

**DRIVER-BASED CELLULAR/PCS INCIDENT DETECTION SYSTEM
IMPLEMENTATION PLAN FOR DALLAS**



PB99-144677

by

Carol H. Walters, P.E.
Research Engineer
Texas Transportation Institute

Poonam B. Wiles, P.E.
Associate Research Engineer
Texas Transportation Institute

and

Scott A. Cooner
Assistant Research Scientist
Texas Transportation Institute

Report 3939-S

Project Number 7-3939

Research Project Title: Evaluate the Feasibility, in Dallas, of Substituting a Driver-Based
Incident Detection System Using Cellular Phones for Traditional Passive Detection

Sponsored by the
Texas Department of Transportation

November 1998

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

1. Report No. TX-99/3939-S		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle DRIVER-BASED CELLULAR/PCS INCIDENT DETECTION SYSTEM IMPLEMENTATION PLAN FOR DALLAS				5. Report Date November 1998	
				6. Performing Organization Code	
7. Author(s) Carol H. Walters, Poonam B. Wiles, and Scott A. Cooner				8. Performing Organization Report No. Report 3939-S	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. Project No. 7-3939	
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Transfer Office P. O. Box 5080 Austin, Texas 78763-5080				13. Type of Report and Period Covered Project Summary: September 1997 - August 1998	
				14. Sponsoring Agency Code	
15. Supplementary Notes Research performed in cooperation with the Texas Department of Transportation. Research Project Title: Evaluate the Feasibility, in Dallas, of Substituting a Driver-Based Incident Detection System Using Cellular Phones for Traditional Passive Detection					
16. Abstract Critical to intelligent transportation systems (ITS) is an efficient form of surveillance on freeways to detect incidents. Traditionally, loop detectors or another form of passive detection have been used to meet this need. Due to the high cost, difficulty of timely installation, and limited funding available to deploy ITS systems, the traditional system has been slow to develop in the Dallas area. This research assesses the feasibility of substituting driver-based incident detection using cellular phones for traditional passive detection. The study is divided into five major tasks: (1) summary of current cellular incident reporting services; (2) identification of issues and potential effectiveness of cellular incident detection in Dallas; (3) development of an implementation plan for driver-based cellular detection; (4) comparison of traditional and cellular incident detection methods; and (5) identification of potential funding sources for the implementation plan. This document concentrates on reporting on the development of the implementation plan for driver-based cellular detection in Dallas. Based on evaluation of existing driver-based cellular incident detection programs and interviews with local public safety officials, researchers decided to rely on the existing 911 system for incident detection instead of having a new number, such as *999, created. Based on this decision, the implementation plan contained four major components: (1) driver education campaign, (2) deployment of reference location signs on the freeway network, (3) establishment of communication interfaces between local 911 centers and TxDOT's Dallas Traffic Management Center, and (4) expansion of CCTV camera network for incident verification. All of these components combined together will form an effective incident detection and verification system that should allow the deployment of passive detection, such as loop detectors, to be scaled back accordingly.					
17. Key Words Cellular, Transportation Management Center, Incident Detection, Emergency Services, Intelligent Transportation Systems			18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161		
19. Security Classif.(of this report) Unclassified		20. Security Classif.(of this page) Unclassified		21. No. of Pages 68	22. Price

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation, and is **NOT INTENDED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES**. The engineers in charge of this project were Carol H. Walters, P.E. No. 51154 (Texas), and Poonam B. Wiles, P.E. No. 60052 (Texas).

ACKNOWLEDGMENTS

The research reported herein was performed by the Texas Transportation Institute as part of a study titled *Evaluate the Feasibility, in Dallas, of Substituting a Driver-Based Incident Detection System Using Cellular Phones for Traditional Passive Detection* and sponsored by the Texas Department of Transportation. Ms. Carol Walters, P.E. No. 51154 (Texas), and Ms. Poonam Wiles, P.E. No. 60052 (Texas), of the Texas Transportation Institute served as the co-research supervisors, and Ms. Terry Sams, P.E., of the Texas Department of Transportation Dallas District, served as the project director.

The authors wish to acknowledge the Project Monitoring Committee for their assistance and guidance throughout the duration of this study. The Project Monitoring Committee was composed of the following members in addition to the project director:

- Abed Abukar, Texas Department of Transportation - Fort Worth District
- Lourenco Dantas, North Central Texas Council of Governments
- Al Kosik, Texas Department of Transportation - Traffic Operations Division
- James McCarley, Dallas Regional Mobility Coalition/North Texas Tollway Authority
- Mark Olson, Federal Highway Administration - Texas Division (Austin)
- Dan Rocha, North Central Texas Council of Governments

The authors would also like to thank the numerous individuals from transportation management centers throughout the United States and 911 public safety answering points in the Dallas area for participating in surveys and telephone interviews during this study.

TABLE OF CONTENTS

	Page
List of Figures	ix
List of Tables	x
List of Abbreviations	xi
1 INTRODUCTION	1
1.1 Cellular Incident Detection	1
1.2 Local Situation	2
1.3 Project Overview	2
1.4 Implementation Plan Organization	3
2 BACKGROUND INFORMATION	5
2.1 Fundamentals of Wireless Phones	5
2.1.1 Explanation of Wireless Call-Making Process	5
2.1.2 Differences in Cellular and PCS Wireless Telephones	7
2.1.3 Differences in Landline and Wireless Telephone Systems	7
2.2 Cellular Statistics	8
2.3 Cellular 911 Issues	10
2.3.1 National Legislative Issues	11
2.3.2 State Legislative Activities	12
2.3.3 Location Technologies	12
2.4 Reference Location Signs	13
2.4.1 ARTIMIS Reference Location Signs	14
2.4.2 Monroe County Expressway Mile Markers	15
2.4.3 St. Louis Metropolitan Area Reference Location Signs	15
2.5 Transportation/Emergency Management Communications	16
2.5.1 Intelligent CAD Study	16
2.5.2 Traffic Management Center Advanced Traffic Management System Operations Concept Document	16
3 DEVELOPMENT OF THE IMPLEMENTATION PLAN	19
3.1 Components of Existing Driver-Based Cellular/PCS Incident Detection Systems in the United States	19
3.2 Determination of Optimal Components for a Driver-Based Cellular/PCS Incident Detection System in Dallas	20

3.2.1	Selection of Option 2 - Reliance on Existing 911 Incident Reporting	20
3.2.2	Selection of Optimal Components for a Driver-Based Cellular/PCS Incident Detection System in Dallas	22
3.3	Components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas	22
3.3.1	Component #1: Driver Education Program	22
3.3.2	Component #2: Reference Location Signs	27
3.3.3	Component #3: 911 PSAP/TMC Communication Interfaces	27
3.3.4	Component #4: CCTV Cameras for Incident Verification ..	35
4	SUMMARY OF RECOMMENDED IMPLEMENTATION PLAN	37
4.1	Estimated Costs for Driver-Based Cellular/PCS Incident Detection System Implementation Plan Components	37
4.1.1	Estimated Cost for the Driver Education Program Component	37
4.1.2	Estimated Cost for the Reference Location Sign Component	37
4.1.3	Estimated Cost for the 911 PSAP to TMC Communication Interfaces Component	37
4.1.4	Estimated Cost for the CCTV Camera Component	38
4.1.5	Total Estimated Cost for the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas	38
4.2	Potential Implementation Plan Funding Sources	39
	REFERENCES	41
APPENDIX A	911 Public Safety Answering Points: Overview of Operations	43
APPENDIX B	Summaries of Meetings with Local 911 Representatives	49

LIST OF FIGURES

Figure		Page
1	Picture of Typical PCS and Cellular Telephones	6
2	Picture of a Typical Cellular Tower	6
3	Cellular Telecommunications Industry Association Estimated Growth in Cellular Subscribers (Jan. 1, 1984 to Jan. 1, 1998)	9
4	Growth in Daily Wireless 911 Calls (1985 to 1997)	9
5	Wireless Location Technologies	13
6	Reference Location Sign	14
7	Two Choices in the Search for the Optimal Driver-Based Incident Detection System in Dallas	21
8	Conceptual Diagram for Information Sharing Linkages Between the Dallas Traffic Management Center and 13 Dallas-Area 911 Centers	33
9	Mobile Data Terminal	34

LIST OF TABLES

Table		Page
1	Dallas-Area 911 Interview Participants	29
2	911 Interview Results	30
3	911 PSAPs Freeway Response Coverage Summary	32
4	Cost Estimation for Components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas	38

