# TABLE OF CONTENTS

**INTRODUCTION** .......................................................................................................................... 8

**TRANSPORTATION MANAGEMENT CENTER DEFINITION, BENEFITS AND CHALLENGES** ..... 9

- Definition ................................................................................................................................. 9
- Benefits .................................................................................................................................... 9
- Challenges ............................................................................................................................... 10
  
  - Technologies and Integration ............................................................................................... 11
  - Institutional Interactions .................................................................................................... 11

**EXISTING CENTERS IN MIAMI-DADE COUNTY — INVENTORY AND OBSERVATIONS** ...... 13

- Florida Department of Transportation – District 6 TMC ......................................................... 13
- Miami-Dade County Traffic Control Center ............................................................................ 18
- Miami-Dade County Office of Emergency Management ......................................................... 20
- Miami-Dade Transit Agency .................................................................................................... 21
- Miami-Dade County Police Department – 911 Center ............................................................ 23
- Summary of Survey Findings .................................................................................................. 24
- General Comments From Surveys .......................................................................................... 25
  
  - On Physical Co-Location of Multiple Agencies in one TMC ............................................ 25
  - On Area-wide TMC Related Needs ..................................................................................... 26
  - On Area-wide TMC Related Goals/Objectives ..................................................................... 27
  - On Area-wide TMC Related Synergies ................................................................................ 27
  - On Area-wide Traffic Management - the Future in 10 to 20 Years .................................... 27

- Other Regional Transportation Services .................................................................................. 28
  
  - SunGuide/SmartTraveler ....................................................................................................... 28
  - The Miami-Dade Expressway (MDX) ..................................................................................... 28
  - Tri-Rail .................................................................................................................................. 32

**TRANSPORTATION MANAGEMENT CENTER FUNCTIONALITIES AND FRAMEWORK FOR**

**INTEGRATION** .............................................................................................................................. 33

- Traffic Management Functionalities ......................................................................................... 33
- Transit Management Functionalities .......................................................................................... 34
- Incident Management ............................................................................................................... 35
- Other Functional Considerations .............................................................................................. 36
  
  - Integrated Workstations ....................................................................................................... 37
  - Automated Information Sharing ............................................................................................ 37
  - Transit Centers - Additional Considerations ......................................................................... 37

- TMC Integration and Joint Operations Considerations .......................................................... 39
  
  - Center-to-Center Coordination ............................................................................................ 39
  - Share Control or Not .............................................................................................................. 40

- Corridor Wide Information Coordination .................................................................................. 41
TABLE OF CONTENTS (CONT'D)

Center-to-Center Interfaces and ITS Standards .................................................. 41
TMC Software Study, A FDOT State ITS Office Initiative ......................................... 41
Traffic Management Centers Pooled-Fund Study (TMC PFS) ....................................... 41
   TMC PFS Objectives ...................................................................................... 42
   Project Status ............................................................................................ 42
   FDOT Commitment .................................................................................... 43
   Additional Information ............................................................................... 43

TRANSPORTATION MANAGEMENT CENTER CASE STUDIES ....................................... 44
TMC Summaries ................................................................................................... 44
   Atlanta NaviGAtor ..................................................................................... 44
   Houston TransStar ..................................................................................... 46
   Milwaukee MONITOR ............................................................................... 46
   Toronto COMPASS ................................................................................. 47
   Detroit, Michigan ITS Center ..................................................................... 47
   Long Island INFORM ............................................................................... 47
   Arizona TrailMaster, Phoenix .................................................................... 48
   Boston Artery/Tunnel Integrated Project Control System ............................... 48
Successful Practices and Lessons Learned ............................................................... 48
   Interagency Interaction ............................................................................. 48
   Intra-agency Interaction .......................................................................... 50
   Transit Integration ..................................................................................... 50
   Media Coordination .................................................................................. 51
   Lessons Learned ....................................................................................... 52

CONCLUSIONS ..................................................................................................... 54
1: Develop TMC Concept of Operation Plan .............................................................. 54
2: On-Site Physical Presence is Important ............................................................... 55
3: On-Site Physical Presence of the Freeway Management and Law Enforcement Agencies is Beneficial ................................................................. 55
4: On-Site Physical Presence of the Freeway Management and Arterial Management Agencies should be given Adequate Consideration ....................................... 55
5: On-Site Physical Presence of the Emergency Management may be Desirable but not Necessary ............................................................. 55
6: Presence of Transit Dispatch in a TMC may be Desirable but not Necessary ............... 56
7: On-Site Presence of Media in a TMC is Beneficial .............................................. 56
8: Consider Developing a Regional Information Exchange Framework .................... 56

REFERENCES ...................................................................................................... 59
LIST OF FIGURES

Figure 1: Existing TMCS ................................................................. 14
Figure 2: Center-to-Center Communications Framework for Traffic Management ...... 34
Figure 3: Center-to-Center Communications Framework for Transit Management ...... 35
Figure 4: Center-to-Center Communications Framework for Incident Management ...... 36
Figure 5: Representative Framework for Regional TMCs Information Exchange ...... 58
LIST OF TABLES

Table 1: Miami-Dade TMC Inventory Survey Questions ........................................ 15
Table 2: Existing TMCs in Miami Dade County ................................................. 16
Table 3: Key Features at Eight Metro Area TMCs ............................................. 45
ACRONYMS

ATIS – Advanced Traveler Information Systems
ATMS – Advanced Traffic Management Systems
AVC – Automated Vehicle Classification
AVL – Automatic Vehicle Location
CAD – Computer Aided Dispatch
CCTV – Closed Circuit Television
CIC – Customer Information Center
COMPASS – TMC for Toronto metro area in Ontario, Canada
CORBA – Common Object Request Broker Architecture
CUTR – Center for Urban Transportation Research, University of South Florida
DATEX – Data Exchange
DERM – Department of Environmental Regulation and Management
DOT – Department of Transportation
DPCC – Data Processing Control Center (Miami-Dade County)
EOC – Emergency Operations Center (Miami-Dade County EOC)
FDO – Florida Department of Transportation
FHP – Florida Highway Patrol
FHWA – Federal Highway Administration
FIU – Florida International University
GCM – Gary, Chicago, Milwaukee
GDOT – Georgia Department of Transportation
HAR – Highway Advisory Radio
HCRS – Highway Closure Reporting System
HOV – High Occupancy Vehicle
INFORM – TMC for Long Island area in New York
ISP – Information Service Provider
ITD – Information Technology Department
ITS – Intelligent Transportation Systems
MAP – Motorist Assistance Patrol
MDOT – Michigan Department of Transportation
MDPD – Miami-Dade Police Department
MDPWD – Miami-Dade Public Works Department
MDX – Miami-Dade Expressway
MHD – Massachusetts Highway Department
MNP – Metropolitan Planning Organization
**ACRONYMS (CONTD)**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTDA</td>
<td>Miami-Dade Transit Agency</td>
</tr>
<tr>
<td>MTO</td>
<td>Ministry of Transportation of Ontario</td>
</tr>
<tr>
<td>NaviGAtor</td>
<td>TMC for Atlanta metropolitan area</td>
</tr>
<tr>
<td>NYSDOT</td>
<td>New York State Department of Transportation</td>
</tr>
<tr>
<td>PAD</td>
<td>Passive Acoustic Detector</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>SR</td>
<td>State Route</td>
</tr>
<tr>
<td>STS</td>
<td>Special Transportation Service (STS)</td>
</tr>
<tr>
<td>TCC</td>
<td>Traffic Control Center</td>
</tr>
<tr>
<td>TMC</td>
<td>Transportation Management Center</td>
</tr>
<tr>
<td>TMC PFS</td>
<td>TMC Pooled Fund Study</td>
</tr>
<tr>
<td>TOC</td>
<td>Traffic/Transportation Operations Center</td>
</tr>
<tr>
<td>TrailMaster</td>
<td>TMC for Phoenix metropolitan area</td>
</tr>
<tr>
<td>TranStar</td>
<td>TMC for Houston metropolitan Area</td>
</tr>
<tr>
<td>U.S. DOT</td>
<td>United States Department of Transportation</td>
</tr>
<tr>
<td>VIDS</td>
<td>Video Imaging Detection System</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Sign</td>
</tr>
<tr>
<td>WisDOT</td>
<td>Wisconsin Department of Transportation</td>
</tr>
</tbody>
</table>
INTRODUCTION

The purpose of this study is to assist the Miami-Dade Metropolitan Planning Organization (MPO) and its partner agencies in planning and implementing regional transportation management centers (TMC) in Miami-Dade County. This document specifically addresses:

- Status of existing TMCs in Miami-Dade County
- Understanding the major functionalities of a TMC in regional transportation management
- Key considerations, including co-location opportunities, in future TMC development initiatives

The document has been prepared based on:

- Inputs received from the agencies responsible for operating freeway management systems, traffic signal control systems, transit services, as well as, providing incident and emergency management services in the Miami-Dade County metropolitan area
- Federal guidelines on TMC implementation
- State-of-practice on TMC operations and functionalities
- State-of-art on TMC development and operations in major metropolitan areas

This document provides a brief description of TMC benefits and challenges. This report provides an inventory of existing centers in Miami-Dade County. TMC functionalities and framework for integration of multiple agencies have been discussed. Several case studies of TMCs in the United States and Canada are discussed to present the state-of-practice in TMC operations. Finally, this document presents a set of conclusions to facilitate multi-agency and multi-modal TMC implementation in the Miami-Dade metropolitan area.

This document will be valuable to transportation policymakers in Miami-Dade County in implementing TMC functionalities in a cooperative and coordinated environment, and explore co-location opportunities. This document will also assist elected officials in the County in their decisions to support the transportation investments that will provide greater value to their constituents by enhancing public satisfaction to travel.
TRANSPORTATION MANAGEMENT CENTER DEFINITION, BENEFITS AND CHALLENGES

DEFINITION

Transportation Management Centers (TMC) serve as the focal point for monitoring, controlling and coordinating various functions for managing a regional transportation system. At a TMC information about the region’s freeways, traffic signals, or transit services is collected and processed, and combined with other operational and control data to initiate control strategies to effect changes in operation. It is also a center for communicating transportation related information to the media and the traveling public.

The terms Traffic Operations Center (TOC) and TMC have been used interchangeably over the years. Historically, the functions of a single TOC have been usually the singular operation of agency-owned transportation facilities or properties. As a result, there are many separate operations centers in a regional system – one operated by a freeway management agency, one or more by the city/county traffic signal operating agencies, another operated by the regional transit agency, and one or more operated by the police, the fire, and the emergency management agencies – all of which are integral to the operations of a regional transportation system.

With the evolution of Intelligent Transportation Systems (ITS), TMC is being increasingly used to designate a center that has pluralistic dimensions in its operations focusing with a major focus on multi-modal and multi-agency coordination. The goal is a seamless integration of the multi-agency services in order to increase the efficiency, mobility and safety of the regional transportation network. TMCs are designed as part of the regional ITS architecture, which is a framework for implementing ITS in a region.

BENEFITS

Benefits of a TMC are numerous. It is often difficult to separate the benefits of a TMC from those of an integrated transportation management system, for which a TMC is an integral part. Benefits of TMCs, including those of the integrated transportation systems that TMCs operate and manage, have been reported in various U.S. DOT studies. Major benefits include:

- A TMC facilitates enhanced communication in all aspects of transportation management (e.g., planning, design, implementation, operation, maintenance) when the involved parties are co-located in the center. A TMC facilitates both daily communication, and communication for special circumstances such as special events or an unusually severe incident.

- Agencies working closely together in a TMC typically produce a more consistent, unified response to a situation, increasing the overall effectiveness of the transportation resources.
• The Toronto COMPASS system is reported to have resulted in a reduction in average duration of incidents from 86 minutes to 30 minutes, that the system prevents about 200 accidents per year, and that average speed has increased 7 to 19 percent.

• Long Island's (New York) INFORM system is reported to have resulted in increase in freeway speeds by 13 percent despite an increase of 5 percent in vehicle miles traveled for the afternoon peak. The number of locations with speeds of less than 30 mph (miles per hour) decreased by 50 percent for the morning peak. INFORM's ramp metering systems is reported to have resulted in a 15 percent accident reduction and a 9 percent increase in speed.

