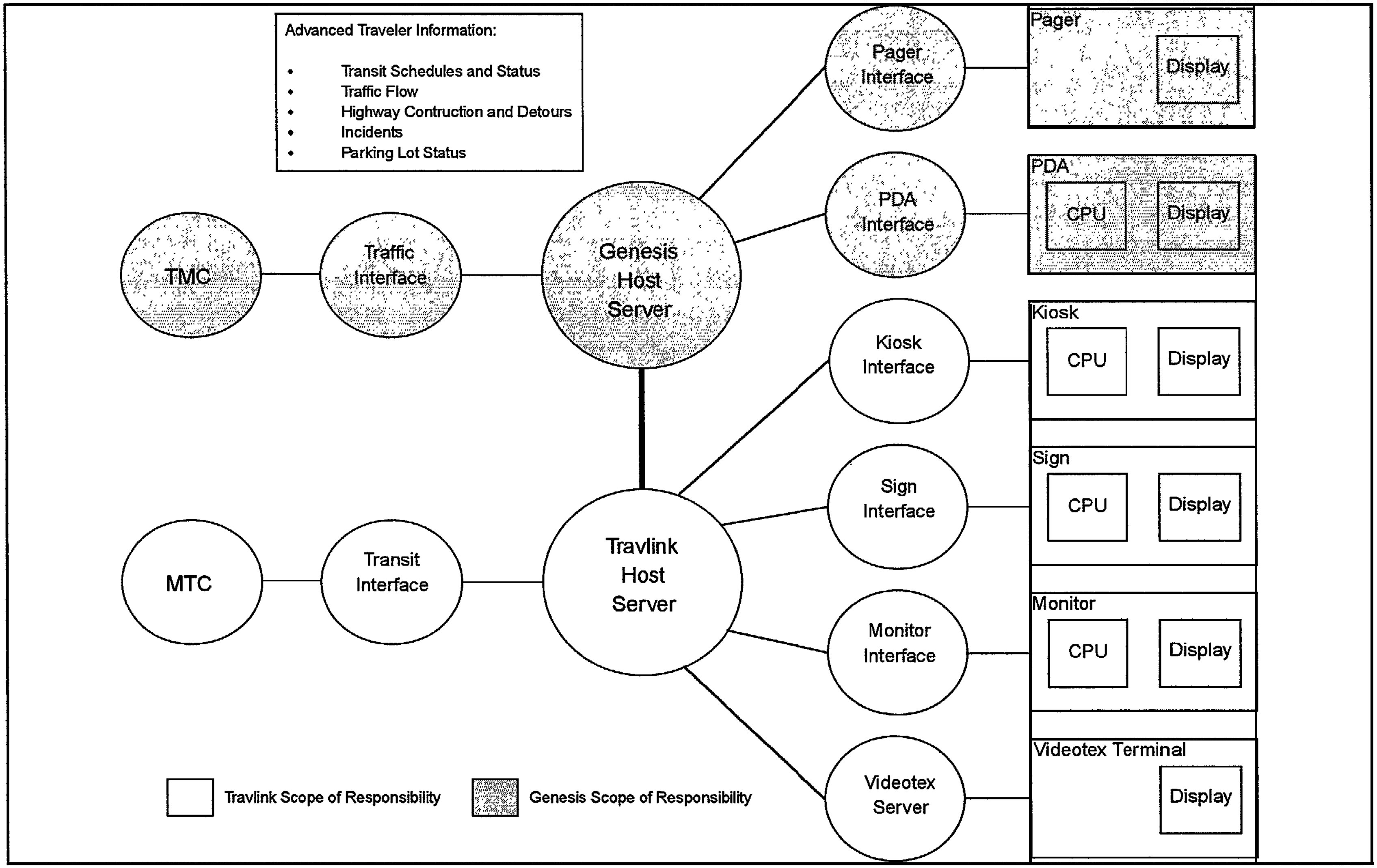

Figure 4. Travlink/Genesis Shared Data Architecture

of innovative approaches using advanced technologies. The test is based on the hypothesis that commuters who have quick and easy access to relevant, accurate, and up-to-date information on existing traffic conditions, bus routes, bus schedules, how to use the bus, and instant ridematching services in their home and workplace will be more likely to use public transportation and other high-occupancy commute modes. The travel time savings and travel time reliability offered by the Houston HOV lanes add further incentives for changing travel modes. In addition, individuals may alter their travel time or travel route based on this information.