LIST OF ABBREVIATIONS

ACN	Automatic Crash Notification
ALI	Automatic Location Identification
ANI	Automatic Number Identification
ARTIMIS	Advanced Regional Traffic Interactive Management and Information System
ATMS	Advanced Traffic Management System
AVL	Automatic Vehicle Location
CAD	Computer Aided Dispatch
CB	Citizens Band
CCTV	Closed Circuit Television
CHP	California Highway Patrol
CMAQ	Congestion Mitigation and Air Quality
CTIA	Cellular Telecommunications Industry Association
DFW	Dallas/Fort Worth
DMS	Dynamic Message Sign
DOA	Difference of Arrival
E911	Enhanced 911
EMS	Emergency Medical Services
FCC	Federal Communications Commission
FTE	Full-Time Employee
GHC	Greater Harris County
GIS	Geographic Information System
GPS	Global Positioning System
IAC	Interagency Contract
ISDN	Integrated Service Digital Network
ITS	Intelligent Transportation Systems
MDT	Mobile Data Terminal
MoDOT	Missouri Department of Transportation
NCTCOG	North Central Texas Council of Governments
NENA	National Emergency Number Association
O&M	Operations and Maintenance
PCS	Personal Communications System
PSAP	Public Safety Answering Point
SFR	State Funded Research
STP	Surface Transportation Program
TDOA	Time Difference of Arrival
TMC	Transportation Management Center
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation

CHAPTER 1 INTRODUCTION

Critical to intelligent transportation systems (ITS) are an efficient form of surveillance on freeways to detect incidents. Traditionally, loop detectors imbedded in the pavement, or some other form of passive detection have been deployed. These loop detector surveillance systems are usually installed with loops in each lane at a spacing of around 0.8 km (0.5 mi) and with a trunkline conduit installation along the freeway which interconnects the loops to each other and to data processing locations. Count information can therefore be obtained for the purposes of determining freeway flow conditions, collecting traffic count information, and computing speeds and occupancy (in this case, the percent of time that a loop is occupied, used as a measure of congestion). With these passive detection systems, closed circuit television cameras (CCTV) are typically deployed at 1.6 km (1 mi) spacings, with the video hard-wired to the Transportation Management Center (TMC) via fiber-optic cable. However, due to the high cost, difficulty of timely installation, and limited funding available to deploy ITS systems, traditional systems have been slow to develop in the Dallas/Fort Worth Metroplex. The opportunity exists to consider new technological capabilities, such as driver-based incident detection using cellular phones, which may hasten the deployment of surveillance or allow its extension to areas outside of the core system. In general, wireless technologies offer tremendous possibilities for cost savings with the potential to work with the hardwired systems already in place.

1.1 CELLULAR INCIDENT DETECTION

Reporting of freeway incidents by drivers, via their personally owned mobile phones, is a common occurrence throughout the United States. Analog cellular type phones and the newer digital phones, commonly referred to as Personal Communications System (PCS) phones, continue to grow in popularity. The Cellular Telecommunications Industry Association (CTIA) estimated the growth in the number of cellular subscribers from 0.1 million in 1984 to over 55 million at the end of 1997 (1). Current increases are estimated to be 33,000 new subscribers per day, with industry analysts predicting 100 million users at the end of year 2000. This would mean approximately 33 percent of drivers nationwide might be expected to be subscribers. The current national average market penetration rate for wireless phones is estimated at 17 percent (2).

Due to the high number of subscribers, cellular/PCS users can detect incidents quickly (in daylight or darkness), during both peak and off-peak periods, whether the incidents occur on the freeway main lanes, shoulder, off the road, or on the arterial system. Mussa (3) conducted a theoretical evaluation of driver-based incident detection and determined that a 10 percent prevalence of mobile phones would assure detection of an incident in less than a minute even under low volume (700 vehicles per hour per lane) conditions. The study by McLean (4)

detailing the Chicago experience with *999 establishes the effectiveness of the service and the willingness of cellular users to help others; 95 percent of the calls received were of the 'Good Samaritan' type, reporting incidents not directly involving themselves. Christenson (5) evaluated some current call-in programs throughout the country and found that cellular incident reporting programs are among the most effective methods for incident detection.

1.2 LOCAL SITUATION

This type of system is working informally in the Dallas/Fort Worth Metroplex using the Emergency 911 call-in number (which is toll-free). The information Dallas-area drivers provide to 911 is now routed to responders but is not currently captured directly by the Dallas TMC for camera verification, freeway management, or notification of the public. The 1995 Dallas Area-Wide ITS Plan (6) developed by the Texas Transportation Institute (TTI) for the Dallas District of the Texas Department of Transportation (TxDOT) specified the continued use of private cellular phone reports as the primary means of incident detection, with video cameras deployed for verification. This raises the possibility of significant cost and time savings in deployment of the ITS Plan. However, in order to assess the potential of foregoing or delaying complete deployment of passive detection, research on the reliability, cost, comparable effectiveness, and deployment time of cellular incident detection was required. In addition, a number of problems need to be resolved in order to optimize such a system: pinpointing the location of incidents from cellular call-in reports, avoiding overload of the 911 system currently in use for these calls, and assessing the merits of a non-911 freeway incident number that would come directly to the TxDOT TMC.

1.3 PROJECT OVERVIEW

This research project, 7-3939, was undertaken by TTI and sponsored by TxDOT as a one-year study. The following five tasks were part of the research work plan:

- Task 1 - Identify the locations in the country with current experience in driver-based cellular/PCS incident reporting services, and summarize the features and effectiveness of those services.
- Task 2 - Identify the issues and potential effectiveness if driver-based cellular/PCS incident detection systems were to be considered for the Metroplex.
 - Task 2.1 Interview cellular/PCS providers.
 - Task 2.2 Interview Emergency 911.
- Task 3 - Develop a possible implementation plan for driver-based cellular/PCS in the Metroplex.

Chapter 1 - Introduction

- Task 4 - Compare traditional surveillance methods and cellular/PCS driver-based methods in terms of the effectiveness and costs related to implementation, operations, and maintenance.
- Task 5 - Identify potential funding sources for the plan, if feasible.

The scope for this project included determination of the optimum criteria for a driver-based freeway incident detection cellular/PCS in Dallas, and comparison of this system with traditional passive detection, including implementation and operating costs as well as effectiveness. During the course of this research, many facets of such a system were investigated. Concerns that the 911 system may be impacted by the influx of callers reporting the same incident were investigated; nationally, the number of emergency 911 calls from cellular customers has reached 30.5 million per year (7). Additionally, because mobile calls are not yet located by 911, information about the problem is required from the caller on location. This information is frequently inaccurate and needs to be verified by multiple calls, or even by the first respondent to the scene. Further, over-reporting of incidents is a typical problem, at least for major incidents. The establishment of a separate call-in number was investigated as well as interaction with current 911 services. Other issues examined include the feasibility of providing freeway reference location signs at frequent intervals to assist in accurately locating the incident scene, and the pressing need to coordinate with the 911 centers and appropriate local response agencies. Since Texas lacks a singular response agency such as a State Highway Patrol, many jurisdictions must be involved, and it will be necessary to effectively interface with all of them. A summary of all of the work tasks for this research is available in the 3939-2 research report; however, this document focuses on summarizing the results of Task 3 of this research (i.e., the development of an implementation plan for a driver-based cellular/PCS incident detection system for the Dallas area).

1.4 IMPLEMENTATION PLAN ORGANIZATION

This report is organized into three additional chapters and two appendices. Chapter 2, Background Information, presents information gathered during a comprehensive literature and Internet search which is essential to understanding the recommendations contained in the proposed implementation plan. Chapter 3, Development of the Implementation Plan, describes the development of the recommended components of a Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas. Chapter 4, Summary of Recommended Implementation Plan, provides estimated costs and potential funding sources for the recommended Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas.

CHAPTER 2 BACKGROUND INFORMATION

This chapter describes some essential background information on the use of wireless phones, both cellular and PCS, for detection of traffic incidents. It is divided into five sections: 1) fundamentals of wireless telephones, 2) cellular statistics, 3) cellular 911 issues, 4) reference location signs, and 5) transportation management center / emergency services communications.

2.1 FUNDAMENTALS OF WIRELESS TELEPHONES

This section will briefly cover two fundamental concepts essential to understanding the wireless telecommunications process. The first subsection gives an overview of how a wireless call is completed. The second subsection explains some of the basic differences between cellular and PCS telephones.