• A study of ramp meters in Detroit measured a 50 percent accident reduction, an 8 percent increase in speed and a 12.5 percent increase in demand. The current expansion of the freeway management system is expected to reduce delays from incidents by about 40 percent. This would lead to an annual reduction of 41.3 million gallons of fuel used, a reduction of 122,000 tons of carbon monoxide, 1,400 tons of hydrocarbon and 1,200 tons of nitrogen oxides.

• The Milwaukee MONITOR system has resulted in the increase of AM peak period average speed by 3 percent while volume has increased 22 percent. Net savings of 1,454 driver hours per peak hour have been calculated as a result of ramp metering alone.

• The Atlanta NaviGAtor TMC also hosts the area motorist assistance patrol program and the state's commercial vehicle operations enforcement program. The delay between the report of a crash and dispatch of emergency services has been cut in half, and accidents are cleared from the roadway 38 percent faster.

• Arizona DOT found that the rapid incident detection and response from TrailMaster resulted in diversion of 21 percent of the vehicles traveling on the affected roadway, resulting in a savings of 1,452 vehicle hours for a major incident.

• A conservative estimate of average freeway incident timesavings as a result of the Houston TranStar system is 5 minutes per vehicle. Analysis has shown that a savings of 30 minutes per vehicle is possible for major freeway incidents. Total annual delay savings is estimated at 573,095 vehicle-hours, resulting in about $8.4 million in savings per year.

**CHALLENGES**

There are many challenges in implementing, operating and maintaining a modern TMC. A U.S. DOT study (Reference 5) on TMC implementation has categorized these challenges in two primary categories:

• Technology and integration of technologies

• Institutional interactions
Technologies and Integration

Each TMC is highly dependent upon technology to accomplish its mission. As the geographical area served by a TMC expands (statewide or corridor-wide in some cases) the devices used to monitor and control transportation systems (either vehicles or stationary field equipment) require that the TMC employ modern communications and computing resources. Communications data rates and switching speeds, and computer processing speeds and bandwidths are multiple orders of magnitude higher than were possible only a few years ago. In addition, the integration of a variety of field devices and control center hardware is also a major undertaking. The integration of new systems with "legacy" systems, which often contain significantly different types of technology, is always a challenge. The agency owning the TMC thus faces a daunting challenge of implementing, operating, and maintaining not only a complex transportation environment, but also a mass of complex (and not always very compatible), and rapidly evolving technology. Thus, the technological complexity of the systems on which the TMC depends is a major operational management challenge.

Experience has shown that, with careful planning, the technological challenges are surmountable, as many regions have done so by implementing and operating TMCs successfully. Examples include INFORM (Long Island, New York), MONITOR (Milwaukee, Wisconsin), NavIGator (Atlanta, Georgia), TranStar (Houston, Texas). It should however be noted that the level of technology integration at each of the above TMC's varies significantly, ranging from being primarily a freeway management TMC (INFORM) to being a multi-mode management TMC (TranStar). The level of integration also depends on the governing goals and objectives related to the TMC, and the institutional interactions (discussed below) among the partnering agencies responsible for implementation of the TMC.

Institutional Interactions

In order to optimize performance and operations in a regional transportation system, establishing effective institutional interactions among multiple agencies is a major challenge, perhaps even a larger one than the technological challenges discussed above. Transportation can seldom be managed unilaterally (by a single agency, or a jurisdiction) if optimal conditions are desired. Travel patterns require interaction between transportation modes, between agencies within jurisdictions, and across jurisdictional boundaries. Interagency cooperation should be a part of every phase of the TMC, from planning through operation and maintenance. In order for the agencies to work together in developing a TMC, there should be governing goals and objectives, mutually agreed upon by the partnering agencies. In most multi-agency TMCs, some coordinating forum exists in order to address issues, assure regular and full communication, and to identify opportunities for improvement.

There are many examples of joint roles of multiple agencies in TMC development and operation. In the Detroit TMC, jointly staffed by the Michigan State Patrol and the Michigan DOT, the State Patrol dispatchers provide incident information to the MDOT TMC operations contractor who provides responses and verification and dispenses traveler information. In the AZTech model deployment, interagency coordination takes place at multiple levels. Committees were created at senior executive, executive, project, and technical working levels to assure communication and coordination, and to allow
each agency or private sector partner to voice its concerns and participate in decision making. In the Houston TrasStar TMC, the are four core agencies present on site – the Texas DOT, the City Traffic department, the County Traffic department, and the Houston Metro (transit). The TranStar Leadership Committee and the Executive Committee facilitate interagency cooperation and conflict resolution.

In Miami-Dade County, the Metropolitan Planning Organization (MPO) ITS Committee has been instrumental in facilitating the institutional interaction for ITS implementation. The Miami-Dade MPO ITS Standing Committee was initially comprised of representatives from the Miami-Dade MPO, FDOT, Public Works Department, Tri-Rail, Department of Environmental Regulation and Management (DERM), Dade County League of Cities, Miami-Dade Transit Agency (MDTA), and FIU's Lehman Center for Transportation Research. Later, the Committee expanded by including representatives from the Miami Dade Information Technology Department (ITD), Broward County MPO, Florida's Turnpike District, Miami-Dade Expressway Authority, Miami International Airport, and the Port of Miami. This TMC study is one of several initiatives that the MPO has undertaken over the years to foster institutional cooperation and coordination in deploying integrated ITS in the region.
EXISTING CENTERS IN MIAMI-DADE COUNTY INVENTORY AND OBSERVATIONS

A survey of the transportation management centers (TMC) in the Miami-Dade County was conducted to inventory the existing conditions. The survey was conducted via telephone and mail-back (via e-mail) questionnaire. Five existing TMCs were included in the survey. Figure 1 shows the locations of these TMCs. Three of these TMCs are responsible for operating and maintaining major transportation facilities or properties, including freeways, arterials and transit properties. The other two are involved in providing the incident and emergency management services. These TMCs are:

- FDOT District 6 Freeway Management Center
- Miami-Dade County Traffic Control System Center
- Miami-Dade Transit Agency Central Control, STS, and Customer Information Centers
- Miami-Dade County Office of Emergency Management Center
- Miami-Dade County Police Department 9-1-1 Center

The survey questionnaire is presented in Table 1. The purpose of the 18-question inventory survey was to generally describe existing operations and responsibilities; types of information being gathered, shared, and disseminated; methods of information gathering, sharing, and dissemination; dedicated space, staff, and operating budget; and future plans. The findings of these surveys will assist future discussions related to defining the collective needs, objectives, and operational issues for the County in regards to providing for the most efficient and cost-effective real-time management of transportation.

Table 2 presents a summary of various elements at the exiting centers. The responses received from the agencies on the survey questions are summarized below:

**FLORIDA DEPARTMENT OF TRANSPORTATION – DISTRICT 6 TMC**

- Area of present coverage includes I-95/US 1 corridor and adjacent arterial interchanges, from Ives Dairy Road south to SW 27th Avenue. Nothing in Monroe County, but $1.5M for ITS needs is planned for the next year.

- Control Center is staffed 24 hours/day, Monday – Friday. On weekends, Florida Highway Patrol handles service patrols ("Road Rangers"). Two new hub buildings at Golden Glades and SR 836 interchanges are capable of acting as satellite facilities during an emergency.
Figure 1: Existing TMCs

Transportation Management Centers
Miami-Dade County

Legend
- Miami-Dade County
- Miami-Dade Urbanized Area*
- Major Roads
- Roads
- TMC

*Based on HHS TIGER

[Map showing existing TMCs in Miami-Dade County]
Table 1: Miami-Dade TMC Inventory Survey Questions

a. Area of coverage?
b. Hours of operations?
c. Satellite centers/remote control?

1. Upgrade plans (and extent to which shared information, co-location, and shared resources are planned)?
2. Dedicated physical space, primary functions/responsibilities?
3. Staffing (number and titles)?
4. Extent of existing, co-located staff?
5. Communication protocols (software platform standards, one-way vs. two-way, rules for moving information, Datex or Corba)?
6. Types of information gathered (voice/video/data, continuous vs. occasional, real-time vs. other, joint access to co-owned equipment)?
7. Methods for information gathering (24-hour hotline, calls from cell phones, cameras)?
8. Capabilities for fusion and synthesis of information (what do you receive and analyze from others: do you receive data and what do you do with it once received)?
9. Methods for information dissemination within and outside of agency (real-time vs. other)?
10. Current extent of information sharing (with whom, when, and why)?
11. Capability for expansion (space, services, staff)?
12. Capital (O & M costs, source)?
13. Degree of performance monitoring from TMC (do you monitor performance, are you trying to improve performance)?
14. Ultimate needs/objectives, vision for the future (center-to-center functions-county/region)?
15. Primary operational issues/concerns?
16. How does your center fit into the county as a whole (regional architecture)?
17. Other TMCs that you are aware of and believe to be vital from a countywide perspective?
18. Any other comments or remarks?
Table 2. Existing Transportation Management Centers in Miami-Dade County

<table>
<thead>
<tr>
<th>Agency</th>
<th>Type of Operations</th>
<th>Staffing</th>
<th>Cost (Operations and Maintenance)</th>
<th>Size</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida DOT, District 6</td>
<td>Freeway Management</td>
<td>24 hr/day, Mon. to Fri. (Weekends by FHP)</td>
<td>$1,000,000 / year</td>
<td>Building a 32000 SF facility ($6 million)</td>
<td>1000 NW 111th Ave. (Housed beside FHP)</td>
</tr>
<tr>
<td>Miami-Dade County Public Works Department TOC</td>
<td>Signal Control (over 2,000)</td>
<td>13 at control center 25 field staff, 17 hours/day, 7 days/week</td>
<td>$6,800,000 / year</td>
<td>5000 SF, Considering new building</td>
<td>7100 NW 36th St.</td>
</tr>
<tr>
<td>Miami-Dade County Emergency Operations Center</td>
<td>Lessen disaster impact</td>
<td>7 to 5, M to F 17 staff</td>
<td>$2,100,000 / year</td>
<td>22,000 SF, built in year 2000</td>
<td>9300 NW 41st St.</td>
</tr>
<tr>
<td>Miami-Dade Transit Agency</td>
<td>MetroRail, MetroMover, MetroBus</td>
<td>24 hr/day, 365 days/year 18 bus traffic controllers</td>
<td>Not available</td>
<td>Several control centers</td>
<td>Main center in the Govt. Center Building</td>
</tr>
<tr>
<td>County 9-1-1</td>
<td>9-1-1 emergency calls</td>
<td>24 hr/day, 365 days/year 95 call takers 40 administrative 95 dispatchers</td>
<td>$23,000,000 / year</td>
<td>A 10,000 SF main center, plus 10 satellite centers</td>
<td>5680 SW 87th Ave.</td>
</tr>
</tbody>
</table>
• FDOT also currently has two variable message signs (VMS) and closed circuit televisions (CCTV) at 37th Avenue and 67th Avenue on SR 826. One VMS and CCTV is also located just north of the Turnpike toll plaza entering the Golden Glades interchange area.

• The FDOT’s center is currently connected to FHP’s computer-aided dispatch (CAD) system, which enables the FDOT control center operators the ability for near real-time monitoring of incidents FHP is handling. FHP can view the video images of the incidents FDOT is monitoring, plus FHP is capable of controlling the FDOT cameras if needed.

• The FDOT management center shares information over the phone with Miami-Dade Public Works, Shadow Traffic, and the fire department during an incident.

• New $6M TMC building (32,000 square feet) contract to be let in May 2001, and the FDOT is working on a $12M incentive to have completion on or before June 30, 2002. Four VMSs, 16 detector stations, and 27 CCTVs are now in an operational testing phase. Fifteen more freeway and arterial VMSs, trail blazers, and ramp meters to be let in July 2001.

• Existing control center (for freeway and incident management) is 2,600 square feet. Eight FDOT operators (production, systems, operations engineers, and maintenance) have been assigned to manage this control center. Also, students from FIU and contracted employees assist.

• Control center operates on a UNIX platform, and the language code is C. Workstations are being upgraded to Windows 2000 platform. Some compliance to the NTCIP is starting to be integrated by end of summer 2001.