"The *Smart Commuter Operational Test* includes two different, but compatible, components. Both components are intended to make better use of the Houston HOV facilities. These facilities have been developed and funded as multi-agency projects.

"The first component, the bus component, focuses on the traditional suburb-to-downtown travel market in the I-45 North corridor. This element focuses on encouraging a mode shift from driving alone to using the bus, changing travel times, and shifting travel routes. These changes in travel decision will result from the provision of current traffic and transit information to individuals in their home and workplace through state-of-the-art videotext and telephone technologies.

"The second component focuses on the suburb-to-suburb travel market in the I-10 West corridor to the Post Oak/Galleria area. This corridor, which is more difficult to serve with traditional, regular-route bus service, provides the opportunity to test the use of a comprehensive employer-based car-pool matching service. This system will include the ability to provide real-time carp001 matches and is structured to encourage a mode shift from driving alone to carpooling and also to encourage an increase from two to three person carpools. "[43]

43 Texas Transportation Institute, ***Houston Smart Commuter IVHS Operational Test,*** provided by TTI on March 10, 1994, pp. 3-4.

The two components of this project will be implemented and evaluated over a five-year period. The project involves multiple agency participation by METRO, Texas DOT, FTA, FHWA, the Houston-Galveston Area Council (Houston's MPO) and TTI. Figure 6 shows that project management structure for the *Smart Commuter* project.

In Denver, a regional traveler information system is planned after the Denver TOC is operational. Outputs from the TOC, which include traveler information is shown in Figure *5.*