2.1.1 Explanation of Wireless Call-Making Process

One of the first tasks in the literature review/Internet search portion of this study was to assess how wireless calls work. This section explains the wireless call-making process. When someone makes a call on their wireless phone, either cellular or PCS (Figure 1), the call is transmitted by low-energy radio signals to the nearest antenna site (sometimes referred to as a cell tower - see Figure 2) which connects with the local phone network. The call is then delivered by landline telecommunications infrastructure if the number you dialed is a home or office phone, or by radio signals if the call is intended for another wireless phone.

Wireless technology uses individual radio frequencies over and over again by dividing a service area into separate geographic zones called cells. Cells can be as small as an individual building (for example, an airport or arena area), as big as 32 km (20 mi) across, or any size in between. Each cell is equipped with its own radio transmitter/receiver antenna.

Because the system operates at such low power, a frequency being used to carry a phone conversation in one cell can be used to carry another conversation in a nearby cell without interference. This allows much greater capacity than radio systems like citizens band (CB) in which all users must try to get their messages on the same limited channels. When a customer using a wireless phone--car phone or portable--approaches the boundary of one cell, the wireless network senses that the signal is becoming weak and automatically hands off the call to the antenna in the next cell into which the caller is traveling. Although many improvements in wireless phone technology have occurred since its inception in 1984, the basic method for completing wireless calls is largely the same.



Figure 1. Picture of Typical PCS (left) and Cellular (right) Telephones

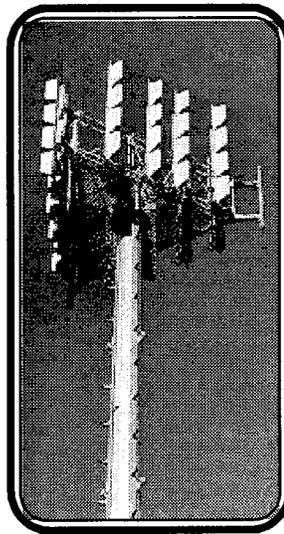


Figure 2. Picture of a Typical Cellular Tower

2.1.2 Differences in Cellular and PCS Wireless Telephones

Another relatively new part of the wireless communications industry is the advent of Personal Communications System (PCS) telephones in early 1996. These telephones are similar to the traditional cellular telephones; however, there are some significant differences. This section will briefly highlight some of the differences in cellular and PCS technologies.

The fundamental difference between the two wireless telephone types is PCS phones utilize digital technology, whereas cellular phones are based on analog technology. A common comparison is PCS phones are to cellular phones as compact discs are to vinyl records. In most cases, digital PCS voice quality has better clarity than cellular with less static and crosstalk and greater call privacy. At this time, in most major markets around the United States, digital PCS service and cellular service are competitive on a cost per minute basis; however, PCS is still more expensive. The added cost of digital PCS provides subscribers with several features that customers with cellular phones cannot have, including: voice mail, caller identification, text messaging, and specialized information services that display stock quotes, sports scores, horoscopes, and other information.

2.1.3 Differences in Landline and Wireless Telephone Systems

This section describes some of the basic differences in landline and wireless telephone systems. According to the Wireless Week Internet site (8), the current 911 system was designed with a land-based phone system in mind because wireless technology did not exist when 911 service was introduced in Haynesville, Alabama, in 1968. The signaling protocol that was readily available in 1968 to send caller information was Centralized Automatic Message Accounting which was used to send the caller's seven digit Automatic Number Identification (ANI). The single ANI field is used as a key to determine the correct Public Safety Answering Point (PSAP) in order to route the call and locate the customer's address, or Automatic Location Identification (ALI). The ANI field is also important to the PSAP when emergency responders need to call back the party that dialed 911 when they are disconnected or do not respond. In the land-based phone systems (i.e., landline systems), the caller's telephone number is synonymous with their location so it is possible to make this match. Geographic Information Systems (GIS) and frequently updated street and address databases allow most PSAPs, especially those in urban areas, to provide Enhanced 911 (E911) service for landline subscribers. Obviously, this is not the case in the wireless environment of cellular and PCS telephones.

In contrast to land-based phone systems, a mobile wireless telephone subscriber's number is in no way related to their location. Today, when a wireless phone is used to call 911, the operator answering the call typically doesn't automatically know where the caller is located. Because wireless phones are portable and users may be traveling in unfamiliar areas, callers often times may not know their location either. To help identify callers' locations so appropriate resources can be dispatched to the scene, the wireless telephone industry and public safety

officials jointly adopted Enhanced 911 (E911) rules for wireless systems. These rules were later adopted by the Federal Communications Commission (FCC); however, few wireless carriers presently offer E911 service because most local PSAPs lack the ability to receive the greater amount of data that E911 calls provide. Most of the nation's PSAPs still have limited-bandwidth lines. These lines are not capable of receiving the "call-back" number and cell-site location information (i.e., the information required in phase I of the FCC rules) that comes with each E911 call. The FCC's rules allow wireless carriers six months to offer E911 service after a local PSAP submits a request for E911, and then only if that state has adopted E911 cost recovery, which typically consists of a monthly 75 cent surcharge on wireless customer bills. This surcharge is needed to offset the wireless carrier's costs of providing the E911 data. Starting in 2001, E911 will enter phase II of the FCC rules when wireless carrier's must add to their networks the ability to report the 911 caller's location within about 125 m (400 ft). As with the FCC phase I requirements, it should be understood that the 2001 date for phase II implementation is a soft deadline that can be pushed back if funding mechanisms are not in place to support the deployment of the location technologies. The ability to geolocate wireless 911 calls will be a significant plus for public safety agencies; however, responders will still need motorists to provide location and other pertinent information to them. The geolocation information generated will provide responders with a very good idea of the problems location; however, in the case of traffic incidents a 125 m (400 ft) difference in position can be on different sides of the freeway which makes a big difference in the appropriate response.

2.2 CELLULAR STATISTICS

From its inception in 1984, the cellular market has grown steadily at an exponential pace, according to figures provided by the *Cellular Telephone Industry Association* (CTIA). The cellular phone market has grown from approximately 100,000 subscribers in the first year to over 55 million wireless subscribers at the end of 1997 (Figure 3). The CTIA (1) and Wireless Week (8) Internet home pages report the following interesting statistics:

- The importance of wireless communications as a safety tool continues to grow. According to the most recent survey conducted by the CTIA, an average of 83,609 people used wireless phones each day to call 911 or other emergency services during 1997. This amounts to 30.5 million calls per year. This compares to 59,180 per day and 21.6 million per year in a similar survey conducted for 1996. The annual survey is based on information provided by police agencies. Figure 4 shows how the number of daily 911 calls from wireless phones has increased during the 1985 through 1997 time period. Most emergency calls from wireless phones are used to report vehicle crashes or other roadside conditions. According to the latest statistics provided by the National Highway Traffic Safety Administration, there were 6.6 million vehicle accidents in 1995.
- By the year 2000, it is estimated that wireless calls to 911 could total 130,000 daily.