• Incident data is gathered through both video image detection and inductive loops. The data collected is processed in the local 170 controller and transmitted back to the interim control center via leased BellSouth lines (leased lines from hubs to control center, FDOT fiber from devices to hubs). The data gathering process is fully activated at this time. However, additional detectors will be added in July to the enhance detection capabilities (confirmed by Road Ranger vehicles and cameras).
The 25 Road Ranger vehicles are equipped with RF-based Teletrac AVL, and help manage minor incidents on both FDOT and Miami-Dade Expressway (MDX) freeways (SR 826, I-95, I-395, I-195, SR 836, SR 112, SR 924, SR 874, and SR 878).

The only formal information sharing with other agencies that exists today is during the local freeway incident management meetings, where crash response procedures are reviewed. The Freeway Incident Management Team meetings are scheduled every other month, and include members of FDOT, FHP, DERM, MDPW, Fire, MDPD, City of Miami Police, SFWMD, and ICS.

The SmartRoute's "Wings" system for the South Florida ATIS project will be establishing a real-time based website and 24-hour hot line for traveler information.

Annual operating and maintenance budget is about $1M.

No performance monitoring of control center "benefits" is done at this time. A private consulting firm (PB Farradynne) has been retained with a contract to evaluate post deployment ITS benefits.

Ultimately, fiber trunkline along all major freeways and expressways is needed, including Monroe County.

Primary operational issues are securing more staffing (less reliance on FIU students as center operators), and co-operational needs being required for MDX facilities.

Partnership success with SmartRoutes for south Florida ATIS will be critical toward establishing coordinated freeway and incident management in the area. Airport Authority needs to join in, but are reluctant since they currently have their own traveler information system.

"Every small decision today should fit into the ultimate plan of the future"

**MIAMI-DADE COUNTY TRAFFIC CONTROL CENTER**

- Area of coverage includes the entire Miami-Dade County, plus seven signals on County Line Road and one signal in Broward County.

- Control Center is staffed 17 hours/day, crews in the field 24 hours/day—both for 7 days/week.

- One centralized center, 5,000 square feet. No plans for expanding existing facility. The planned new TMC building (two miles northwest of existing facility) has been delayed, but anticipated to begin construction within three years. New building architectural design includes a couple of guest offices. Invited FDOT to co-locate, but FDOT wanted to co-locate w/FHP and county maintenance staff could not be accommodated into future FDOT/FHP future control center.
Existing control center is responsible for traffic signal monitoring and control (currently no video monitoring capabilities), school speed zones, and the reversible lane operations on NW 199th Street at Pro Player Stadium. All communication and control now only through leased dedicated voice grade telephone circuit; will have fiber-optic connection in the future.

Twelve professionals and one clerical person constitute the current control center staff. Twenty-five traffic signal construction and maintenance staff provides field and central support.

Responsible for 2,020 signals (1,800 over leased lines from BellSouth - copper in field and fiber at the center, and the other 200 over county-owned copper lines). There are eight signals per line, each signal polled once per second.

Communication system is 1975 Sperry Rand (UTCS). Available bandwidth is being fully utilized, and the county has customized some reporting capabilities. The outgoing message consists of five useful bits (hold, advance, test, skip, and flash), plus 3 addressing bits and 3 occasionally used standby system control bits. The incoming message consists of six useful bits (4 phase returns, flash, and local preempt), plus 5 bits for each of two system sensors that have been abandoned.

No automated information gathering system, just some verbal (telephone, radio) and fax.

Second-by-second data is archived for 24 hours, then overwritten. Records of "problems", defined as a 2-second or more malfunction in signal operation, are stored for 10 years. Data are also sometimes used for crash reconstruction. Numerous reports to staff are automatically generated at appropriate frequencies, which vary from three times daily to once a month. Open dispatches to eight traffic signal contractors are automatically faxed twice daily.

Public needs to call-in for information. Thirty different agencies can dial-up from PC with password to get real-time status of signals. No electronic communication system is in place between FDOT and County. FDOT calls County when they have detours. Two-year work order is in place to connect the two centers (leased telephone line or fiber) for data/video communications.
• Annual operating & maintenance budget is $6.8 million, which comes from the general fund. FDOT is planning to start paying for O&M for signals on state roads.

• “Before” and “after” floating car studies constitute performance monitoring of system. Not enough active loops to use data.

• Not able to utilize system to its full capability, mostly because of major staffing shortage in maintenance. Interim solution for signal coordination (at 10% of ultimate TMC cost) will keep existing system operational for 10 more years.

• A new ATMS was originally scheduled to be designed and operational in January of 1999. Negotiations between County management and the current system management consultant regarding the continuation or abandonment of the project are proving to be time consuming.

• Viewed as the most important traffic control center in the County. Even though it was built over 25 years ago, it still has the most immediate impact on motorists.

• The concept of other centers is viewed with a "wait and see" attitude. Their success is not critically important to this system.

MIAMI-DADE COUNTY OFFICE OF EMERGENCY MANAGEMENT

• Area of coverage includes the entire Miami-Dade County, plus unincorporated areas.

• Emergency Operations Center (EOC) is normally staffed 5 days/week, 7am-5pm, and 24/7 under emergency conditions. They work closely with six other municipalities during times of emergency: Hialeah, Miami Beach, Coral Gables, North Miami, North Miami Beach, and Homestead.

• Currently, the EOC has no arrangements with the County’s transportation departments for sharing of video feeds. Representatives from the County’s transportation centers will temporarily co-locate in their control center during emergencies (“Team Metro”) to disseminate emergency information from a centralized command center.

• The Fire & Rescue headquarters building at 9300 N.W. 41st Street, including the emergency operations center (22,000 square feet, opened in May 2000) is 140,000 square feet. There are 17 civilian staff members that report to the EOC Director (10 professional management coordinators and 6 clerical & support staff). There are an additional 20 positions in non-emergency roles.

• They review and maintain existing emergency preparedness plans for the County and 30 municipalities; and monitor weather conditions, terrorism activities, changes in Cuban government, and the Turkey Point nuclear plant (automated). They are working with Channel 6 to provide real-time feed for weather.
• Blast faxing (thru e-mail) is the most common form of information dissemination. An instructional video has been prepared as part of a public safety campaign. They also provide information on the County's Warning Point (24-hour hotline thru the Police Department).

• Normally, there is no real-time information gathering except just during and after major storms. Turkey Point nuclear plant has sirens and recorded voice messages that can be activated to reach out to a 10-mile radius from plant.

• Performance monitoring consists of review of "after action reports". Recommendations for improving emergency response procedures come from these reviews.

• They try to maximize the safety and availability of sheltering. "Visualization of expressway" from interpretation of others allows them to gauge east-west evacuation demand and patterns in times of emergency.

• Capital construction budget for headquarters was $23 million ($3.5M for emergency operations center). Annual operating and maintenance budget is $2.1 million. They receive about $1.25 million per year in state grants.

• The EOC realizes that they need to connect to other centers (e.g., National Weather Center, FDOT, etc.)

• Staff number increase is desirable, but County would have to handle the associated expense to do so. Citizens should be more self-sufficient and knowledgeable during emergencies.

• EOC needs ALL the information that is available (particularly FDOT freeway video surveillance) in order to maximize their use of existing infrastructure.

MIAMI-DADE TRANSIT AGENCY

Central Control Center, Special Transportation Services (STS) Center, Customer Information Center:

• MDTA covers the entire area of Miami-Dade County, and the most southern area of Broward County. There is an agreement between the two counties to overlap areas of coverage for better transportation service.
MDTA has two transportation management centers, and a customer information service center. The central control center is located at 111 NW 1st Street (5th floor), and the STS center is located on the second floor of the garage building at 2775 SW 74th Ave. The Customer Information Center is located at the MDTA northeast garage, 360 NE 185th St.

The Central Control center operates three independent systems: MetroRail, Metro Mover, and Metro Bus. Operation is 7 days a week, 24 hours a day, and 365 days a year. The Central Control Center's function is to handle security, accidents and mechanical malfunctions. MetroRail and Metro Mover share the same control room and personnel, and they are cross-trained to operate both systems. Metro Bus operations are handled in a separate but immediately adjacent room, with a glass wall between the two centers. MetroRail has an additional center (control tower) located at 6601 NW 4th Ave. (4th floor) to control trains as they enter and leave the maintenance yard. This location can also serve as backup to the Central Control center.

Metro Mover does not have any other control center. Metro Bus has three additional centers: Coral Way (2775 SW 74th Ave.), Central Garage (3300 NW 32nd Ave.), and Northeast Garage (360 NE 185th St.). These additional Metro Bus centers serve to dispatch bus operators and resolve any logistical problems that relate to sick or late operators.

The STS center handles special transportation services and Medicare trips. The STS program is contracted privately to Intelitrans, and their center functions as a call center to make trip reservations. This center also assigns trips to the transportation providers (private or County), resolves any scheduling conflicts or problems, user complaints, and coordinates payments to the private transportation providers.

The MetroRail system gathers voice/video/data information on a real-time basis. Data and voice are carried in the County's SONET fiber ring (OC-3). Voice is also transmitted via 800MHz radio system for redundancy. For security purposes, data generated by real-time events is private and does not have direct connections with the fiber backbone. The computers and peripherals are part of an Ethernet network. A new system is now being developed to provide real-time data on train position.

The MetroRail video system (analog) is for security. Each station has up to seven cameras, which are monitored at the Central Control center. Plans for a digital replacement, using a fiber optic carrier (independent of the County's SONET ring because of lack of available bandwidth) are now being developed.

The Metro Mover system is a stand-alone system that lacks flexibility in sharing data (Intel 486 architecture). The system gathers voice/video/data information on a real-time basis. The voice system uses T1 lines for center-to-station communication. The 800MHz radio system is used for center-to-vehicle communications. The data and video systems are similar to the MetroRail data and video system. Over the next 4 years, data sharing capabilities will be incorporated.
• The Metro Bus system has three integrated systems: 1. TOS that assigns operators to routes and buses, 2. SCHEDULER that schedules the routes, and 3. CAD/AVL that is used for security, schedule adherence and vehicle mechanical monitoring. Voice/video/data information is gathered on a real-time basis. The voice system uses the 800MHz radio. The video system is local to the vehicle, and records information in solid-state devices that can be playback in special equipment (used as a accident investigation tool). The data system flow between TOS and CAD/AVL is in real-time basis. TOS and CAD/AVL reside in different computers and in different networks for security purposes. The CAD/AVL collects GPS data via 800MHz radio system from all vehicles (buses are polled every 2 minutes, MetroRail and Metro Mover every 30 seconds). MDTA has funding to develop real-time location reporting system for public use.

• The Customer Information Center is the call center for the public, where a voice response unit guides the caller through a menu-driven list of services (schedule times, special events, route map by mail, complaints, and automated trip planning using the telephone keys). The telephone switch, voice response software, and trip planning software are all connected to the MDTA Ethernet backbone. There are two NT workstations connected to the MDTA Ethernet backbone that manage the statistics from the automated call distribution system.

• Future plans are underway to inform public of static and dynamic schedules. One pilot project will create 3 kiosks that will interface with an Intranet web page (e-Government initiative). A second project is part of an ADA compliance retrofit for MetroRail stations (real-time arrival time signs at stations).

MIAMI-DADE COUNTY POLICE DEPARTMENT - 911 CENTER

• Area of coverage includes unincorporated Miami-Dade County; the incorporated areas of Miami-Dade County can contract for service.

• Center is staffed 24 hours/day, seven days a week.

• Remote centers or satellite centers include ten other police stations that also receive emergency calls from the public.

• A new computer-aided dispatch system is planned in the near future, but no vendor or price has been established. The new system will have map capabilities. In the meantime, in-house upgrades to some of the existing CAD functions are being done. The center has a self-built CAD system, so the center staff is making their own changes and modifications with no new software or hardware.

• They do not receive nor have any current means of accessing video feeds from FDOT, and they do not receive or transmit information in any way other than telephone (voice).

• The Miami-Dade Police Department participates on the Critical Incident Management committee with FDOT and FHP. They also plan for emergency contingency operations, and have a representative at all EOC functions.
• The only direct contact they have with other transportation agencies is with the County’s Traffic Signal Control center to advise them of a malfunctioning or knocked out signal.

• The 911 Center is physically housed in the County’s Data Processing Control Center (DPCC) building at 5680 SW 87th Avenue.