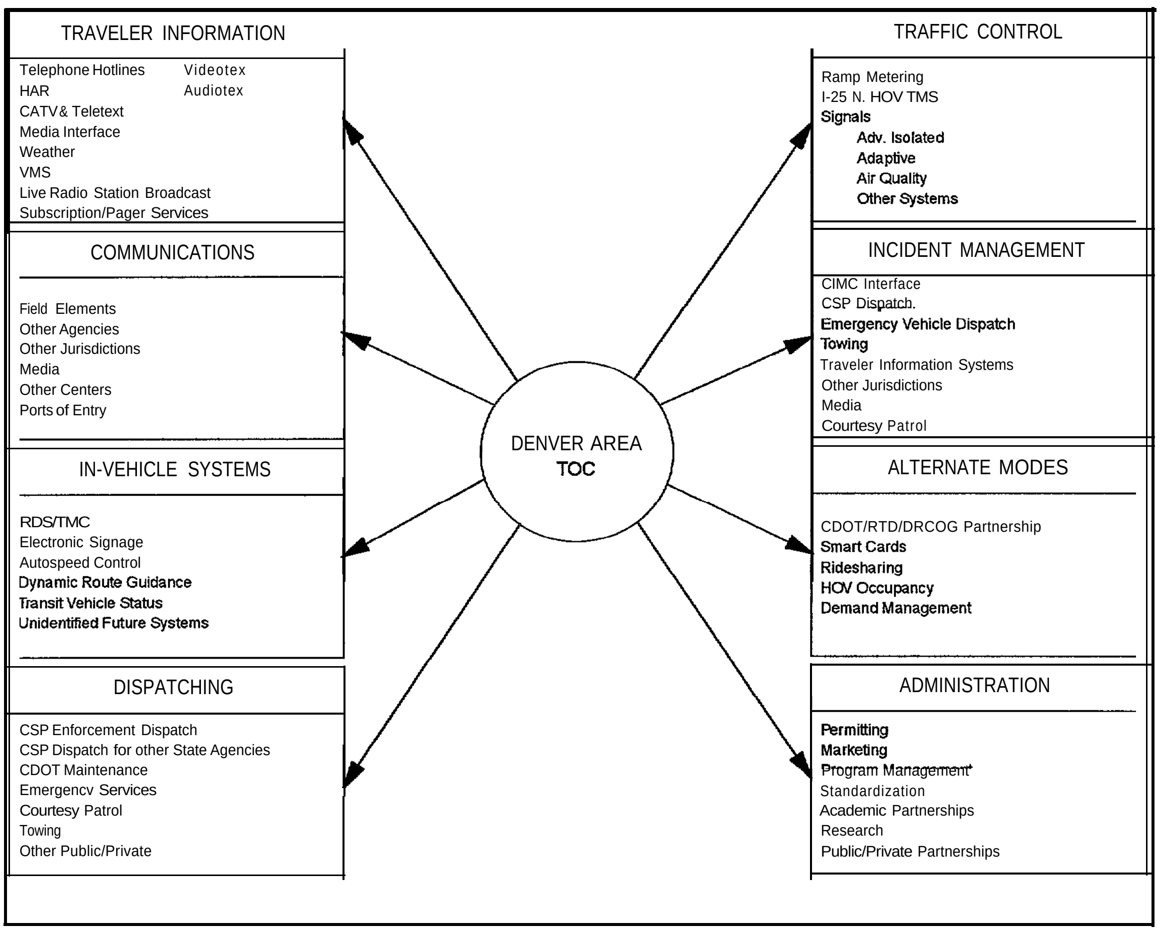

Figure 5. Denver Area TOC Outputs

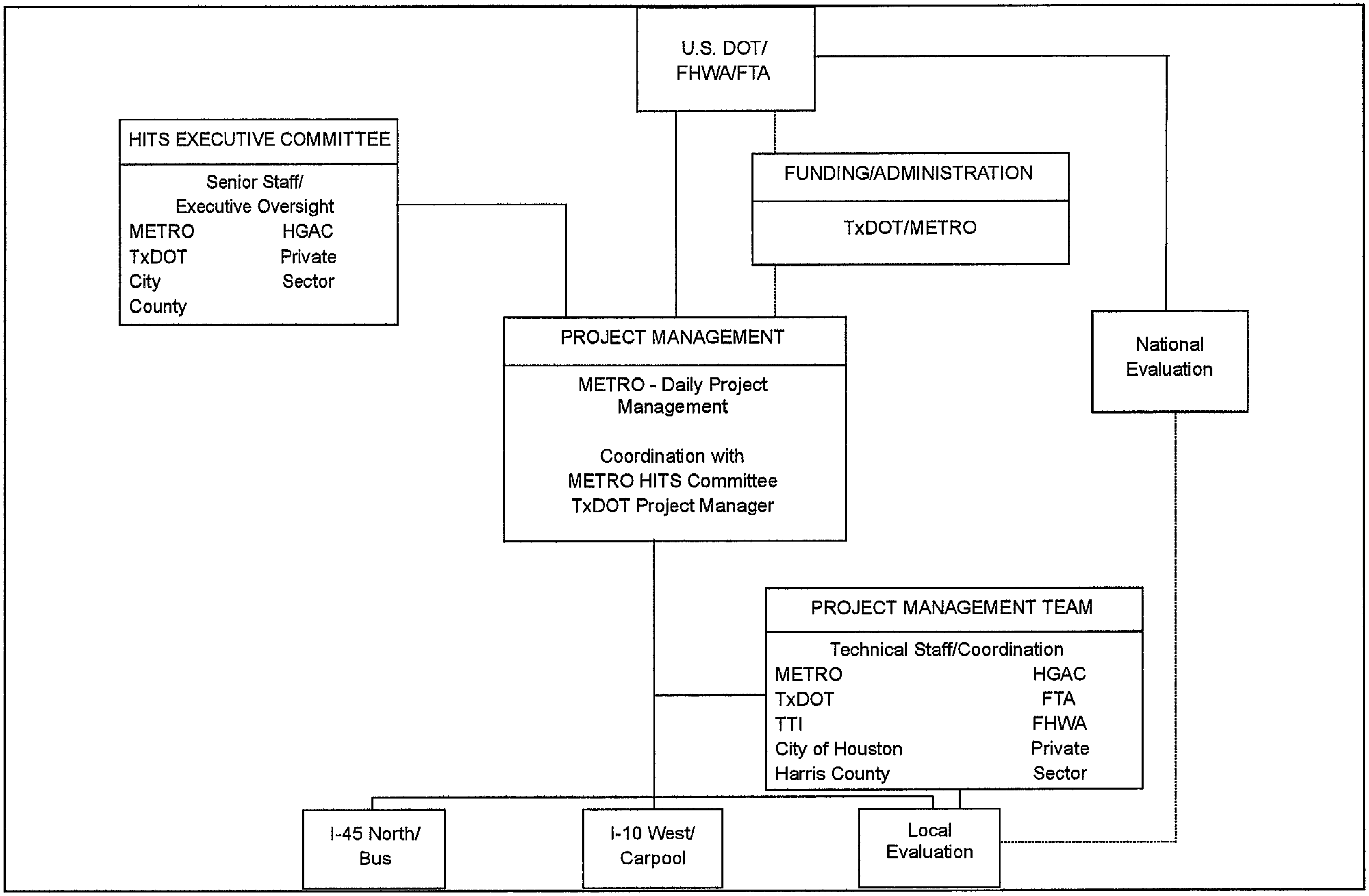

Figure 6. Houston *Smart Commuter* Project Management Structure

SECTION 6. CONCLUSIONS AND PRELIMINARY GUIDELINES

The integration of transit into TMCs is fairly recent. For those TMCs that have been in-place for several years, transit was not a major player in the development or operation (with the exception of information-only TMCs like SRS and TRANSCOM). In some cases, transit was an afterthought when metropolitan areas began to approach traffic management and control from a regional perspective, and realized that transit plays a significant role in regional transportation.

The key factors that have led to successful integration are organizational and institutional mechanisms that result in cooperation and coordination among participating agencies, and the use of technologies that ensure the efficient and timely collection and dissemination of traveler information. It is these issues that must be addressed by a guidelines document to provide potential integrators with a comprehensive set of recommendations for successfully integrating transit into a TMC. In this report, preliminary guidelines will be presented in the following subsections that can be further refined and expanded in a final guidelines document. An outline of the final guidelines document is presented in Section 6.3.

This study resulted in the following general conclusions:

- It is not necessary to co-locate transit dispatch/operations with traffic operations in the TMC, but it does facilitate the immediate exchange of information, and, institutionally, it creates a “friendly” environment in which transit and traffic have equally important roles in managing the region’s transportation.

- The organizational and institutional issues are much more critical than the technology. TMCs’ success or failure will depend on the degree to which transit operations and traffic management entities coordinate and cooperate, not solely on the technologies that they employ.

- When a TMC is created or expanded to include transit, each participating organization must be a stakeholder. That is, each organization must contribute resources and expertise to receive benefits from the TMC.

- Non-transit agencies must recognize the importance of transit to the whole transportation picture in a region. This may require education for both transit agencies and traffic organizations

- The roles and responsibilities of transit and traffic agencies participating in a TMC do not have to drastically change for the organizations to cooperate. Transit agencies will still be focused on all the aspects of providing their services, and traffic management will still be focused on improving the traffic flow and managing incidents.