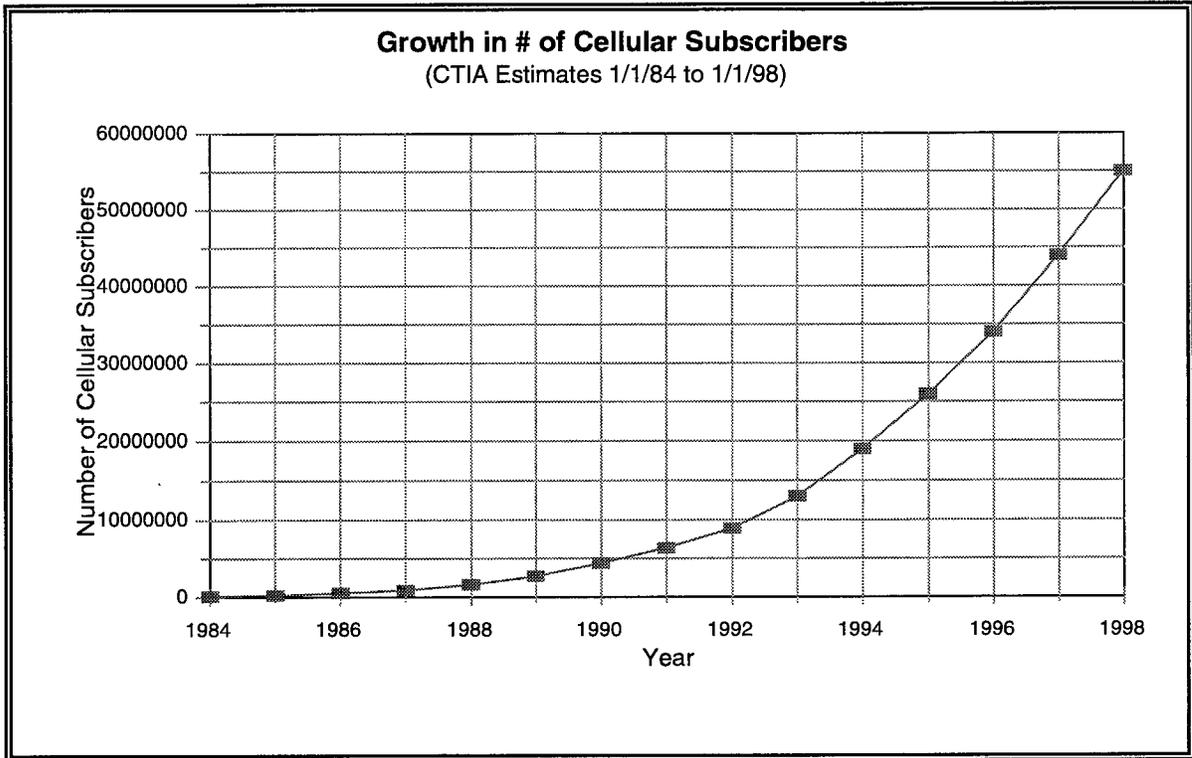


Figure 3. Cellular Telecommunications Industry Association Estimated Growth in Cellular Subscribers (Jan. 1, 1984 to Jan. 1, 1998)

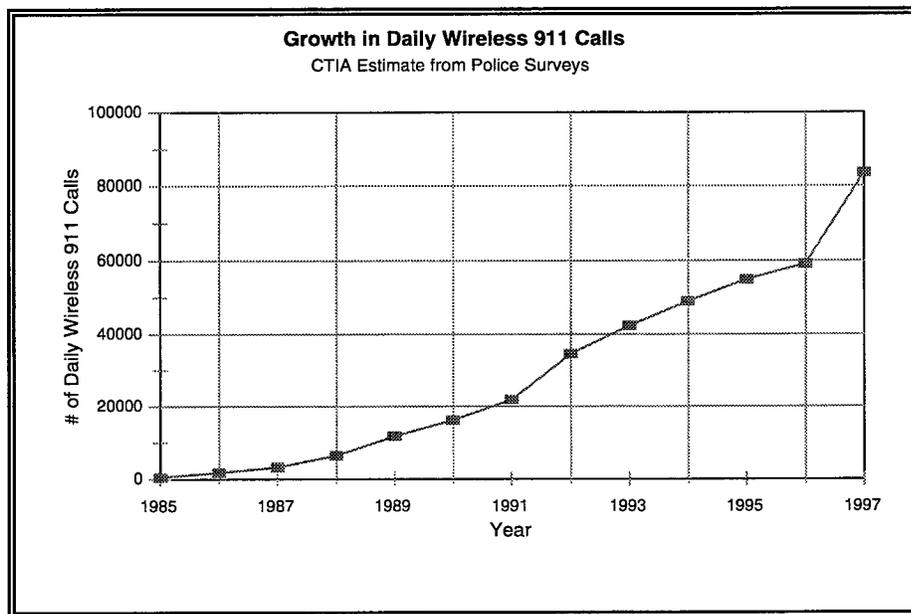


Figure 4. Growth in Daily Wireless 911 Calls (1985 to 1997)

- A national poll found that over 60 percent of wireless phone users have called for help in cases of car trouble or medical emergency, or to report a crime or drunk driver; and close to 90 percent polled said safety and security were the best reasons for owning a wireless phone. In fact, by a two-to-one margin, those polled said safety and security are more important to them than business convenience.
- The national average penetration rate for wireless phones is 17 percent (2). If the average penetration rate is assumed for the Dallas District of the Texas Department of Transportation, approximately 500,000 wireless phones would potentially be available for monitoring area freeways according to the North Central Texas Council of Governments (NCTCOG) 1997 Population Estimates (9). This calculation is based on 2,956,900 people in the Dallas District (Collin, Dallas, Denton, Ellis, Kaufman, Navarro, and Rockwall counties). It should be noted that the 17 percent penetration rate is probably conservative because of the high presence of telecommunications companies in the Dallas area (Note: this does not include Tarrant County).

A Peter D. Hart Research Associates survey conducted in March of 1997 and reported on the CTIA home page (1) revealed some interesting data on wireless subscribers in the United States:

- There is a 50/50 split between male and female cellular subscribers and a 66/34 split for PCS subscribers.
- 31 percent of cellular subscribers are between the ages of 18 and 34, 34 percent between 35 and 49, and 35 percent are 50 and over.
- 36 percent of PCS subscribers are between the ages of 18 and 34, 45 percent between 35 and 49, and 19 percent are 50 and over.
- Most important reason to subscribe to a wireless telephone service is to be able to communicate in an emergency (46 percent of respondents).
- 15 percent of the survey respondents indicated that traffic/weather information was the service most desired in addition to their basic wireless service.

2.3 CELLULAR 911 ISSUES

This section contains a variety of information related to the provision of 911 service for wireless telephones. It is divided into several subsections: national legislative activities, state legislative activities, and location technologies.

2.3.1 National Legislative Activities

2.3.1.1 Wireless 911 Activities

The FCC regulates the activities of the wireless telephone industry. The FCC acted in July of 1996 to set three new regulation deadlines for making wireless 911 calls more compatible with the present landline 911 systems. These new regulations, found in FCC Rule 94-102, were in response to an outcry from public safety organizations frustrated with the inability of their current systems to automatically locate wireless 911 calls. Locating wireless 911 calls is a large problem because 90 percent of wireless 911 calls are made by highway travelers, and of these, an estimated 50 percent cannot describe their location to operators (10). Most current landline telephone systems have E911 features built into the system. These features automatically provide the operator with a display of the physical address and seven digit phone number of the phone that was used to dial 911. In contrast, when an individual dials 911 on a cellular or PCS digital phone, 911 operators do not know the location of the individual or the wireless phone number of the phone being used. Not having the ALI or ANI for wireless 911 calls puts the onus on the individual reporting the incident to rapidly and accurately provide information to the operator. At this point in time, most public safety agencies' incident response depends on motorists' ability to provide timely and reliable information on the location and severity of traffic-related incidents (i.e., accidents, stalled cars, debris, etc.). The FCC's orders to start implementing the three regulations in FCC Rule 94-102 were effective October 1, 1996, and the deadlines are measured from that date. The following list, obtained from the FCC home page (11), provides a description of the three deadlines for wireless service providers:

- **Deadline #1:** By October 1, 1997, every wireless 911 call from a radio handset assigned a number usable for callback (Code Identification), or from a comparable Text Telephone used by individuals with speech or hearing disabilities, must be forwarded without interruption to a PSAP. There is nothing the PSAP needs to do in advance to make this happen. Upon a specific PSAP request, even calls from phones lacking Code Identification must be forwarded without interruption.
- **Deadline #2: Caller Location Phase 1.** By April 1, 1998, cellular telephones, PCS and certain Specialized Mobile Radio operators 'must relay the telephone number of the originator of a 9-1-1 call and the location of the cell site or base station receiving a 9-1-1 call from any mobile handset or text telephone device . . . to the designated PSAP.'
- **Deadline #3: Caller Location Phase 2.** By October 1, 2001, the standard for ALI must improve dramatically. It changes from the cell site or base station receiving the call to a radius of 125 m (410 ft) around the caller.

2.3.2 State Legislative Activities

Currently in the state of Texas, a monthly fee is charged on wireless phone bills, with the fee varying by Council of Governments, 911 districts, and home rule cities. Legislation, which would establish one fee statewide, has been approved by the House and Senate and is waiting final approval from the Governor. The fee is to be 50 cents per wireless telephone per month. The wireless carriers will remit one check monthly to a state agency for the amount collected, less a 1 percent collection fee. The state agency will distribute the funds to the various 911 governing bodies using a formula based on population, not on the number of access lines. The legislation does not require special accounting or justification of the use of the fee outside the requirements already established for the use of other 911 emergency service fees. The liability protection previously given to landline carriers will now be extended to wireless carriers as well (12).