• The Center has approximately 10,000 square feet of space for functional positions, and 2,000 for administrative offices. The annual operating budget is $23 million.

• This Center is responsible for answering all calls for the police and fire departments, and calls from citizens not knowing whom to contact for County governmental services. The Center also provides Emergency Medical Dispatch instructions over the telephone until medical help arrives to the caller.

• The Center’s staff consists of 95 call takers (police complaint officers), 95 police dispatchers, and approximately 40 administrative staff.

• Five other Public Service Answering Points exist in Miami-Dade County (City of Miami, City of Miami Beach, City of Coral Gables, City of Hialeah, and City of Pinecrest). Some of the smaller municipalities are not open for service 24 hours a day, so the County 911 Center can receive their calls if requested during off hours.

• The County’s 911 Center receive information via telephone or from police radio only (regarding crashes and other traffic incidents). For crashes, the 911 Center dispatches an officer and medical help as needed. For traffic movement problems, the 911 Center notifies the County’s Traffic Maintenance Office.

• This Center currently does not get involved in traffic monitoring or disseminating traffic information, and they do not anticipate being involved in such activities.

**SUMMARY OF SURVEY FINDINGS**

Based on the survey results presented above, several key findings can be identified:

1. There is very little interaction (real-time sharing of information) among all the transportation management centers.

2. Performance monitoring of transportation management center activities and functions is not formally conducted and reported.

3. An overall formal plan for establishing compatible communication interfaces and protocols between transportation management centers is yet to be developed.

4. Very little traffic conditions information is currently shared with the public, although this will soon change dramatically as the South Florida Advanced Traveler Information System (ATIS) comes on-line.
5. Very little real-time information gathering exists, and sharing of this information (mostly video) is not shared among all the transportation management centers.

6. Although constrained in various ways, all transportation management centers would like to be doing and providing more.

GENERAL COMMENTS FROM SURVEYS

Several of the survey respondents expressed their opinion on key TMC development issues. Omitting the individual identity, these respondents are simply identified as Transportation Manager and Law Enforcement Officer, and their opinions on issues such as the physical co-location of agencies, needs, goals/objectives and synergies are summarized below.

On Physical Co-location of Multiple Agencies in one TMC

- Transportation Manager 1: Housing several agencies under one roof could be beneficial. At the same time it presents logistical difficulties and disadvantages; for example, lack of real estate for future growth, lack of space to house equipment, parking space, storage, lack of outside plant facilities, etc.

- Law Enforcement Officer: They should indeed, be housed under one roof. Currently, with the construction of new center at the DOT property off SR 836 and SW 107 Avenue, there is a possibility that the TMC be located there. The offices of the Freeway Incident Management Team are located in that complex, as it is the region’s DOT and the Florida Highway Patrol. With the expansion of the new dispatch center, larger screens for Freeway Management will be available. The players, however are too many: Public works, MDPD, Traffic Maintenance, Fire and Rescue, etc. -- far to many to be housed under one roof. However, as the State DOT and the Miami-Dade Expressway authority are two crucial players in the Freeway Management Team, it is good that they are located in the complex. All others have computer access.

- Transportation Manager 2: Two drawbacks to housing multiple TMCs under one roof are as follows:
  a. A terrorist attack would wipe us all out simultaneously.
  b. Most TMC-operating agencies work closely with other non-TMC-operating agencies and want to be in close physical proximity to them. If their TMC is moved to a central site, then they must sever their close physical ties with the other agencies, or bring them along. However, bringing them along requires too much space at the central site and forces them to, in turn, sever physical ties with other agencies. The physical break has to be tolerated somewhere, and the best place is where electronic interaction will be most successful, probably between TMCs, unfortunately.
**On Area-wide TMC Related Needs**

- Transportation manager 1: Open systems, NTC/IP compliant, modular, and seamless communication transfer between TMCs. A full computer control over an entire signal system or Advanced Traffic Management System (ATMS) and fully integrated with EMC and 9-1-1 would be ideal for preemption, assuring there is a limited access to EMC and 9-1-1 when it comes to changing signal patterns. Devices (surveillance and other) should be deployed in all state roads that are covered by Service Patrols ("Road Rangers"). Some arterials as well as state roads in different municipalities will benefit from this service (Road Rangers) as well. Any on-ramp signaling system, just like any signal under any centralized location, should be under the control of a center. For the ICS I-95 Phase B Project, the ramp signaling devices would be controlled by FDOT. More dynamic message signs (DMSs) are needed, not only on I-95, but also on other state roads.

- Law Enforcement Officer: Currently, the Free Incident Management Team works closely with several agencies in order to fulfill their mission. We are mainly concerned with the freeway system in the County, namely, I-75, I-95, SR-826, SR 836, SR 954, SR 874, and the Florida Turnpike, within the geographical location of Miami-Dade County. It would be ideal to extend the system to all state roads within the County; however, it is not feasible, logistically or economically. The road ranger program is almost fully operational, with the last gap (weekends) being close to implementation. Currently, we have service during the weekdays, from Monday at 6 a.m. through Saturday at 6 a.m., or something like this. It should continue to be limited to the expressway network, as this is where the need for rapid clearing of the road assistance is prevalent.

The Intelligent Corridor is almost fully operational for the area surrounding the cloverleaf. The message boards are informational for people traveling on SR 826 towards I-95, or for people traveling north or southbound I-95 in the vicinity of the cloverleaf. With the cameras already in place on I-95 from the southernmost point to almost Broward County, additional boards could be installed. SR 826, additionally, could greatly benefit of information, but the cost is prohibitive.

Automated access to expressways (by controlling the entrance ramps or ramp meters) would be great tools to expedite traffic. The Committee has been toying with this idea for a while, but the cost involved is substantial. I-95 is the ideal route to start with the controlled access, which could be eventually extended to SR 826 and the southern portion of I-75.

- Transportation Manager 2: Ideal Locations for video surveillance are those, which are the most likely to experience irregular traffic flow situations such as the following:
  
  a. Major event generator like arenas, stadiums, race tracks
  
  b. Major intersections near bridges or railroad crossings where preemption and recovery operations could be made more efficient with manual remote intervention
c. Major volume intersections and roadways where the detection of occasional flow failures can be managed to help a large number of motorists

Assuming the road ranger program is successful as stated by the FDOT, the rangers should be on all expressways. We should also consider having them on call to assist on major arterials.

Variable message signs are a huge waste of money in my opinion. A better HAR system should instead be developed with those funds.

**On Area-wide TMC Related Goals/Objectives**

- Transportation Manager 1: Goal — making sure that all TMCs adhere to a common protocol so that information can be exchanged freely between systems.

Main objective is to maintain highways free of traffic related incidents and in turn reduce travel time. As far as response time is concerned, it is difficult to set response time standards because every road and traffic conditions vary from location to location.

- Law Enforcement Officer: All stalled vehicles should be removed from the roadway within 15 minutes.

- Transportation Manager 2: Remove non-moving vehicles from the travel lanes immediately (not in 15 or any other specific number of minutes).

**On Area-wide TMC Related Synergies**

- Transportation Manager 1: (On cost savings) We need to study this more in-depth because costs sometimes are difficult to define. TMCs should share data, but should not have administrative access to each other's data. Yes, all 5 TMCs shall have access to the information from SmartRoute system.

- Transportation Manager 2: All TMCs should have convenient and quick access to each other's data and to SmartRoute system data.

**On Area-wide Traffic Management – the Future in 10 to 20 Years**

- Transportation Manager 1: I see traffic management reaching to the average people, where you can log in from your house, or your wireless laptop, or at a kiosk (in the airport, bus station, etc.), and receive real-time information; therefore, he will be more empowered and in control of his driving experience. What will it take? Investment in quality individuals, investment in technology and infrastructure, and commitment from anybody who in one-way or another uses state roads.
• Law Enforcement Officer: Not good.... Unless a new north-south expressway is built, the volume of traffic in our expressways will continue to increase, and the current capacity for expansion is almost non-existent. With the new NW 17 avenue exit and toll plaza is built on SR 836 (currently under construction), there is no capacity to expand any longer in that corridor. The turnpike (SR 821) is currently adding one additional lane in each direction, from SR 836 to the county line. And SR 826 is being widened and expanded to full capacity, with no possibility of future expansion. Gridlock will be the consequential result, unless this new North-South expressway is built.

OTHER REGIONAL TRANSPORTATIONS SERVICES

Besides the five TMC surveys discussed above, there are several other operational entities in Miami-Dade County that should be consulted in developing a potential regional TMC. A brief discussion on these operations is provided below.

SunGuide/SmartTraveler

As part of the Florida DOT’s ongoing ITS deployment initiatives, in May 2001, South Florida’s SunGuide/SmarTraveler Advanced Traveler Information Services (ATIS) was unveiled. Privately operated by SmartRoute Systems (SRS), the core ATIS services in the SmarTraveler are an interactive voice response (IVR) telephone service and a real-time traffic information web site. The IVR telephone system now allows South Florida travelers from Miami to West Palm Beach to get real-time traffic information by dialing into the system from a cell or landline telephone. Travelers can call 305-914-3838 in Miami-Dade County, and 866-914-3838 in Palm Beach and Broward Counties to access this traveler information service. In the future, it is anticipated that callers in the region will be able to access the system by dialing 511 (the U.S. DOT initiative to establish a nationwide three digit call number for traveler information). The real-time traveler information website is found at www.smartraveler.com. Internet users can get real-time traffic information by clicking on a specific highway segment in the three-county region – Miami-Dade, Broward and Palm Beach.

The Miami-Dade Expressway (MDX)

The Miami-Dade Expressway (MDX) operates and maintains State Roads 836, 924, 112, 874 and 878 in the Miami-Dade County. Since becoming operational in 1996, the MDX has achieved several important goals on the five expressways the MDX operate. The MDX ITS initiatives include:

  • Starting a roving patrol service (Road Ranger) that aids stranded motorists, helping to prevent traffic tie-ups.

  • Instituting SunPass electronic toll collection lanes that allow vehicles to pass through toll plazas without stopping, thereby speeding traffic flow.
MDX's five-year work program (2002 – 2006) includes implementing MDX's system-wide Intelligent Transportation System (ITS). The MDX is currently developing an ITS Master Plan for Deployment of ITS Devices on its roadways. The ITS Master Plan will identify where and how ITS technologies can be implemented within the MDX corridors to improve safety, efficiency and incident management for the County. The Master Plan will guide the MDX efforts to improve transportation mobility on its roadways throughout the county.

The MDX has also embarked on Rapid Deployment Initiatives to deploy ITS in the SR 836 Corridor to support future construction efforts along this roadway. Other ITS rapid deployment concepts to support incident management include accident investigation sites (AIS), and roadway reference markers.

The MDX is currently building a Transportation Management Center (TMC). The TMC will be housed in the MDX Headquarters at 3790 N.W. 21st Street, Miami FL 33142.

With regard to TMC co-location and integration opportunities in Miami-Dade County, the MDX offered several suggestions. A summary of these suggestions is provided below.

**On efficiencies of potential co-location of some or all of the TMCs in Miami-Dade County:**

- One joint information technology (IT) staff managing and maintaining the computer equipment and the LAN

- Many ITS maintenance and operations functions could be supported by shared ITS technicians

- Interaction between agency staff will increase leading to an understanding of each others responsibilities (this is an issue that will require resolution and agreement from the various parties prior to the implementation – likely to be territorial / control disagreements before agreement is reached)

- Communications lines between agencies (especially among staff) may be enhanced by the knowledge of who is doing what.

- Cross-trained staff can offset shortcomings in staff assignment and/or need for additional staffing.

- The various software platform systems can be integrated with certain software modules accessible only to certain staff, or the systems can remain separate with the enhanced capability that certain (pre-defined) information can be exchanged.

- Reduced staffing levels required for off-peak period.
On drawbacks/circumstances that might make it impossible to co-locate all of the centers (or certain centers), the MDX offered the following response:

- Roles, jurisdiction and function of the centers are some the major issues that need to be considered when housing the centers under one roof
- Disparity between 911 operators and DOT ATMS operator salaries
- Labor union agreements
- Favorable location of the TMC for functional operation of the various center-agency functions.
- Institutional infrastructure issues such as who pays for the building, maintenance, utilities, communications infrastructure costs, etc.
- Funding, construction, equipment, and maintenance of facilities

On synergies/cost savings through integration of TMCs, the MDX expressed the following opinion:

- Synergies and cost savings are very much achievable through integration of TMCs. In addition to the shared staff described above and the cost (and life) savings due to interaction among agencies' staff, the cost of building a building and maintaining it will be much lower.