- The technologies employed in the collection and dissemination of transit and traffic data by the TMC will greatly improve the effectiveness of managing regional transportation, but they cannot substitute for transportation management.[44]

6.1 INSTITUTIONAL AND ORGANIZATIONAL ISSUES

The TMCs were asked to describe any institutional issues or obstacles that occurred during TMC development and how they were resolved. From the responses and on-site interviews, there were three major issues that could provide guidance for those organizations contemplating or actually integrating transit into a TMC.

Outreach for organizational support should begin with small, manageable pieces of the TMC's goals and objectives. Don't expect each organization to immediately cooperate and coordinate with others in trying to reach all the TMC's goals.

44 Reference 9, p. 21.

The example provided by the GHTMC confirms this on an on-going basis. Houston Metro has greater resources than most other transit agencies in the country, so they may be viewed as being able to contribute to the GHTMC more than another, smaller agency. Also, their role is larger than most transit agencies - they are responsible for operating and maintaining the HOV lanes, in addition to other non-traditional responsibilities. However, they are an equal partner with the other three agencies that participate in the TMC.

In Houston, pooling limited resources from participants is viewed as the way to accomplish various plans that achieve the GHTMC's objectives. Further, each agency has learned that it can not only learn from the other agencies, but it can share resources with other agencies, which will add some value to the agency. Together as a consortium, the GHTMC is a much stronger organization that can achieve more than any one individual agency could on its own.

The GHTMC has become a focal point for cross-jurisdictional issues. In this, they have focused on achieving small goals in order to accommodate different jurisdictions. The successes of smaller projects can be realized much easier than those of larger projects. Further, a number of smaller successes may build confidence much better than one large success.

The GHTMC also realizes that their particular organizational structure may not work everywhere for a variety of reasons, including politics[45] and resources. However, even if the same mechanisms cannot be put in place elsewhere, the basic principle of pooling resources and expertise to create a strong common base can be applied widely.

The roles and responsibilities of individual participating agencies can remain the same if they participate in the TMC.

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45 Another unique aspect of Houston's politics are that the Mayor served as head of the Texas Transportation Commission and the chair of METRO's board.