2.3.3 Location Technologies

The development of location technologies for cellular and digital PCS phones is being undertaken in response to the FCC Phase 2 requirements. Having location information is crucial to the timely delivery of emergency medical services (EMS) to accident victims; however, public safety officials commonly report that motorists have great difficulty providing accurate location information to 911 operators. The problem of inaccurate location information given by motorists reporting a traffic incident with their cellular phone may soon be alleviated by technology. There are two basic location options: antenna-based systems that locate callers by calculating the caller's distance from two (Direction of Arrival (DOA)) or three or more (Time Difference of Arrival (TDOA)) receivers or a Global Positioning System (GPS) receiver embedded into the phone to pinpoint location via satellite. Figure 5 shows these wireless location technologies and their estimated accuracy. Speculation is that wireless users would pay for installing the antenna-based system through an increase in subscription fees by a few dollars per month. If the GPS system is used, the price of a cellular phone could go up by as much as \$10 per month (13). The costs to wireless providers have been estimated between \$10,000 and \$50,000 per cell site for the antenna-based solution and \$100 to \$300 per cellular phone for the GPS-based solution (14). There are multiple technologies in varied states of development which can be used to identify a cellular caller's location; however, it appears that funding is the primary deterrent to their widespread deployment at this time. Depending on terrain and geography, the most appropriate technology will be determined by the wireless service providers. The CTIA is working with the wireless industry to develop a standard interface between the service provider switch and the PSAP. The following subsections highlight a few of the location technology demonstration projects.

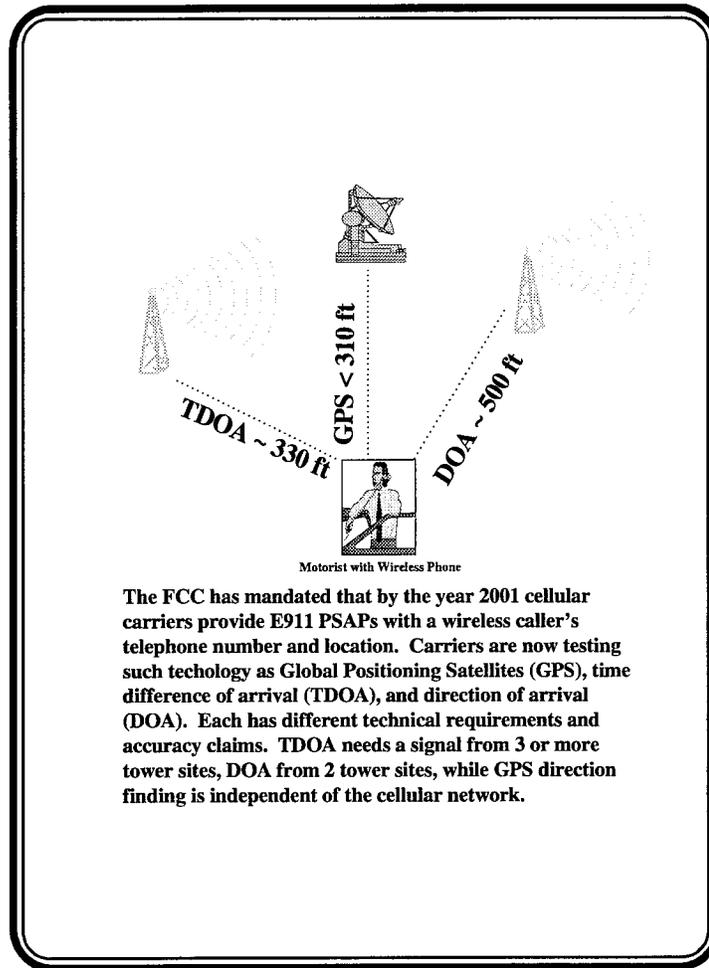


Figure 5. Wireless Location Technologies

2.4 REFERENCE LOCATION SIGNS

A critical link in the emergency response process is the accuracy of incident location information provided to responding personnel. Assuming that the report of an incident or accident is typically initiated by the driving public via their wireless phones, it is important that motorists be able to provide timely and accurate information on the location of the problem to the response dispatch center. In complex urban freeway environments, this can be a difficult problem for motorists and the dispatchers who ultimately decide the appropriate emergency units to notify. One relatively low-cost solution that is being implemented in several areas is the installation of reference location signs at frequent intervals to assist motorists in providing dispatchers with more reliable and accurate incident location information.

2.4.1 ARTIMIS Reference Location Signs

The Advanced Regional Traffic Interactive Management and Information System (ARTIMIS) is a system that includes a wide range of traffic management components for the Cincinnati-Northern Kentucky urbanized area freeway system. One of the early deployment projects was the installation of reference location signs for improving the emergency response process. Figure 6 shows the prototypical reference location sign used in Cincinnati. An evaluation was performed to determine if installation of reference location signs at 0.16 km (0.1 mi) intervals would improve the ability of emergency personnel to respond to incidents or accidents on the freeway system.

A short-term evaluation was conducted of white on blue and white on green reference location signs on a 3 mile section of Interstate 275 in Cincinnati. A University of Kentucky study (15) determined that the reference point signs were a beneficial addition to the location information available to the driving public based on field observations and subjective opinions of emergency response personnel. The blue median signs appeared to be more prominent than green signs placed on the shoulders. Spacing of the signs did not create the impression of unnecessary clutter and an 8 in number size was appropriate (16). Based on the findings of the short-term evaluation, a recommendation was made to install the white on blue reference point

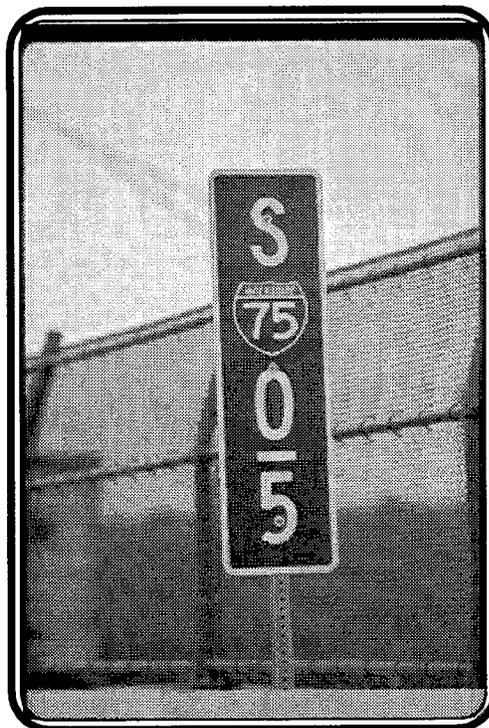


Figure 6. Reference Location Sign

signs in the median at 0.16 km (0.1 mi) intervals on all interstates in the ARTIMIS project. The ARTIMIS reference location signs were approximately \$1,900 per km (\$3,000 per mi).

2.4.2 Monroe County Expressway Mile Markers

The first stage of the implementation of the Advanced Traffic Management System in the Rochester, New York, area involved the installation of expressway mile markers and street name signs to many of the overpasses on the Interstates. The concept for this project evolved from discussions with the Monroe County 911 agency, state police, and New York State Department of Transportation sign engineers (17).

Two types of expressway mile markers were installed during the first implementation stage. Large markers (green with white letters) containing cardinal direction, interstate route shield, and milepoint number were placed at 1.6 km (1 mi) intervals. Smaller markers (blue with white letters) containing cardinal direction, milepoint, and tenth milepoint numbers were put in at 0.16 km (0.1 mi) intervals. One hundred and fifty-two kilometers (95 mi) of expressway were outfitted with this mile marker system at a total cost of approximately \$97,000. The feedback has been positive, and plans are underway to add mile markers to expressways outside Monroe County.

2.4.3 St. Louis Metropolitan Area Reference Location Signs

In 1993, an American Trucking Association incident management seminar was held in the St. Louis area. One of the seminar subgroups consisted of response entities such as police and ambulance providers. This group identified inaccurate reporting of incident location as a significant problem in the St. Louis metropolitan area. Based on discussions at this seminar, the Missouri Department of Transportation (MoDOT) decided to pursue funding for the deployment of a reference location sign system in St. Louis. Another important factor that influenced MoDOT to deploy reference location signs was that the *55 cellular call-in program operated by the Missouri Highway Patrol was being extended into urban areas such as St. Louis (*55 was previously only in rural areas of Missouri). The St. Louis metropolitan area is classified as a non-attainment area so MoDOT used Congestion Mitigation Air Quality (CMAQ) funds to pay for the deployment of reference location signs on 288 km (180 mi) of freeways. The signs were installed for \$260,000, approximately \$1,000 per kilometer or \$1,500 per mile (18).

The reference location signs in St. Louis were installed almost two years ago. There has been no formal evaluation of their effectiveness (i.e., how many motorists use them when reporting an incident to dispatchers), but they seem to be an effective addition to the overall incident management system according to a MoDOT representative. The reference location signs have direction, route number, and milepoint number on them. MoDOT sign engineers decided not to use the Interstate route shield on the reference location signs like in Cincinnati because of a legibility issue. The engineers wanted the letters on the reference location signs to

be as large as possible so that they could be easily read and used by motorists. The reference location signs are located in the median of the freeway at 0.4 km (0.25 mi) spacing and are white lettering on a blue background. The signs are mounted back-to-back so that both directions of travel can utilize them. The milepoint number information is tied to the milepost system that was already in place.