On data sharing/access among TMCs:

- The data sharing should have a data distribution mechanism to select or filter which information is presented to an agency/agency personnel. This can be accomplished through some regional operations coordination framework.
- The technological framework should include sharing of information, control, and resources, with a high-degree of automation using state-of-the-art software systems, hardware and communication capabilities. Some of these capabilities could include, the following:
  - Automated tailored data exchange capabilities of commercially available databases.
  - Transparent access to cross-agency static and real-time information, as agreed upon by the agencies.
  - Multi-agency equipment control capabilities such as control of closed circuit television (CCTV), variable message signs (VMS), traffic signals, etc.

In MDX's view, there are several issues to consider when proposing the integration of several TMCs. It is important that the option of integration through the Southeast Florida Regional Architecture be revisited to derive an understanding for the data needs required for coordination. Developing a regional coordination council should be considered to develop and address a feasible framework for all participating agencies to
conduct coordinated transportation management at the regional level. This could be a parallel effort to the ongoing Florida Incident Management Team Meetings.

In addition to the TMC co-location and integration issues described above, the MDX offered suggestions on related ITS objectives, issues, and device deployments in the context of regional traffic management (including multi-jurisdictional facilities that provide alternate routing of traffic) are summarized below:

**ITS objectives** — In MDX’s view the basic objectives for Florida ITS have been addressed in the Florida Statewide ITS Strategic Plan. How all or some of those objectives apply to ITS Deployment in Miami-Dade County should be coordinated through a regional operations coordination framework to provide synergies with Southeast Florida region.

Ramp metering — Ramp metering has proved to be a good measure to ensure even freeway flow. Ramp meters are most effective when used area-wide with expressways that have parallel arterials, collector distributor roadways to efficiently distribute traffic.

Variable message sign — The deployment of VMS is needed for en-route traffic information dissemination to complement highway advisory radio (HAR) information. VMS can play a significant role in managing incidents effectively. This is one area where a regional ITS system needs to be developed, as the VMS information is most useful when alternate routes are available in response to an incident impacting highway capacity.

Incident response — ITS can best provide support to this objective with good training and emergency response plans through incident detection, response and management. It will most likely be preventing 'vehicle hours of delay' from increasing. A goal of 'removing stalled vehicles in less than 15 minutes' sounds like a reasonable and achievable goal; however, achieving this target time is dependent on geometry, congestion level and available staff. As for a target to decrease the 'response time by 20 percent', this will depend on response plans and emergency response teams preparedness and training. This type of target time is very location dependent, and may not be achievable, if the response times are already very good.

Traffic management in Miami-Dade County in 10 to 20 years from now — Traffic management in the next 10 to 20 years should help improve the system's efficiency and effectiveness for both providers and consumers of transportation services. The process to achieving this should be based on regional integration and coordination of the various agencies identified in the Florida ITS regional architecture. On the roadway side of things, regional operations coordination would enable the Miami Dade Expressway Authority, District 6 Florida Department of Transportation (SUNGUIDE), Miami Dade Traffic Control System, and the Turnpike Operations Center and public safety agencies to coordinate their "regional" transportation functions by sharing information, coordinating activities and pooling resources. Integration and coordination with other agencies and neighboring counties is also necessary to accomplish this goal.
Overall, the MDX's vision is to implement a corridor-wide Intelligent Transportation System (ITS) network for improved transportation mobility within the County. The MDX, since its inception in 1996, has embarked on development of a 20-year Master Transportation Plan that addresses the County's immediate and long-range transportation needs on MDX roadways. The plan includes roadway improvement programs that will help avert traffic gridlock in the County. In addition to these roadway improvements, the MDX has embarked on rapid deployment initiatives to improve the efficiency of the roadway network with ITS.

**Tri-Rail**

Tri-Rail is South Florida's commuter railroad, operating seven days a week from 18 train stations along a 71-mile rail corridor. Tri-Rail is the only regional commuter rail system in Florida. As the north-south spine of South Florida's transportation network, trains run parallel to Interstate 95 servicing Palm Beach, Broward, and Miami-Dade counties. The rail corridor extends northward from the Miami Airport Station in Miami-Dade County through Broward County to the northern terminus at the Mangonia Park Station in Palm Beach County. Connecting bus service is available from all 18 train stations. For service to downtown Miami or cities in South Miami-Dade, Metrorail is easily accessible from Tri-Rail's Metrorail Transfer station. Tri-Rail provides convenient connecting service to the area's three international airports; Miami International Airport, Ft. Lauderdale/Hollywood International Airport, and Palm Beach International Airport.

Tri-Rail tracks the trains in real-time and posts the train status information on the Tri-Rail web site (http://www.tri-rail.com). Information is updated on this web page every five to seven minutes.
TRANSPORTATION MANAGEMENT CENTER FUNCTIONALITIES AND FRAMEWORK FOR INTEGRATION

The context of this report is to study those aspects of TMC functionalities that enhance the integrated operations and management of transportation facilities in the Miami-Dade County. The focus of this study is not so much on the individual TMC details but on those functionalities that facilitate center-to-center information exchanges. The functionalities discussed in this section focus on three major functional areas that have significant impacts in the Miami-Dade County's transportation operations—Traffic Management, Transit Management, and Incident Management. The USDOT ITS Architecture and Standards program materials (source: http://www.iteris.com/itsarch/; http://www.its-standards.net), which provide the basis for almost all transportation systems integration in the nation, are used to identify the functional capabilities that should be incorporated in the center-to-center communications in the Miami-Dade County.

TRAFFIC MANAGEMENT FUNCTIONALITIES

Applicable to both FDOT District 6 and Miami-Dade County PWD, the TMC communications in traffic management should support a number of capabilities including:

- Exchanging near real-time traffic data and control information to support a regional traffic management strategy.
- Exchanging information with maintenance and construction operations for the efficient management of maintenance activities.
- Providing near real-time traffic information for use by information service providers (organizations that provide traveler information directly to the traveling public) and the media. Similarly, information service providers and the media share information that they receive from other sources with traffic management.
- Exchanging information with transit and emergency operations to support traffic signal priority and preemption for transit and emergency vehicles, respectively.
- Developing a more complete view of the status of the transportation network by acquiring transportation (e.g., public transportation) and event information from other centers.
- Providing near real-time traffic information for use by other operations centers, such as emergency management and transit management.
These other centers could include another traffic management, transit management, and emergency management centers, as well as information service providers and other transportation service providers. The extent to which information and control are shared between centers is determined through working arrangements among agencies or jurisdictions. Figure 2 shows the center-to-center communications framework for traffic management (source: http://www.its-standards.net/).

Figure 2: Center-to-Center Communications Framework for Traffic Management

TRANSIT MANAGEMENT FUNCTIONALITIES

Applicable to Miami-Dade Transit Authority, the TMC communications in transit management should support a number of capabilities including:

- Providing multimodal coordination between transit (bus) agencies and other types of public transportation (i.e. rail, airlines) at transfer points, including coordinating information between local/regional transit organizations including schedules, on-time information, and ridership
- Coordinating with traffic management centers to obtain near real-time traffic conditions on transit routes and to request signal priority on the selected route(s)
- Providing transit incident information, schedules, and fare and pricing information to an information service provider
- Providing transit information suitable for media use
Coordinating with financial institutions on the approval and status of electronic fare payments

Coordinating with law enforcement regarding the notification of violations

The extent to which information and coordination are shared between centers is determined through working arrangements among agencies or jurisdictions. Figure 3 shows the center-to-center communications framework for transit management (source: http://www.its-standards.net/).

Figure 3: Center-to-Center Communications Framework for Transit Management

INCIDENT MANAGEMENT

Applicable to FDOT District 6, Miami-Dade County PWD, Miami-Dade Transit Agency, The Florida Highway Patrol, The County Police Department, and the County Emergency Operations Center, the TMC communications for incident management in a multi-agency regional transportation network should support a number of capabilities including:

- Coordinate with the traffic management center to obtain real-time road and traffic conditions, coordinate closures, detours, and special access routes, request resources, control surveillance equipment, and coordinate special traffic control strategies (e.g., emergency signal preemption).

- Exchange incident reports, incident status, and response coordination information between emergency response agencies.
- Obtain real-time incident information from public safety call takers, including the nature and location of an incident.
- Provide incident information to the traveling public via the media and information service providers.
- Coordinate information about hazardous materials between HAZMAT responders and HAZMAT shippers, carriers, and other HAZMAT information resources.

Note that the center-to-center communications in incident management support the coordination and exchange of incident-related information between many allied agencies. The communication interfaces support coordinating incident management activities among agencies, disseminating of situation awareness and response plans to all agencies, and allowing resources to be requested, tracked, and managed. In this context, "incidents" include all types of transportation-related incidents such as traffic accidents, planned roadway closures, and special events. The extent to which information and coordination are shared between centers is determined through working arrangements among agencies or jurisdictions. Figure 4 shows the center-to-center communications framework for incident management (source: http://www.its-standards.net/).

Figure 4: Center-to-Center Communications Framework for Incident Management

OTHER FUNCTIONAL CONSIDERATIONS

In addition to the desired capabilities in key functional areas described above, there are other considerations that are related to the efficiency of integrated and coordinated TMC operations. Several functionalities that may be considered almost mandatory include
workstation integration and automated information reporting/sharing. These functionalities are briefly described below.

**Integrated Workstations**

A key concept in efficient TMC operations is the term "integrated workstation". Though different systems or software may exist in the operations center, a separate workstation should not be required to monitor or manipulate each of these systems. The integrated workstation concept allows common information to be shared across multiple systems and provides a common interface to the network. The integrated workstation should also allow all system functions, manipulations, or operations to be performed at either a single workstation, or at two workstations. An operator should not need multiple workstations to perform or complete his daily functions. An integrated workstation not only benefits the users of the system, but also can promote economies-of-scale in the installation, operation, and maintenance of the system. In a nutshell, the workstations provide operator interfaces that allow the TMC personnel a more effective means to gather and categorize traffic/transit information, to simplify the interpretation of system information, and to provide the ability to quickly formulate solutions to problems as they arise.

**Automated Information Sharing**

The sharing of information among various agencies in a regional transportation network is essential to operating an efficient and seamless transportation system. In a regional transportation network, which is usually controlled by multiple jurisdictions, the TMCs that incorporate seamless electronic information sharing capabilities among multiple agencies facilitate many activities including:

- Alerting other agencies of incidents and construction activities that may impact their respective facilities
- Facilitating coordinated multi-agency responses to these major incidents
- Using variable message signs (VMS) and highway advisory radio (HAR) belonging to one agency to describe unusual conditions on another agency’s facilities
- Creating an integrated clearinghouse of real-time and multi-modal traveler information

**Transit Centers - Additional Considerations**

While most of the requirements described above are applicable to both traffic and transit oriented TMCs, the transit oriented centers have additional functional needs for the basic fact that transit agencies operate vehicular fleets, and do not own the roadways on which the transit buses operate. Most transit agencies have some form of operations center or room where transit functions such as communications with transit vehicles are performed. Transit vehicle types may include buses (local or express), trains, commuter rail, carpools, vanpools, taxis, or paratransit. Some of the more common purposes or functions of a transit operations center include providing the following:
- Fleet management, including vehicle locations, schedule adherence, service restoration for disabled vehicles, vehicle rerouting, vehicle control, or emergency response.
- Demand management, such as vehicle dispatch for ridesharing programs or paratransit.
- Fare collection or revenue operations.
- Incident response coordination within the transit agency and with other agencies, such as other transit authorities, public agencies, or other organizations, including the traffic, police, and fire departments.
- A central database repository, as part of an integrated system in support of different departmental functions. Such functions may include fleet management, demand management, maintenance operations, reporting functions, or planning operations, such as scheduling.
- Traveler information for the media or general public, including pre-trip planning (mode selection), in-vehicle or en-route information.