During the course of this study, many TMCs noted that traffic management and control organizations have very different goals than transit agencies. Therefor, the issue of integration was not necessarily understood. There was, however, an understanding that transit has an impact on traffic and vice versa. Whether or not transit operations are co-located with traffic operations in a TMC, each organization still has mutually supportive goals. The integration provides the opportunity for each organization's goals and objectives to be met more efficiently through a TMC.

For example, the Montgomery County DOT TMC has transit dispatch and the transit information center co-located with traffic management. On an on-going basis, the transit dispatchers benefit from knowing about a traffic incident in real-time, so that alternatives can be developed and a solution implemented almost immediately. Also, transit dispatch can alert traffic management about problems that have been encountered by bus drivers, so traffic management can take action.

It is important to note that transit and traffic operations do not have to be co-located to have effective and real-time communication between the two. In several cases where communication links exist between the TMC and the transit agency, the transit agency can benefit from real-time traffic data and traffic managers can be alerted to problems encountered by transit vehicle operators.

A cooperative or inter-agency agreement can be one of many tools to gain coordination and cooperation.

This study revealed an overwhelming number of comments from TMCs about cooperation and coordination among participating agencies. It was felt that this was the biggest problem in integration. A number of TMCs offered solutions that worked in their regions, and the most frequently mentioned was an inter-agency agreement.

Inter-agency agreements can ensure cooperation and coordination, while maintaining each organization's view of their roles with respect to transportation management. Different organizations and jurisdictions do not all have the same interest in transportation, which could pose an obstacle to their participation without such an agreement. For example, organizations such as the police, who are often responsible for incident management, will not view transportation management the same as transit agencies who are responsible for providing transportation services according to routes and schedules.

Another solution was not a direct solution, but is promising, given the recent emphasis on providing customers with multi-modal traveler information. The need for traveler information that includes both traffic and transit may naturally bring transit and traffic agencies together in an effort to provide that information. The Travlink project, which combines information from the Mn/DOT Traffic Management Center and from MTC, may result in a stronger relationship between the agencies. Also, the two agencies have acknowledged their coordination officially through an internal I-394 Operations Plan that includes involvement by MTC in operations that pertain to transit facility usage.

Yet another solution is the use of technologies to foster and promote cooperation among agencies. For instance, if transit is not part of a TMC, transit vehicles could still be used as traffic probes to aid in traffic management.

6.2 TECHNOLOGIES AND INFORMATION INTEGRATION ISSUES

The TMCs were asked to describe any technical issues or obstacles that were encountered during TMC development. From the responses and on-site interviews, there were three major technical issues that were identified and could provide guidance for those organizations contemplating or actually integrating transit into a TMC.

Technologies are not substitutes for transportation management.

Sophisticated technologies are being employed by transit agencies, whether or not they are associated with a TMC. Further, TMCs are employing advanced technologies to collect and disseminate data. However, these technologies cannot substitute for personnel with expertise in transit operations and traffic management. For example, one of the TMCs in the study stated that there was a concern about the effects of ramp meter queues on the local streets. The solution to this particular problem was to build a queue over-ride capability into the ramp meter algorithm. Clearly, the ramp meter algorithm cannot, on its own, substitute for human expertise in traffic control.

Another TMC stated that to have an efficient and effective TMC, personnel from several different disciplines must be represented. These disciplines include not just traffic engineering, but electrical engineering, computer science, public relations and media.

Technology can integrate transit and traffic operations if they are not co-located.

The issue of co-location was addressed by the TMCs in two ways. In the case of Montgomery County, the DOT felt that collocating transit dispatch, the transit information center and traffic management afforded them the greatest opportunities for exchanging valuable data and information. Most others suggested that communications links, such as fiberoptic connections, were just as successful at exchanging data as collocating there operations was. Furthermore, transit agencies have usually built their own operations facilities, and it would not be feasible for them to move into the TMC just for the sake of being co-located.

Perception of technology by the public is an important consideration.

The issue of the traveler's perception of transit and traffic information was mentioned by TMCs on several occasions. First, motorists have become accustomed to radio traffic reports, which are not always timely or reliable. Also, motorists did not necessarily believe or feel confident in the initial uses of VMS. Transit agencies have distributed trip information that may evoke varying degrees of confidence in customers. As the collection and distribution of both traffic and transit information has become more sophisticated, the customer's perception of the quality and timeliness of the data has improved, but it is still a challenge to convince customers that they are receiving real-time, accurate information for decision-making.

Second, there is an issue of privacy as technology such as smart cards, AVI and CCTV are used to manage transportation. This will be an on-going issue for transit operators and traffic management agencies as more of these technologies are implemented.