2.5 TRANSPORTATION MANAGEMENT CENTER / EMERGENCY SERVICES COMMUNICATIONS STUDIES

The last portion of the literature review concentrated on two research studies about communication between transportation management centers and emergency management agencies, specifically those responsible for responding to freeway incidents. Appendix A provides an overview of how 911 public safety answering points operate and handle response to emergencies that are reported to them. The information in this Appendix is important to understand in order to comprehend the summaries of the two research studies.

2.5.1 Intelligent CAD Study

This TTI study, sponsored by Southwestern Bell Company Technology Resources, Inc., is still ongoing (19). The thrust of this research is the development of the Intelligent CAD concept. The Intelligent CAD concept is basically the ability for TMCs and emergency management agencies to electronically share incident-related information across institutional boundaries. The concept is based on the premise that there will be benefits for both parties. The TMC will primarily benefit from receiving notification of incidents reported to the emergency management agencies via 911 almost in real time. The emergency dispatchers could benefit from receiving information from TMC such as verification of incident location, CCTV camera images, congestion information, and alteration of signal timing along response routes. Ultimately, the ability to automatically share critical information could help save lives, reduce the probability of long-term injury, decrease incident duration, mitigate the probability of secondary incidents, and limit non-recurrent congestion levels. The product of this research effort is expected to be a conceptual design of an Intelligent CAD system including system configuration, information flow diagrams, communication requirements, and operation scenarios.

2.5.2 Traffic Management Center Advanced Traffic Management System Operations Concept Document

The Traffic Operations Division of TxDOT developed a preliminary document that captures the current concepts of how the standard Advanced Traffic Management System (ATMS) will be used to support traffic and emergency operations in TMCs in Austin and El Paso (20). An appendix of this preliminary document provides a section on emergency services /ATMS system-to-system communications that describes some of the essential items (common data protocol, common incident report attributes, and communication mediums) necessary to

Chapter 2 - Background Information

facilitate sharing of information between the TxDOT Austin District TMC and city of Austin Emergency Services.

CHAPTER 3

DEVELOPMENT OF THE IMPLEMENTATION PLAN

This chapter describes the preparation of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas. The chapter is organized into three major sections. Section 3.1 gives an overview of components of driver-based cellular/PCS incident detection systems which are already in existence throughout the United States. Section 3.2 presents information on the determination and selection of the optimal components for the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas. Section 3.3 provides detailed information on each of the recommended components of the Implementation Plan for Dallas.

3.1 COMPONENTS OF EXISTING DRIVER-BASED CELLULAR/PCS INCIDENT DETECTION SYSTEMS IN THE UNITED STATES

This section provides an overview of the different components of driver-based cellular/PCS incident detection systems based on the examination of existing systems throughout the United States. A driver-based cellular/PCS incident detection system can have a number of different components depending on the system design and desired features. There are, however, several core components that all of the driver-based cellular/PCS incident detection systems have. These core components are the following:

- drivers equipped with cellular or digital PCS telephones;
- wireless and landline telecommunications infrastructure owned by private sector corporations; and
- 911 PSAPs, which are communication centers operated by agencies responsible for answering 911 emergency calls.

In addition to these core components, this research has determined that there can be several other optional elements in a driver-based cellular/PCS incident detection system including:

- driver education program;
- 911 PSAP/Transportation Management Center (TMC) communications interfaces;
- Non-911 cellular call-in program number dedicated to reporting traffic-related incidents directly to the TMC;
- advertising and promotion of cellular call-in program;

- reference location signs;
- recruitment of 'expert' drivers to serve as mobile monitors;
- use of roadside call boxes equipped with cellular telephones; and
- deployment of CCTV camera systems to help the TMC verify incident reports.

3.2 DETERMINATION OF OPTIMAL COMPONENTS FOR A DRIVER-BASED INCIDENT DETECTION SYSTEM IN DALLAS

This section gives information on the determination and selection of the optimal components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas. The research efforts documented in the 3939-2 research report provided a wealth of background information on driver-based cellular detection and its feasibility in the Dallas area. The primary objective of this research was to determine the optimal driver-based cellular/PCS incident detection system for Dallas. The search for the optimal driver-based detection system came down to two basic options: (1) develop a cellular call-in program for motorists to report incidents directly to the Dallas TMC via a number such as *999 or (2) establish an information exchange with 911 agencies to receive notification of incidents on freeways. Figure 7 on the following page provides a graphical representation of the two options described in the preceding sentence.

3.2.1 Selection of Option 2 - Reliance on Existing 911 Incident Reporting

After reviewing all of the information collected in the literature and Internet search, and from surveys and interviews, the research committee unanimously concurred that the second option, i.e., establishing an information exchange with 911 agencies to receive notification of incidents on freeways, was the preferred direction for the Dallas area. Several factors affected this decision including:

- Dallas area 911 agencies indicated a willingness to share traffic incident information with the TxDOT Dallas TMC.
- TxDOT currently has limits placed on the number of full-time employees (FTE) making it difficult to add the staff that would be needed to answer the incoming calls expected if a non-911 cellular call-in program such as *999 was implemented.
- Local 911 agencies have problems locating incidents from motorist reports, making it likely that TxDOT, with a much larger jurisdiction, would experience even greater difficulty.

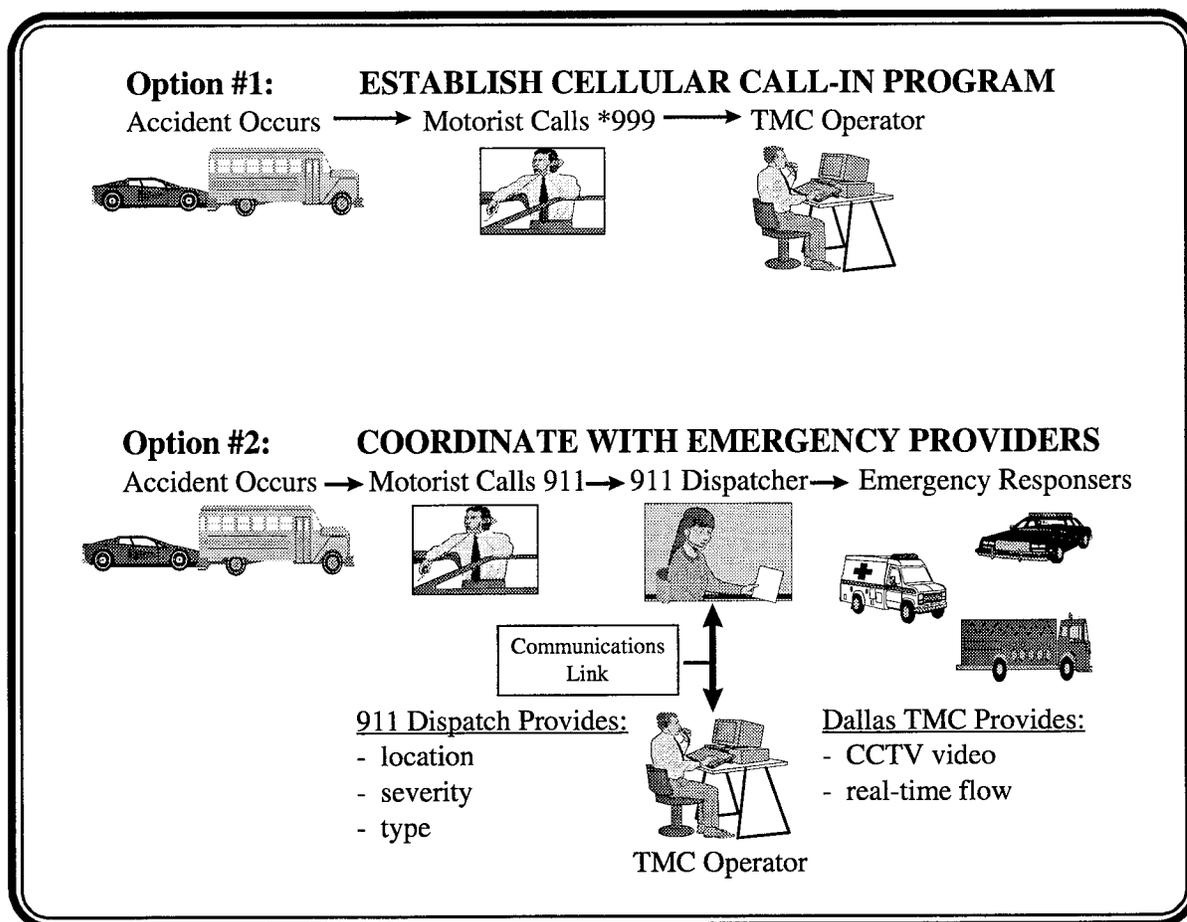


Figure 7. Two Choices in the Search for the Optimal Driver-Based Incident Detection System in Dallas

- Reluctance was expressed by local cellular providers to give free airtime for a call-in number in addition to the free airtime they are already providing for cellular 911 calls, therefore, TxDOT would either have to pay for the *999 calls or motorists would have to pay which would likely result in decreased usage.
- Several local 911 agencies voiced concern over a three digit number other than 911 being used to report situations that they consider to be emergencies.
- There is concern about the liability of TxDOT handling emergency calls that would have to be rapidly forwarded to the correct 911 public safety answering point.
- Continued reliance on the existing 911 system for incident reporting has the advantage of being already familiar to the public, free for cellular/PCS telephone users, and already having full coverage of the Dallas urbanized area.