As with the traffic operation center workstations, the concept of integrated workstation is equally applicable to transit oriented operations centers. The primary objectives are the same: the operator interface on the workstation provides a more effective means for personnel to collect and categorize transit information, to simplify the interpretation of system information, and to provide the ability to quickly formulate solutions to problems that arise.

At many transit operation centers, each dispatcher or operator has two personal computers or workstations at his disposal.

- Workstation #1 - This workstation normally has some mapping software depicting the service area, and icons that may indicate the locations of the vehicle fleet, the status of each vehicle, and where the vehicle demands are. For a commuter railroad or light rapid transit system, the map software would indicate the rail tracks, the locations of the switching blocks, and the stations. Information can also be collected from the field indicating the locations of the trains. For a paratransit system, the map software might indicate the location of the vehicles, the date, time, and location of the pickup request, and the location of the drop-off point.

- Workstation #2 - The second workstation is usually dedicated to communications control. Using this workstation, the dispatcher or operator can easily communicate with whomever he may need to at the moment. The person may be a vehicle operator or engineer, another dispatcher, a station manager, a maintenance crew, a supervisor, or emergency personnel such as the police department or fire department. The workstation allows the operator to quickly and seamlessly switch between different communication lines or media, such as radios, cellular phones, or direct phone lines.
• In addition to the workstations located in the TMC (e.g., staff office, operations console), several remote workstations may also be included outside the TMC. Remote workstations may be necessary when all operations of the transit authority are decentralized. For example:

• In metropolitan cities where the service area may be large, the planning division, the maintenance division, and the revenue collection divisions may be located at locations away from the operations center. In these cases, a remote workstation at each of these divisions is desirable so each respective department can retrieve and share its information without requiring a presence in the operations center.

• Many agencies have multiple operating bases where buses are dispatched from more than one garage. In this situation, each operating base has a dispatching function, but the local dispatching is limited to assigning drivers to specific vehicles and making sure that all pieces of work are covered. Once the drivers pull out onto the road, they become under the control of the central dispatcher who is the only one that exercises real-time control. The central dispatch can be located at one of the operating terminals or it can be located at a central office. A critical need for data transfers includes letting the central dispatch function know which operators and which vehicles are assigned to which pieces of work. With some level of automatic vehicle location (AVL) systems implementation, this is done automatically, but if the system is not so equipped, the information must still be passed on to the central dispatcher.

TMC INTEGRATION AND JOINT OPERATIONS CONSIDERATIONS

The U.S. DOT study on the TMC Implementation Guide (Reference 5) provides some excellent observations on the TMC coordination and integration aspects of a regional transportation system. A study (Reference 15) by the Institute of Transportation Engineers on the Management and Operations of ITS also provided some valuable thoughts on TMC resource sharing/joint operations /integrations. The following discussion is primarily based on those documents.

Center-to-Center Coordination

Coordination among multiple centers typically increases the effectiveness of each center, providing a superior overall perspective of the area under control, and making clearer the impact of actions taken by any individual center. However, a major step in achieving this coordination is the selection of which pieces of information will be shared, and how (the level of integration) the information will be available. Many of the Southern California ITS Showcase projects involve sharing information between TMCs. In the InterCAD project, incident related information is shared between the computer aided dispatch systems of several regional enforcement and EMS agencies at federal, state, and local levels. Appropriate information is shared with the regional Caltrans TMC through a bi-directional Internet link.

Two primary alternatives for sharing of information are "push", where the originating center automatically transmits the information to the other center, and "pull", where the receiving center inquires for information it desires, receiving that information as the result
of actions following the inquiry. In a common client/server environment, a combination of the two may result from the receiving center "subscribing" to information from the originator, who then automatically transmits the desired information until the subscription indicates otherwise.

Cross-center coordination begins not when the center is operational, but early on during initial planning, design, and implementation. Involving all agencies active in the situations addressed by the TMC ensures that the center is optimally configured, equipped, and staffed to achieve full benefit from the taxpayer investment. Information Sharing is the he focus of cross-center coordination. Typical examples of infrastructure-based information sharing include messages on variable message signs and highway advisory radio. Non-infrastructure intensive traveler information includes provision of information via broadcast media, press, Internet, telephone systems, or via fax. Information sharing may occur at any time, i.e., as part of event planning, during an event, or following the event as a "post mortem" evaluation.

In event planning, agencies should work to comprehensively detail the actions to be performed, identifying who is responsible for each action, and how information will flow during the event. During the event itself, sharing information on what is transpiring and how, and on how each agency is responding adds to the total effectiveness. In a post-event analysis, careful consideration of how the event proceeded, step-by-step, and of how improvements can be achieved is beneficial. This includes both planned events (such as parades) and unplanned events (such as traffic incidents). Good examples include the detailed plans prepared by Houston Metro's law enforcement staff at the TranStar control center detailing freeway, arterial, transit, and crowd control plans for major events such as the annual Rodeo.

Center-to-center coordination is of even greater importance for traffic signal systems. Where neighboring centers control signals along a primary signalized corridor, coordination is critical to achieving optimal flow conditions. Interaction may take place in real time or may only be necessary if conditions are changing in the centers, such as for special events or construction-related lane closures.

**Share Control or Not**

A major issue requiring careful examination while planning interaction between centers is the decision of whether centers will share control of one another's assets. The primary deciding factor is typically legal or regulatory in nature, of whether the employees of the first jurisdiction can legally take actions, which can impact the citizens of the second jurisdiction. Issues of liability for damage to each jurisdiction's equipment must also be addressed. Operational procedures may differ between the centers, requiring additional training, documentation, and conflict resolution procedures. Workload may change as well, depending on whether each center uses the other's assets in its stead, or only under unusual circumstances. Formal interagency agreements are necessary before such activity of shared control begins because of the many impacts of shared control. The processes for informing responsible personnel and decision-making or authorization will need to be clearly stated in the agreement, and appropriately reflected. Memoranda of understanding, signed by senior agency officials, clarify both the strategy and the specific actions that can be expected from each agency partner during system operation, and how information moves between the agencies.
CORRIDOR WIDE INFORMATION COORDINATION

Often the impacts from incidents or scheduled events (construction, road closure, etc.) may traverse outside of a metropolitan region impacting a whole corridor involving multiple metro areas in multiple cities and states. The I-95 Corridor Coalition has been operating an Information Exchange Network (IEN) among its member agencies throughout the northeast (Maine through Virginia). The IEN consists of over sixty computer workstations and four regional servers connected in a wide-area Ethernet network. The system architecture is primarily distributed in nature with workstations located at the Coalition members' TMCs. Each workstation provides a point of entry and access to regional and corridor-wide transportation information.

CENTER-TO-CENTER INTERFACES AND ITS STANDARDS

The information exchange and sharing of control between centers will be greatly expedited by the use of ITS standards. A major step will be the availability of the final center-to-center portion of the National Transportation Communications and ITS Protocol. This protocol will provide a common language for the movement of information and control between centers. It will exist in two forms, each recognizing a different systems paradigm. The structured model of information management will be applied in the DATEX version, whereas an object-oriented model will be in the CORBA version.

TMC SOFTWARE STUDY, A FDOT STATE ITS OFFICE INITIATIVE

The FDOT State ITS Office, in cooperation with the Michigan Department of Transportation and the Federal Highway Administration, has recently completed a Traffic Management Center Systems Software Study (Reference 16). The study provides the Florida Department of Transportation (FDOT) State Intelligent Transportation Systems (ITS) Office with a recommended approach to implementing a common software system throughout the State of Florida as well as an opportunity to share common components of the software system with other State Departments of Transportation (DOT). This study include short-term and long-term recommendations for implementing a common TMC software system for FDOT, discusses an approach for migrating each FDOT district to the long-term recommendation, and identifies software and hardware benefits of implementing a common software system.

TRAFFIC MANAGEMENT CENTERS POOLED-FUND STUDY (TMC PFS)

The goal of the TMC PFS is to assemble regional, state, and local traffic management agencies and the Federal Highway Administration (FHWA) to (1) identify human-centered and operational issues that are common among Traffic Management Center (TMC) operators and managers; (2) suggest approaches to addressing identified issues; (3) initiate and monitor projects intended to address identified issues; (4) disseminate results; and (5) assist in solution deployment.

There are currently 19 states participating in the TMC PFS. Any public agency or authority that is responsible for managing travel and operating traffic on a portion of the
surface transportation system is eligible to join and participate in the TMC PFS. The Florida Department of Transportation is a member of the TMCPFS.

The FHWA provides the staff and resources to manage and support the day-to-day administration of the TMC PFS.

**TMC PFS Objectives**

The TMC PFS is intended to serve as a forum for the participants to identify and address human-centered and operational issues that are common among several traffic management centers. The TMC Study will focus on issues that arise from traffic management centers that are part of traffic signal control systems, or freeway management systems. Within these broad topic areas, the following are offered as examples issues that might be addressed within the intended scope:

- Operations planning and program issues.
- Operational strategies and plans.
- Operator procedures and task allocation.
- Operator-computer interfaces.
- System design and implementation.
- Facility and system performance monitoring, evaluation, and reporting.
- Contracting and procurement practices and issues.
- Traffic management and operations related to construction and maintenance work zone.
- System maintenance concepts and plans.
- Operator training.
- Personnel requirements and job descriptions.
- Personnel retention.
- Interagency cooperation and communication.

**Project Status**

Four projects were selected in 2000 and are currently underway:

- Operator Requirements Matrix ($199,842)
- Changeable Message Systems Guidelines ($149,953)
- Maintenance Concept & Plans ($249,841)
- Configuration Management ($250,000)

Two projects were selected for funding in 2001:
  - Integration of Freeway and Arterials Operations (est. $350,000).
  - TMC Concept of Operations Development (est. $300,000)

**FDOT Commitment**

Florida DOT has contributed $100,000 to this contract, and plans to contribute $50,000 every year in the next three year. This will be a five-year program.

**Additional Information**

Additional information on the FHWA pooled fund study can be found on the website - http://tmcps.ops.fhwa.dot.gov/
TRANSPORTATION MANAGEMENT CENTER

CASE STUDIES

The U.S. DOT has conducted several case studies documenting information on operations at various TMCs within the United States and Canada. This section provides a summary of eight TMCs that were studied in detail in various U.S. DOT case studies. While the primary focus of each of these centers is freeway management, several are also responsible for traffic signal system operation and various aspects of transit system management. The eight TMCs discussed below represent a broad range of centers in their systems' size, age, purpose, and implementation. These TMCs are:

- Atlanta NaviGAtor, Georgia
- Houston TranStar, Texas
- Milwaukee MONITOR, Wisconsin
- Toronto COMPASS, Ontario, Canada
- Detroit Michigan ITS Center, Michigan
- Long Island INFORM, New York
- Arizona TrailMaster, Phoenix, Arizona
- Boston Artery/Tunnel Integrated Project Control System, Boston, Massachusetts

Table 3 presents an overview of various elements at each of these TMCs.

TMC SUMMARIES

Atlanta NaviGAtor

The Atlanta's NaviGAtor TMC began operations to serve the needs for incident management, congestion management, and motorist assistance during the 1996 Olympic Games in Atlanta. NaviGAtor's mission has been expanded to serve as part of the Georgia DOT's statewide freeway incident management program. It uses vehicle detectors, closed-circuit television, variable message signs, and ramp meters communicating over a fiber optic and microwave network. As a result of the NaviGAtor services, the delay between the report of a crash and dispatch of emergency services has been cut in half, and accidents are cleared from the roadway 38 percent faster.