6.3 OUTLINE OF GUIDELINES REPORT

Based on the preliminary guidelines presented in Sections 6.1 and 6.2, the following outline describes the contents of the final guidelines document.

EXECUTIVE SUMMARY

SECTION 1. OVERALL GUIDELINES

This section would contain general guidance regarding the integration of transit into TMCs, depending on the timing of the integration (before the TMC is developed, while it is being developed, or after it was developed).

SECTION 2. ORGANIZATIONAL GUIDELINES

This section would present organizational guidelines focusing on issues such as co-locating with traffic management, changes in organizational roles and responsibilities, and introducing technology into the organization. The following guidance would be discussed in this section:

- It is not necessary to co-locate transit dispatch/operations with traffic operations in the TMC.
- Technology can integrate transit and traffic operations if they are not co-located.

- The roles and responsibilities of individual participating agencies can remain the same if they participate in the TMC.
- Outreach for organizational support should begin with small, manageable pieces of the TMC's goals and objectives.

Examples of successful organizational approaches to integration will be included in this section.

SECTION 3. INSTITUTIONAL GUIDELINES

This section would present institutional guidelines focusing on issues such as creating partnerships with other participating agencies, educating non-transit agencies about transit, and developing cooperative or inter-agency agreements. The following guidance would be discussed in this section:

- When a TMC is created or expanded to include transit, each participating organization must be a stakeholder. That is, each organization must contribute resources and expertise to receive benefits from the TMC.
- Non-transit agencies must recognize the importance of transit to the whole transportation picture in a region. This may require education for both transit agencies and traffic organizations.
- A cooperative or inter-agency agreement is a tool to gain coordination and cooperation.

Examples of successful institutional approaches to integration will be included in this section.

SECTION 4. TECHNOLOGY INTEGRATION

This section would discuss the integration of APTS and TMC technologies at the TMC or an alternate location. The APTS technologies that would be covered in this section include the following:

- Passenger Information Systems;
- Multiprovider Trip Reservation Systems;
- Communications Systems;
- Automatic Vehicle Location Systems; and
- Transit Operations Software.

TMC Technologies that would be covered in this section include:

- Adaptive Signal Control;
- Computerized Signal System;
- Geographic Information System;
- Graphics-based Display(s);
- Incident Detection;
- Automated Logging/Recording;

- Video Surveillance Cameras;
- Closed-circuit Television;
- Video Imaging Vehicle Detection System;
- Inductive Loops/Loop Detectors;
- Ramp Meters;
- Vehicles as Traffic Probes;
- Surveillance Aircraft;
- Roadside-mounted Radar Detectors;
- Variable Message Signs; and
- Highway Advisory Radio,

This section will also discuss the following issues:

- Technologies are not substitutes for transportation management.
- Perception of technology by the public is an important consideration.

SECTION 5. TRAVELER INFORMATION SYSTEMS

This section would discuss how APTS and TMC technologies can be integrated to create an ATIS. Examples of successful APTS/TMC integration for an ATIS would be included in this section.

SECTION 6. RESOURCES REQUIRED FOR INTEGRATION

This section would provide guidelines for determining what resources would be needed for integration into a TMC, including technology, public relations and media specialists. This section would also cover other resource issues, such as charging fees (or using advertising to pay) for information made available through the TMC.

SECTION 7. RECOMMENDATIONS FOR FTA

The review and assessment of TMCs, along with the development of preliminary guidelines, indicates that before final guidelines are prepared, FTA may want to consider the following:

- The collection of data regarding specific aspects of integration from those TMCs that have transit as an integral part of their operations;
- The sponsorship of a joint workshop with FHWA to bring together those TMCs that have integrated transit and those that are considering it; and
- The selection of a site that will be integrating transit to "test" the final guidelines before they are published.

This study collected data regarding the level of integration of transit into TMCs, but did not focus on the specific plans and methods used to accomplish the integration. It would be very useful to readers of the guidelines to present very specific case studies and to develop specific guidelines on integration based on these case studies. Potential sites from which this detailed data might be collected include:

- Anaheim;
- Denver;
- Houston;
- Milwaukee;
- Minneapolis/St. Paul;
- Montgomery County; and
- San Antonio.

In addition, those TMCs that were not reviewed in this study, but were identified in the initial list may provide additional data that would be useful in developing the guidelines.