3.2.2 Selection of Optimal Components for Driver-Based Incident Detection System in Dallas

The next step in the development of an implementation plan, after deciding to rely on the existing 911 systems for incident detection, was to select the optimal components for the driver-based incident detection system in Dallas. The research team and project monitoring committee, composed of representatives of TxDOT, NCTCOG, Dallas Regional Mobility Coalition, and the Federal Highway Administration, determined that the following four optional components were recommended for inclusion in the Implementation Plan:

1. driver education program;
2. reference location signs;
3. 911 PSAP/TMC communications interfaces; and
4. CCTV camera system for verification of incident reports.

The following section will provide additional information on each of the four recommended components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan.

3.3 COMPONENTS OF THE DRIVER-BASED CELLULAR/PCS INCIDENT DETECTION SYSTEM IMPLEMENTATION PLAN FOR DALLAS

This section will outline and provide detailed information on each of the four recommended components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas.

3.3.1 Component #1: Driver Education Program

This section describes the driver education program component of the Dallas-Area Driver-Based Incident Detection Plan. The TxDOT Highway Operations Manual states that in order to increase the effectiveness of cellular incident detection, a campaign to inform drivers about the cellular call-in system and the benefits of reporting an incident is recommended (21). The need for driver education has also been supported by representatives of local 911 agencies during project-related discussions. Finally, organizations such as the National Emergency Number Association (NENA) and the Cellular Telephone Industry Association (CTIA) have stressed the importance of proper use of cellular telephones for reporting incidents to 911 on a national level. Based on these rationale, it was determined that a driver education program would be an integral component of a successful driver-based detection system for Dallas.

The development of a driver education program was not included in the scope of the

work tasks of this research project, however; the development of the driver education component has been proposed as a State Funded Research (SFR) project by the TxDOT Dallas District. The basic objectives of the proposed SFR research will be to determine driver education needs for conveying information to emergency 911 systems via mobile phones and to develop a driver education campaign targeted at Dallas-area drivers. While it is not known at this time exactly what the education needs or program content might be, it is likely that parts of existing campaigns might be applicable. Each of these campaigns has been successful and components of each, potentially with modifications to accommodate local ideas and issues, may ultimately be incorporated in the campaign for Dallas-area motorists. At this point, the driver education component of this plan is largely dependent on the funding and timing of the SFR project. The following subsections present information obtained in a literature search from existing campaigns, such as those produced by NENA, CTIA, California Cellular 911 Education Task Force, and Greater Harris County 911.

3.3.1.1 NENA and CTIA National Driver Education Campaigns

The CTIA, in conjunction with numerous public safety agencies and administrative organizations such as the NENA (22), put together a publication entitled “A Guide to Safe and Responsible Wireless Phone Use.” This publication identifies some of the important items for drivers to know in order to properly use their cellular phones from a national perspective. The following list provides the 10 important items:

1. Get to know your phone and its features, such as speed dial and redial.
2. When available, use a hands-free device.
3. Position your phone within easy reach.
4. Let the person you are speaking to know you are driving; if necessary, suspend the call in heavy traffic or hazardous weather conditions.
5. Do not take notes or look up phone numbers while driving.
6. Dial sensibly and assess the traffic; if possible, place calls when you are not moving or before pulling into traffic.
7. Do not engage in stressful or emotional conversations that may divert your attention from the road.
8. Use your wireless phone to call for help. Your wireless phone is one of the greatest tools you can own to protect yourself and your family in dangerous situations-with your phone at your side, help is only three numbers away. Dial 911 or other local emergency number

in the case of fire, traffic accident, road hazard, or medical emergency. Remember, it is a free call on your wireless phone.

9. Use your wireless phone to help others in emergencies. Your wireless phone provides you a perfect opportunity to be a 'Good Samaritan' in your community. If you see an auto accident, crime in progress, or other serious emergency where lives are in danger, call 911 or other local emergency number, as you would want others to do for you.
10. Call roadside assistance or a special wireless non-emergency assistance number when necessary. Certain situations you encounter while driving may require attention, but are not urgent enough to merit a call for emergency services. But you still can use your wireless phone to lend a hand. If you see a broken-down vehicle posing no serious hazard, a broken traffic signal, a minor traffic accident where no one appears injured, or a vehicle you know to be stolen, call roadside assistance or other special non-emergency wireless number.

Furthermore, the publication goes on to point out that callers dialing 911 from a wireless phone should be prepared to provide their name and wireless phone number, describe what happened, how many injured victims are involved, and the exact location of the emergency. The publication suggests that callers should try to identify major landmarks or mile markers (this could be reference location signs) and that they should not hang up until the operator asks them to end the call.

3.3.1.2 California Cellular 911 Education Task Force Public Awareness Campaign

The California Cellular Education Task Force was created to develop a comprehensive uniform statewide campaign to educate and heighten awareness of cellular subscribers and the general community on the responsible use of cellular 911. The task force was comprised of members of the California Highway Patrol (CHP), Cellular Carriers Association of California, and the State 911 Program Office. The task force created the following goals and objectives for their driver education/public awareness program (23):

Goals:

1. Reduce inappropriate calls to cellular 911;
2. Reduce non-emergency calls to cellular 911; and
3. Reduce 911 busy tones for cellular 911 callers.

Objectives:

1. Publicize problems with multiple calls on the same incident;
2. Publicize amount of calls to 911 statewide;

3. Publicize inappropriate calls to cellular 911;
4. Publicize appropriate calls to cellular 911; and
5. Educate the public on the difference between wireless and landline 911.

The Cellular 911 Education Task Force public awareness campaign was designed to educate the public about the value cellular users provide to public safety by correctly identifying an emergency and providing accurate information about the nature and location of the emergency to the CHP. The statewide campaign effort included public service announcements, point-of-sale displays, educational pamphlets, and more. The task force developed a set of recommended guidelines for California drivers to use when calling cellular 911:

- Call cellular 911 only for emergencies such as to report a traffic accident, a traffic hazard (i.e., disabled vehicle or debris blocking the roadway), a reckless or suspected intoxicated driver, a medical emergency, any type of fire (i.e., vehicle, structure, or wildfire), a driver in distress, or a crime in progress.
- Know your location and the location of the emergency when calling cellular 911. Unlike 911 calls made from your home or business, the CHP cannot identify the phone number and location of a cellular phone. Therefore, be prepared to provide the CHP with your location, the location of the emergency, your cellular phone number, and area code.
- If emergency response agencies are already on the scene of a traffic accident, don't call cellular 911.
- Multiple calls reporting the same emergency clog the lines and prevent the CHP from addressing new emergency situations. Do not call cellular 911 for weather reports, road conditions, directions, phone numbers, movie/theater times, or general information.

3.3.1.3 Greater Harris County 911 Driver Education Campaign

The Greater Harris County 911 Emergency Network and its Cellular Safety Coalition Partners (GTE Wireless, Houston Cellular, and Southwestern Bell Wireless) developed an educational campaign to inform cellular users about the correct procedures when calling 911 (24). The Greater Harris County 911 Emergency Network is the 911 administering agency responsible for all of Harris and Fort Bend Counties in the Houston, Texas, metropolitan area. The campaign message is: 1-Where 2-Who 3-What. The Network recommends the following special procedure for emergency cellular call reporting: 1-Where: give as much location information as possible, such as city, county, address, landmark; 2-Who: the caller's name and cellular phone number; 3-What: what type of emergency assistance is needed, such as police, fire, or ambulance.