The NaviGAtor TMC hosts the Georgia DOT, as well as the area motorist assistance patrol program and the State's commercial vehicle operations enforcement program.
### Table 3: Key Features at Eight Metro Area TMCs

<table>
<thead>
<tr>
<th>Agencies in TMC</th>
<th>Functions in Control Room</th>
<th>Other Functions in TMC</th>
<th>Approx. TMC Area</th>
<th>Control Room Size</th>
<th>Centerline Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDOT (Multiple Functions)</td>
<td>Traffic Operations, MAP, Traveler Information, Broadcast</td>
<td>Planning, Design, Training, Management, HOV/COVO, Outreach</td>
<td>73,500 sq. ft.</td>
<td>1,300 sq. ft.</td>
<td>220</td>
</tr>
<tr>
<td>TxDOT, Metro Transit, City, County</td>
<td>Traffic Operations, Transit Dispatch, Law Enforcement, MAP, Broadcast</td>
<td>Projects, Design, Special Events, Emergency Operations, Outreach</td>
<td>54,000 sq. ft.</td>
<td>3,600 sq. ft.</td>
<td>122</td>
</tr>
<tr>
<td>WMsDOT</td>
<td>Traffic Operations</td>
<td>Planning, Design, Inspection, Outreach</td>
<td>6,500 sq. ft.</td>
<td>600 sq. ft.</td>
<td>63</td>
</tr>
<tr>
<td>MTO</td>
<td>Traffic Operations, Vehicle Information</td>
<td>Planning, Design, Training, Maintenance, Various</td>
<td>2,500 sq. ft.</td>
<td>1,800 sq. ft.</td>
<td>60</td>
</tr>
<tr>
<td>MDOT, Mich. State Patrol</td>
<td>Traffic Operations, MAP</td>
<td>Design</td>
<td>14,000 sq. ft.</td>
<td>3,600 sq. ft.</td>
<td>180</td>
</tr>
<tr>
<td>NYSDOT, Contractor</td>
<td>Traffic Operations, MAP, Traveler Information</td>
<td>N/A (State Office Building)</td>
<td>3,000 sq. ft.</td>
<td>625 sq. ft.</td>
<td>165</td>
</tr>
<tr>
<td>ADOT, Arizona State Patrol</td>
<td>Traffic Operations, Incident Teams, Broadcast</td>
<td>Design, Analysis</td>
<td>18,000 sq. ft.</td>
<td>2,400 sq. ft.</td>
<td>254</td>
</tr>
<tr>
<td>MHD, Mass Pike</td>
<td>Traffic Operations, Tunnel Control</td>
<td>Various (Major Office Building)</td>
<td>5,000 sq. ft.</td>
<td>2,400 sq. ft.</td>
<td>7.5</td>
</tr>
</tbody>
</table>

### Incident Detection Methods

<table>
<thead>
<tr>
<th>Devices/ Other Methods</th>
<th>Loops CCTV MAP Scanner</th>
<th>Loops CCTV Police Officer Calls</th>
<th>Loops CCTV MAP</th>
<th>Loops CCTV Police MAP</th>
<th>Loops Radar PAD CCTV Buses MAP Probes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CCTV, CCTV, MAP, Scanner</td>
<td>CCTV, CCTV, Police Officer Calls</td>
<td>CCTV, CCTV, MAP</td>
<td>CCTV, CCTV, Police MAP</td>
<td>CCTV, CCTV, Buses, MAP Probes</td>
</tr>
</tbody>
</table>

### TMC Staffing

<table>
<thead>
<tr>
<th>Number of Operator Positions</th>
<th>10</th>
<th>9</th>
<th>5</th>
<th>6</th>
<th>3</th>
<th>12</th>
<th>6</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Prime Shift Operators</td>
<td>3+</td>
<td>3+</td>
<td>5</td>
<td>4</td>
<td>2+</td>
<td>5</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Total Operations Staff</td>
<td>10</td>
<td>12</td>
<td>12</td>
<td>9</td>
<td>5</td>
<td>18</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Operations Staff Source</td>
<td>Mass Pike as Contractor</td>
<td>Agency Staff (FT and PT)</td>
<td>Contractor Personnel</td>
<td>Temporary Part-time</td>
<td>Staff, Students</td>
<td>Staff, Students</td>
<td>Agency Staff</td>
<td></td>
</tr>
<tr>
<td>Number of Shifts</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

### Media Interface Examples

<table>
<thead>
<tr>
<th>Media Accommodations in TMC</th>
<th>None</th>
<th>None</th>
<th>Being Privatized</th>
<th>None</th>
<th>Broadcast Booth</th>
<th>Broadcast Position</th>
<th>Broadcast Booth/office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media On site</td>
<td>None</td>
<td>Metro</td>
<td>Being Privatized</td>
<td>Metro in Building</td>
<td>Radio</td>
<td>Metro</td>
<td>Metro (Designated ISP)</td>
</tr>
</tbody>
</table>

AVC – Automated Vehicle Classification  
CCTV – Closed-Circuit Television  
GCM – Gary, Chicago, Milwaukee  
ISP – Information Service Provider  
MAP – Motorist Assistance Patrol  

MHD – Massachusetts Highway Department  
MTO – Ministry of Transportation of Ontario  
PAD – Passive Acoustic Detector  
VIDS – Video Imaging Detection System  
VMS – Variable Message Sign  

Source: Based on information in Reference #8.
Houston TranStar

The TranStar TMC is a multiagency transportation management center providing traffic management, traveler information, and emergency management for the greater Houston area, including limited assets in Galveston. The goals of Houston TranStar are to manage emergency response, promote emergency management awareness and public safety, promote the benefits of Houston TranStar, increase efficiency, improve productivity, and enhance mobility, congestion management, and safety. TranStar resources include variable message signs, highway advisory radio, loop detectors, closed-circuit television, lane control signals, ramp meters, a motorist assistance patrol, and an AVI-based congestion detection system extending beyond the conventionally detectorized area. An extensive traffic signal system upgrade/replacement of 3,000 signals is under way. As a result of the TranStar services, average freeway incident time saving is about 5 minutes, but analysis has shown that a savings of 30 minutes is possible for major freeway incidents. Total annual delay savings is estimated at 573,095 vehicle-hours, resulting in about $8.4 million in savings per year.

In TranStar TMC, the four core agencies are the Texas DOT, the City of Houston, Harris County, and Houston Metro. Houston and Harris County Offices of Emergency Management are also present.

Milwaukee MONITOR

The MONITOR TMC manages Wisconsin DOT’s freeway traffic management system in the metropolitan Milwaukee area. MONITOR uses vehicle detectors, closed-circuit television, traffic responsive ramp metering with high occupancy vehicle (HOV) priority, freeway and arterial variable message signs, and highway advisory radio. The TMC is also the focus for regional distribution of road closure information. Wisconsin DOT has reported travel time reductions of 9, 12, and 16 percent on three separate roadway segments as a result of MONITOR’s systems. AM peak period average speed has increased 3 percent while volume has increased 22 percent. Net savings of 1,454 driver hours per peak hour have been calculated as a result of ramp metering alone.

Wisconsin DOT is the key agency. A captain level full-time liaison from the county Sheriff’s department is present in the MONITOR TMC to provide coordination with law enforcement and emergency management.
Toronto COMPASS

The COMPASS TMC in the Toronto metro area balances traffic between express and collector lanes on Highway 401, and provides incident detection and incident management. COMPASS uses vehicle detectors, closed-circuit television, and variable message signs communicating over a fiber optic network. A 1994 evaluation showed that the COMPASS system has resulted in a reduction in average duration of incidents from 86 minutes to 30 minutes, that the system prevents about 200 accidents per year, and that average speed has increased 7 to 19 percent. Two smaller COMPASS TMCs in the Toronto area monitor adjacent roadways.

The COMPASS TMC focuses on freeway operations. The Ministry of Transport, Ontario is the key agency.

Detroit, Michigan ITS Center

The Michigan ITS Center in Detroit includes ramp meters, detectors, and closed-circuit television, and highway advisory radio, communicating via microwave and spread spectrum radio to an OC-48 fiber optic network. The focus of the TMC is to make the traveler’s trip less stressful by providing better information so the traveler can avoid congestion or other driving problems. A study of ramp meters in Detroit measured a 50 percent accident reduction, an 8 percent increase in speed and a 12.5 percent increase in demand. The current expansion of the freeway management system is expected to reduce delays from incidents by about 40 percent.

The Michigan ITS Center is jointly staffed by the Michigan DOT and the Michigan State Patrol.

Long Island INFORM

The INFORM system on Long Island, New York includes vehicle detectors, closed-circuit television, traffic signals, ramp metering, and variable message signs communicating over a coaxial network. The TMC identifies traffic congestion and incidents or situations likely to cause congestion, and provide information to motorists and incident management resources to minimize the duration and impact of such situations. The system monitors and manages traffic on Long Island’s three major east-west limited access routes, with work under way to instrument north-south arterial connector routes as well. Results of INFORM studies show that freeway speeds increased 13 percent despite an increase of 5 percent vehicle miles traveled for the afternoon peak. The number of locations with speeds of less than 30 mph decreased by 50 percent for the morning peak. A study of the INFORM ramp metering system found a 15 percent accident reduction and a 9 percent increase in speed.

INFORM was implemented by the New York State Department of Transportation, and used primarily for freeway management. The INFORM TMC also hosts the regional motorist assistance patrol.
Arizona TrailMaster, Phoenix

The TrailMaster TMC in Phoenix is the hub of the Arizona Department of Transportation's statewide freeway incident management program. The objectives of TrailMaster are to support optimum utilization of the freeway system, provide a safe and efficient environment for users, and ensure efficient utilization of ADOT resources. The system uses vehicle detectors, closed-circuit television, and variable message signs communicating to the control center over a fiber optic network. Traveler information is provided via multiple methods, including on-site broadcaster, Web site, video feeds to other media, and the AZTech metropolitan model deployment initiative kiosks, onboard navigation, computerized telephone, and bulletin board systems. In a study of a typical incident, Arizona DOT found that the rapid incident detection and response from TrailMaster resulted in diversion of 21 percent of the vehicles traveling on the affected roadway, resulting in a savings of 1,452 vehicle hours for this incident.

The TMC also hosts the Arizona DOT and the Arizona State Patrol.

Boston Artery/Tunnel Integrated Project Control System

The Boston Artery TMC is an integrated traffic management and tunnel systems control application for Boston's 7.5 mile Central Artery/Tunnel system. The objective of this system is to monitor security, traffic, and systems (fire, water level, air quality) status, and to respond to incidents, nonstandard needs, or failures rapidly and effectively. The traffic management components also support management of traffic through the heart of Boston and to and from Logan Airport, and thus they are also involved in supporting both daily travel and any special events that occur on Boston's roadways. The integrated project control system applies vehicle detectors, overheight detectors, closed-circuit television, lane control signals, and variable message signs communicating over a fiber optic network.

The system is being implemented by the Massachusetts Highway Department, and is operated by the Massachusetts Turnpike Authority.

SUCCESSFUL PRACTICES AND LESSONS LEARNED

The following provides a summary of successful practices and lessons learned from the TMC case studies conducted by the U.S.DOT. This summary focuses on the inter-agency, intra-agency, and the media interaction aspects only.

Interagency Interaction

Interaction with partner agencies in the incident management process is one of the most important and complex components of TMC operations.
• Both Detroit and Milwaukee had law enforcement officers on-site at their TMCs, with Detroit cohabiting the control room with Michigan State Police dispatchers, and Milwaukee having a dedicated, captain-level liaison on site from the Milwaukee County Sheriff's department. When the captain was attending other duties, a Sheriff's department radio, tuned to the appropriate traffic frequency, remained in operation in Milwaukee's control room.

• Houston hosts officers from both Houston Metro and Harris County in its control room

• Atlanta has a full-time control room console position for a Georgia Department of Transportation (GDOT) commercial vehicle operation (CVO) and high occupancy vehicle (HOV) enforcement officer.

• Atlanta noted that it regularly received calls from area law enforcement agencies requesting that it dispatch motorist assistance patrol vehicles to existing incident sites.

• Houston is investigating the feasibility of mobile command centers for incidents and special events, drawing on both military experience and more recent activity in work zone traffic management.

• Because of the numerous agencies involved in transportation in their areas of coverage, Arizona (statewide), Long Island, and Atlanta (also statewide) face the greatest challenges when coordinating with multiple law enforcement units. This coordination is typically conducted via telephone, with either dedicated or "speed-dial" lines to the dispatch functions at the relevant agencies.

• Houston, given its complex multiagency, multifunction role, recognized the value of having a facilitator for its multifaceted activities. The Houston facilitator allows each agency to focus on its skills, resources, and primary purpose in any situation, resulting in faster consensus.

• Regarding construction-related road closures, Milwaukee has the enviable position of having pre-approval authority over all closures on its road network and for being the final authority on initiation of any road or lane closure.

• The Arizona Highway Closure Reporting System (HCRS) has been so successful that adjacent states have approached the Arizona Department of Transportation (ADOT) about expanding the system for multistate, regional application.