In addition to the distribution of this study report, it would be very beneficial for FTA to jointly sponsor a workshop with FHWA for those organizations that have integrated transit and those that would like to integrate. This two-day workshop would be a "roll-up-yoursleeves" workshop, with presentations being given by those who have successfully integrated transit into their TMC. The benefit of such a workshop would be to further discuss integration, with specific examples, and to refine the preliminary guidelines based on expertise present at the workshop.

Finally, "industry" credibility could be given to the guidelines (that would have been developed up to a point after the workshop) if they were tested in the field. It is expected that this "operational test" would involve the following activities:

- Site selection;
- Selection of participating agencies;
- Meetings to plan and implement the integration according to the guidelines;
- Evaluation of the integration in terms of the feasibility of the guidelines; and
- Redevelopment of the final guidelines.

FTA may want to solicit some FHWA support to accomplish this task.

APPENDIX A. LIST OF INTERVIEW QUESTIONS

GUIDELINES FUR INTEGRATING TRANSIT INTO TRANSPORTATION MANAGEMENT CENTERS:
DRAFT LIST OF INTERVIEW QUESTIONS

Name of TMC: ______________________________

Location/Street Address: ______________________________

City/Town: ____________________ State: ________ **Z i _p :**

Contact Person: ____________________ **Title:** ____________

Phone Number: ____________________ **Fax Number:** ____________

1. Does the TMC:
(check only one)

_ Provide information only (does not perform transit dispatch or traffic control)?
_ Provide only traffic control and management?
_ Provide both information and control?

2. What institutions and organizations currently participate or will be participating in the operation of the TMC? (check all that apply)

_ City/municipal government NAME: ____________________
_ State government NAME: ____________________
_ Transit agency NAME: ____________________
_ Local DOT NAME: ____________________
❑ State DOT NAME: ____________________
_Other: Please Specify -> NAME: ____________________

3. Does or will the TMC include transit operations as one of its functions?

_I YES _ NO

a. If YES, was transit added after the TMC was in operation?

❑ YES _ **NO**

b. If NO, is there an effort underway or planned to incorporate transit operations (e.g., dispatching) into the TMC?

_ YES _ NO

i. If there is no effort underway or planned to incorporate transit into the TMC, please explain the rationale for not incorporating it.

4. If the TMC includes transit operations (dispatch and/or scheduling functions), are transit operations co-located with traffic operations?

_ YES • I NO

5. What was the rationale for transit operations to be co-located or not co-located with traffic operations?

6. If there is an effort underway or planned to incorporate transit into the TMC, please briefly describe the plans and timetable for this incorporation.

7. If transit was integrated into the TMC, please briefly describe the steps that were taken to accomplish the integration.

8. What organization oversees TMC operations (e.g., operational decisions made by one organization) or is this TMC operated by a coordinated/cooperative group of participating organizations (decisions made by participating organizations)? If possible, please provide an organization chart (attach it to this form).

9. Are the roles and responsibilities for each organization documented? If possible, please provide any available documentation.

10. How are traffic and transit operations coordinated in the TMC?

11. Do the TMC operations personnel have responsibilities that are specific to the TMC (e.g.., their job descriptions specify that they must be located at the TMC), or can these employees do their jobs either at the TMC or at their respective agencies?

12. If employees can be located at their respective agencies, how do they perform their TMC-related duties from a "remote" location?

13. What advanced technologies are currently employed in the TMC? (check all that apply)

    _ Adaptive signal control
    • I AVL *Please specify:*
        • I GPS
        ❑ LORAN-C
        _ Signpost
        _ Dead reckoning
    • I Computerized signal system
    _ Geographic Information System
        Please specify name of software: ____________
    _ Graphics-based display(s)
    _ Incident detection
    • I Automated logging/recording
    _ Other: Please Specify -> ________________________________

14. What additional advanced technologies will be employed in the TMC in the future? (check all that apply)

    ❑ Adaptive signal control
    ❑ AVL *Please specify:*
        _ GPS
        _ LORAN-C
        _ Signpost
        _ Dead reckoning
    ❑ Computerized signal system
    ❑ Geographic Information System
        Please specify name of software: ____________
    ❑ Graphics-based display(s)
    ❑ Incident detection
    ❑ Automated logging/recording
    ❑ Other: Please Specify -> ________________________________

15. Please provide a functional diagram of the TMC.

16. What transit information is currently collected?

17. What additional transit information will be collected in the future?

18. How often is transit information collected?

19. How is transit information collected?

20. What transit information is currently distributed by the TMC?
(check all that apply)

_ Timetables
_ Real-time timetables
_ Routes
• I Route details
_ Fares
_ Bus location
• I Next-stop announcements
• I Other information Please specify: ______