• Toronto has developed a low-workload system for capturing information about lane closures and faxing that information, regularly updated, to relevant agencies and other interested parties.

• Atlanta's system—featuring both the central GDOT TMC and traffic control centers (TCC) at the city, counties, and outlying areas in which traffic management is being implemented—shares all construction closure information over the distributed network, allowing partner agencies full access to the closure information in the system.
• Houston monitors parking availability during similar large events. Houston has on-site Houston Metro officers who perform detailed special event planning, and who participate in event execution and coordination. Houston Metro estimated that the Houston TMC manages one special event per week, including some that involve the planned presence of livestock on the roads, and others that may last for several days.

• Houston's emergency operations center is located within the TMC. Houston officials were enthusiastic about the effectiveness of collocating the emergency operations center and TMC, citing outstanding cooperation and coordination during emergency operations.

• Toronto has prepared an area adjoining its TMC control room for emergency operations. Atlanta's TMC is located adjacent to the Georgia emergency operations center.

• The Houston area is supported by an alliance of wrecker companies, working from a common dispatch center. The alliance is presently discussing relocating its dispatch function to a location within the TMC to further improve coordination.

**Intra-agency Interaction**

• Milwaukee and Atlanta have taken a direct approach to their TMC intra-agency coordination. Both co-locate their planning, design, inspection, and operations under a single TMC organizational unit.

• For most TMCs, maintenance is located in a separate facility in the metropolitan area and typically reports to the DOT district office, rather than to the ITS unit.

• Phoenix maintains contact with ADOT maintenance statewide through its radio system (in the control room) and via pagers.

• Also in Phoenix, operations, maintenance, and systems supervisors maintain a joint list of desired system improvements.

• In Milwaukee, both operations and management personnel can access the advanced traffic management system remotely via a dial-up connection.

**Transit Integration**

• In situations where the transit fleet depends upon the roads managed by the TMC, such as for express and circulator routes, the value and extent of integration can be significant.

• In situations where the TMC's detection and surveillance networks are limited, information from AVL and operators on buses serving as traffic probes can significantly expand the traffic network information available to the TMC.
Centralized integration typically features transit personnel in the TMC control room. In such cases, often other transit functions, such as bus dispatch, are also migrated to the TMC. Decentralized integration is also possible, through extensive electronic sharing of voice, data, video, and control capability over communications lines between the TMC and transit control centers.

While the above observations from the TMC case studies amply depict the benefits of cooperation and coordination among the traffic and transit management agencies, a Federal Transit Administration study (Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers, FTA, 1994) concluded the following on transit integration into TMCs.

- 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.

**Media Coordination**

- Positive TMC interaction with the media can greatly benefit the TMC’s mission. Although TMCs are not necessarily designed for such a public relations role, they often become the focus of outreach to the public, to the media, and to the professional transportation community.
Milwaukee, Houston, and Atlanta have outreach staff on site, facilitating their relationship with the media and expanding their ability to broaden understanding of their advanced traffic management system and purpose by the traveling public and key decision makers.

Atlanta has initiated direct public outreach efforts through billboards and bus advertisements and regularly leverages the extremely positive image of its motorist assistance patrol program to build support for the state’s ITS activities.

Atlanta also features preinstalled media hookups and a dedicated media broadcast area.

The Phoenix control room hosts a local broadcaster during peak periods, as does Long Island when the broadcaster is available.

In both Atlanta and Milwaukee, the media were required to pay for the acquisition and installation of the equipment the media needed to access their computer and video feeds.

Lessons Learned

This summary of the lessons learned from the TMC case studies also focuses on the inter-agency, intra-agency, and the media interaction aspects

• Early and strong Metropolitan Planning Organization (MPO) support for the TMC concept in the region helped provide a good foundation for advancing a TMC system and traffic management concepts for many years. Gaining such support also helped define, for those responsible for examining the long-term transportation situation, the regional needs the TMC would meet.

• The TMCs stated that the implementing agency must predetermine (in a feasibility study or conceptual design study) the purpose of the TMC and then ensure that the Advanced Traffic Management System would support that purpose effectively. A system design that did not address and support the specific, known transportation needs of the region (and did not support the involved agencies’ long-term transportation strategy) could result in negative public and political reaction and many challenging years of ITS program management.

• A common theme TMCs expressed was the need for adequate space, including the value of having a facility that could be expanded as space needs increased. Most TMCs soon discovered that when their site was operational, an ongoing stream of agencies and functions found it beneficial to locate within their TMC.

• In multiagency circumstances, one TMC noted the importance of each agency having some “home turf” in the TMC, in which it could comfortably address sensitive internal issues, away from other TMC residents.
There was general agreement that providing dedicated space to media within the center (typically in or adjoining the control room) supported an effective (and less disruptive) media relationship, and built positively on the TMC’s outreach program.

The presence of law enforcement officers in the TMC provided a boost to the security level at those centers with such arrangements.

Those TMCs that hosted both traffic management and emergency management capabilities noted that the TMC needed to be properly configured and outfitted for that mission. Appropriate requirements typically included adequate sizing of backup power units, communications connections, and accommodations for personnel working around the clock.

Especially for those TMCs where multiple elements of the ITS program (planning, design, construction/inspection, operations, maintenance) were co-located, there was significant value gained by designing laboratory and testing facilities into the TMC. Such facilities supported evaluation of new equipment, testing and calibration of new and repaired units, and debugging of interfaces between the equipment and computer and communications systems.
CONCLUSIONS

Based on the information, analysis and discussion presented in the previous chapters, this study makes the following conclusions with regard to developing TMCs in the context of the Miami-Dade County regional transportation management.

1: DEVELOP TMC CONCEPT OF OPERATIONS PLAN

Research conducted by CUTR on TMC implementation practices revealed that most regional TMCs in the nation have conducted general planning studies prior to implementing the TMC, but none developed a TMC Concept of Operations Plan. The concept of operations for a TMC deals with a wide array of topics relating to the operations and maintenance of the TMC and its systems. In the U.S. DOT studies the development of a Concept of Operations Plan has been highly recommended. The key elements of a TMC Concept of Operations Plan are:

- The systems
- Operational facility needs
- Integration and testing
- Roles and responsibilities of the participating agencies
- Performing and procuring operations and maintenance
- Training and documentation
- Operational procurement and contracting

The discussion of each topic should be adequate to clearly identify:

- Each of the functions to be performed within the TMC
- The number of staff and their areas of responsibility
- The systems, tools, training, facilities, documents, and other equipment necessary for the staff to perform their duties
- The processes the staff will follow in performance of their duties, including interactions between the staff and between staff and external organizations.

It is recommended that the Miami-Dade County/MPO ITS stakeholders develop a TMC Concept of Operations Plan prior to implementing a TMC that will involve multi-agency presence or involvement. The findings of this report are a first step to this goal.
2: ON-SITE PHYSICAL PRESENCE IS IMPORTANT

The general consensus on TMC operations indicates that the regional transportation systems were better served if multiple transportation agencies were present physically at a TMC facility. The Houston TranStar TMC design allows face-to-face interaction among the operations staff from four major agencies co-located in the same large room. In New York City Joint Traffic Operations Center, three agencies -- the New York State DOT, the New York City DOT, and the New York Police Department -- are co-located in adjacent rooms. Staff in both TMCs expressed the value of proximity and face-to-face interaction. Staff proximity is most productive in dealing with complex tasks that require multi-agency response such as, for example, traffic and emergency response coordination to clear a freeway spill of hazardous materials.

3: ON-SITE PHYSICAL PRESENCE OF THE FREEWAY MANAGEMENT AND LAW ENFORCEMENT AGENCIES IS BENEFICIAL

There were more examples of favorable operational relationship as a result of co-location of freeway management agency and law enforcement agencies (State DOT and Highway Patrol, or equivalent) in a TMC. Therefore, the decision by the FDOT District 4 and the Florida Highway Patrol to co-locate their operations should be considered a welcome development. However, it is not fully understood what degree of operational integration is required to achieve optimum performance. The Concept of Operations Plan (recommended in 1) should investigate the full potential of co-location of the FDOT and FHP.

4: ON-SITE PHYSICAL PRESENCE OF THE FREEWAY MANAGEMENT AND ARTERIAL MANAGEMENT AGENCIES SHOULD BE GIVEN ADEQUATE CONSIDERATION

TMCs around the nation recognize that the full benefits of transportation management will be achieved only when the control of freeways and surface streets is performed in an integrated manner. However, until now the integration of freeway and surface street management are observed to be sporadic. Based on existing experience, a desired level of integration would likely include placement of closed-circuit television and variable message signs on arterials and some level of shared control of ramp metering and signal timing. The physical co-location should be driven by the agencies' desirability to relinquish some command/control under mutually agreeable conditions. The Concept of Operations Plan is expected to include additional analyses on the circumstances that may provide meaningful insights of co-location in the context of the Miami-Dade County area freeway and arterial operations.

5: ON-SITE PHYSICAL PRESENCE OF THE EMERGENCY MANAGEMENT MAY BE DESIRABLE BUT NOT NECESSARY

Opinions expressed at many TMCs indicate that the proximity of emergency management agency personnel at or near a TMC facility has been beneficial. There has not been found any strong argument for co-locating the emergency management
functions at a TMC. In case of Miami-Dade County, a regional TMC and the County Emergency Operations Center can be linked through a regional information exchange framework (discussed in 8) allowing electronic sharing of TMC traffic information and videos with the County Emergency Operations Center.

6: PRESENCE OF TRANSIT DISPATCH IN A TMC MAY BE DESIRABLE BUT NOT NECESSARY

Not much information was available on the traffic and transit integration on-site. However, significant opportunities for cooperation and coordination exist between traffic and transit management agencies. Houston TranStar TMC noted that, although no formal procedures existed for interaction between traffic operations and transit, much traffic information was passed back and forth between the TMC based dispatchers and buses. Houston stated it would be investigating the possibility of information transfer between its computer-aided dispatch system and its advanced traffic management system. However, such information exchange can occur effectively even without the requirement for co-location transit management with traffic management. As indicated in a FTA Study, it is not necessary, but beneficial, to co-locate transit dispatch/operations with traffic operations in the TMC. The possibility of co-locating transit dispatch in a TMC should be investigated in further detail during the development of the TMC Concept of Operations Plan (see 1).

7: ON-SITE PRESENCE OF MEDIA IN A TMC IS BENEFICIAL

The TMC case studies have shown that TMCs should accommodate on-site the traffic/transit information reporting media to facilitate transportation information dissemination and to increase general public awareness and focus towards ITS.

8: CONSIDER DEVELOPING A REGIONAL INFORMATION EXCHANGE FRAMEWORK

Although the TMC integration via co-location may be desirable, it is perhaps more realistic to consider that all levels of desired co-location will never be achieved in a regional transportation network because of many constraints such as availability of space and funding, institutional inertia and turf protection, and varied level of technology deployment at multiple agencies.

This study recommends that the Miami-Dade MPO ITS Standing Committee consider the feasibility of developing a regional information exchange framework, which will likely lessen the impact of a desired co-location not materializing.

A representative ITS information exchange framework including integration stages is presented in Figure 5. The lead agency in developing the regional multi-agency TMC may also be the lead agency in developing the regional ITS information exchange framework.
There are examples of such regional transportation information exchange framework systems at various metro areas in the nation. As stated previously, many of the Southern California ITS Showcase projects involve sharing information between TMCs. In the InterCAD project, incident related information is shared between the computer aided dispatch systems of several regional enforcement and EMS agencies at federal, state, and local levels. Appropriate information is shared with the regional Caltrans TMC through a bi-directional Internet link. In the New York City metropolitan area, TRANSCOM (a consortium with representation from 16 transportation agencies) is developing a regional architecture (RA), which will provide a regional architecture workstation at each agency TMC and enable each agency to exchange information in real time.
Figure 5: Representative Framework for Regional TMCs Information Exchange
REFERENCES

1. Center for Urban Transportation Research (CUTR), *ITS Plan Update for Miami-Dade County*, Miami-Dade MPO, June 1999


4. U.S. Department of Transportation, *Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in Miami, Fort Lauderdale, FY00 Results*, Washington DC


7. U.S. Department of Transportation, *Metropolitan Transportation Management Center, A Case Study, Georgia NaviGAtor*, Washington DC, October 1999