21. What additional transit information will be distributed by the TMC in the future?
(check all that apply)

_ Timetables
_ Real-time timetables
• I Routes
_ Route details
_ Fares
• I Bus location
_ Next-stop announcements
❑ Other information Please specify: ______

22. How is transit information currently distributed?
(check all that apply)

❑ Cable television
❑ Radio broadcast
❑ Personal computer/modem
❑ Information kiosk (interactive) at business/shopping complex
❑ Information kiosk (interactive) at transit stop/center
❑ Telephone
❑ Display (non-interactive) at business/shopping complex
❑ Display (non-interactive) at transit stop/center
❑ On-board transit vehicle
❑ Other: Please Specify -> ______

23. How will transit information be distributed in the future?
(check all that apply)

_ Cable television
_ Radio broadcast
_ Personal computer/modem
❑ Information kiosk (interactive) at business/shopping complex
_ Information kiosk (interactive) at transit stop/center
_ Telephone
_ Display (non-interactive) at business/shopping complex
_ Display (non-interactive) at transit stop/center
_ On-board transit vehicle
_ Other: Please Specify --> ________________________________

24. Is the transit information distributed on a real-time basis?

_ *YES* _ *NO*

If NO, how frequently is the transit information distributed?

____

____

25. Is the transit information provided free of charge?

_ YES _ NO

If YES, how is the TMC operation funded? ________________________________

If NO, what is the charge? ____

26. Does advertising partially pay for the distribution of transit information?

_ YES _NO

27. What traffic information is currently collected?

28. What traffic information will be collected in the future?

29. How is traffic currently controlled?

30. How will traffic be controlled in the future?

31. What technologies are currently being used to collect traffic information? (check all that apply)

- ☐ Video surveillance cameras
- ☐ Closed-circuit television
- ☐ Video imaging vehicle detection system
- ☐ Inductive loops/loop detectors
- ☐ Ramp meters
- ☐ Vehicles as traffic probes
- ☐ Surveillance aircraft
- ☐ Roadside-mounted radar detectors
- ☐ Satellite
- ☐ Other technology: Please specify: ____________________

32. What additional technologies will be used in the future to collect traffic information? (check all that apply)

- ☐ Video surveillance cameras
- _ Closed-circuit television
- _ Video imaging vehicle detection system
- _ Inductive loops/loop detectors
- _ Ramp meters
- ☐ Vehicles as traffic probes
- _ Surveillance aircraft
- _ Roadside-mounted radar detectors
- _ Satellite
- _ Other technology: Please specify: ____________________

33. How is traffic information currently distributed?
(check all that apply)

• I Variable message signs
• I Highway advisory radio
_ Radio broadcast
_ Cable television
_ Personal computer/modem
_ Information kiosk (interactive) at business/shopping complex
_ Information kiosk (interactive) at other location
_ Telephone
_ Display (non-interactive) at business/shopping complex
• I Display (non-interactive) at other location
• I On-board automobile

34. How will traffic information be distributed in the future?
(check all that apply)

❑ Variable message signs
❑ Highway advisory radio
_ Radio broadcast
_ Cable television
❑ Personal computer/modem
❑ Information kiosk (interactive) at business/shopping complex
_ Information kiosk (interactive) at other location
_ Telephone
_ Display (non-interactive) at business/shopping complex
_ Display (non-interactive) at other location
_ On-board automobile

35. Is the traffic information distributed on a real-time basis?

❑ YES ❑ NO

If NO, how frequently is the transit information distributed?

____

____

36. Is the traffic information provided free of charge?

☐ YES ☐ NO

If NO, what is the charge? ______________________________

37. Are there any technical and/or institutional issues or obstacles that surfaced during TMC development?

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a. If there were any technical/institutional issues, how were they resolved?

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____

38. Are there any "lessons learned" that would benefit other organizations developing TMCs?

APPENDIX B. LIST OF CONTACTS

LIST OF CONTACTS[46]

NAME/TITLE	ORGANIZATION	PHONE/FAX
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46 Shaded rows indicate persons referred to in the course of the study. No direct contact was made.

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Jim Wright	MnDOT	612-296-8567
Bruce Zvaniga	Toronto	416-392-9631

APPENDIX C. LIST OF REFERENCES

LIST OF REFERENCES

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