The 911 Network's safety coalition partners driver education campaign consists of several significant efforts. The first effort involves distributing cellular phone stickers with the '1-2-3' message in their phone bills for current subscribers and in their 'welcome kits' for new subscribers. The second effort involves putting a '1-2-3' message in each of the Cellular Safety Coalition partners' newsletters. Another part of the campaign message involves encouraging cellular phone users to listen to radio messages that emphasize the procedures for calling 911 on a wireless phone. The final campaign effort involved billboards with the '1-2-3' message throughout the Houston area.

3.3.1.4 Dallas/Fort Worth Driver Education Brochure

Several agencies in the Dallas/Fort Worth Metroplex have produced a brochure for educating drivers of the proper procedures for calling 911 from a cellular or PCS digital phone. The brochure was developed via a cooperative effort between the Tarrant County 911 District, NCTCOG, Denco Area 911 District, and Dallas 911. The 3x8 inch brochure was printed and delivered to area residents that subscribe to the Dallas Morning News and Fort Worth Star Telegraph daily newspapers. The brochure starts out by informing readers that 911 operators do not know where you are or your wireless phone number when you call 911. It also points out that it is possible that your 911 call may end up at a 911 center in another city. The brochure provides these guidelines for drivers to use when reporting an incident to a 911 operator:

- Where: provide the operator with the incident location (use address or landmarks to help).
- Who: provide the operator with your name and cellular number.
- What: provide the operator with the nature of the emergency.

The brochure also suggests several tips for drivers to use when reporting an incident to a 911 operator:

- Tip #1: If you're in a vehicle, pull over and stop.
- Tip #2: State the name of the city or county you're calling from.
- Tip #3: Give as much information as possible.
- Tip #4: Give a description of the vehicle or individual involved.
- Tip #5: Don't put yourself at risk to report information.

This brochure was sponsored by several entities including: Domino's Pizza, PrimeCo, Tom Thumb, Southwestern Bell, Tiburon, Inc., Frost Bank, Plant Equipment, Inc., SCC, and True Position.

3.3.2 Component #2: Reference Location Signs

During the course of this research, the problem of locating incidents from cellular telephone reports was prominent in the review of literature and during telephone interviews and other discussions with TMCs nationwide and local 911 PSAPs. The problem of wireless calls to 911 not being routed to the proper 911 PSAP was also identified as a local concern. Because wireless calls to 911 do not provide public safety operators with the caller's location or 10-digit calling number like landline 911 calls, critical time is spent trying to determine the information needed to make decisions on the proper response. This time can result in a delayed response that causes loss of life, more severe injuries, and greater overall delay to motorists on the freeway. Based on these findings and the support of local 911 agencies and TxDOT, it was determined that a reference location sign system was a necessary component of a driver-based detection system for Dallas.

It was not a surprise that this research concluded that a reference location sign system was needed to help alleviate the problem of inaccurate location reporting by motorists to local response agencies. In fact, prior to this research, the Dallas Area-Wide ITS Plan recommended that a reference location sign system be implemented. The development of a reference location sign system was not specifically delineated in the work tasks of this one-year study; however, because of the Dallas ITS Plan recommendation, the development of a reference location sign system is part of the work tasks for the fiscal year 1998-1999 Interagency Contract (IAC) between the TxDOT Dallas District and TTI.

As part of the Task 1 literature review of this study, information on three existing reference location sign systems (i.e., Cincinnati, Ohio, Monroe County, New York, and St. Louis, Missouri) was gathered. The information on the three systems revealed that at this point there is a wide variety of reference location sign designs, system deployment costs, and perceived effectiveness. It should be noted that the deployment of reference location signs for incident reporting is a relatively new concept (all of them implemented in the last three years), therefore, not a lot of research has been performed on their effectiveness. The IAC work on reference location signs will focus on developing the optimal system for Dallas.

3.3.3 Component #3: 911 PSAP/Transportation Management Center (TMC) Communications Interfaces

After deciding not to implement a new cellular call-in program such as *999, the need for another method of incident notification method for the TxDOT Dallas TMC became necessary. Telephone interviews with local 911 PSAPs revealed a willingness to share traffic

incident-related information with the TxDOT Dallas TMC. The information that Dallas-area drivers provide to 911 is now routed to responders but is not currently captured directly by the Dallas TMC for CCTV camera verification, freeway management, or notification of the public. These items revealed the need for the development of reliable, preferably automated, communications interfaces between the Dallas TMC and the numerous local 911 PSAPs with responsibility for initiating response to freeway incidents. The rest of the following subsections will provide information on the third component of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas: communications interfaces between the TxDOT Dallas TMC and local 911 PSAPs.

3.3.3.1 Telephone Interviews with Local 911 PSAPs

Interviews with 911 PSAPs were conducted only in the eastern (Dallas) part of the Metroplex. There are 17 different cities with 911 PSAPs in the TxDOT Dallas District that have responsibility for freeway incidents. There are another 13 PSAPs with freeways within city boundaries in the western subregion surrounding Fort Worth. In all, 10 Dallas-area 911 PSAPs were interviewed (Table 1). Each of the 911 PSAPs were asked the following 10 questions:

1. Is your 911 system in danger of overload from calls from wireless phones? Explain.
2. Are the majority of wireless 911 calls for traffic problems? (Give statistics.)
3. Do you have statistics or anecdotal information on the number of multiple 911 calls for major traffic accidents? How big a problem are the multiple calls?
4. Do you have a procedure for handling multiple calls if the same incident is being reported?
5. Is there ever a problem with a 911 call being routed to the wrong jurisdiction? If so, how often?
6. Do motorists reporting traffic problems have difficulty providing dispatchers with accurate information on the problem's location? If so, how big is this problem? Do you think that special signs with location information on them would be helpful in addressing this problem?
7. Have the local wireless telephone service providers achieved compliance with FCC Phase I location requirements?
8. What equipment do your 911 dispatchers have available?

9. Would you support creating a number for motorists with wireless phones to use for reporting traffic problems to the Texas Department of Transportation?
10. Could your agency easily share freeway incident information with the Texas Department of Transportation traffic management center? If so, explain how it might be accomplished.

Table 1. Dallas-Area 911 Interview Participants	
Person	Agency
Sergeant Cheryl Hitt	Carrollton Police Department
Jay K. Kreps	Coppell Police Department
Sherrie Wilson	Dallas Fire Department
Gene Yates	DeSoto Police Department
Captain Chuck Reeves	Farmers Branch Police Department
Krista Roberts	Garland Police Department
Lieutenant Mark Ferris	Irving Police Department
Sergeant J.W. Smith	Mesquite Police Department
Melissa Tutton	Plano Public Safety Communications
Captain Joe Hanna	Richardson Police Department
Bill Munn	Tarrant County 911 District

3.3.3.2 Findings From Dallas-Area 911 Interviews

This section summarizes the findings from the telephone interviews with the Dallas-area PSAPs listed in Table 1. The interviews were conducted in order to get the public safety perspective on issues related to cellular incident detection and also with coordination with transportation agencies. Table 2 on the following page provides an overview of how each of the 10 PSAPs interviewed responded to the interview questions. In order to draw some conclusions from the interviews as a whole, a list was created to consolidate and identify trends in the responses received. The following list provides some of the significant findings of the interviews:

1. Every PSAP expressed a willingness to share traffic incident information with the TxDOT Dallas TMC.

Table 2. 911 Interview Results											
Question	Carrollton	Coppell	Dallas	DeSoto	Farmers Branch	Garland	Irving	Mesquite	Plano	Richardson	Tarrant County
1	No	No	No	No	Yes	Yes	Yes	No	No	Yes	No
2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3a	D-K	10	D-K	D-K	D-K	30	10	12	D-K	30	20
3b	No	No	Yes	No	Yes	Yes	Yes	No	No	Yes	D-K
4	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes Yes	Yes No	Yes D-K	Yes Yes	Yes Yes	Yes No	Yes Yes	Yes Yes	Yes D-K	Yes Yes	Yes Yes
6	Yes Yes	No Yes	Yes Yes	No Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
7	No	No	No	No	No	No	No	No	No	No	No
8	CAD	CAD	CAD AVL	CAD	CAD	CAD	CAD	CAD	CAD	CAD	CAD
9	Yes	Yes	No	D-K	D-K	Yes	D-K	D-K	No	No	No
10a 10b	Yes call	Yes call	Yes auto	Yes D-K	Yes auto	Yes call	Yes D-K	Yes call	Yes auto	Yes auto	Yes D-K

D-K : "Don't Know" answer provided to the question

CAD : Computer Aided Dispatch

AVL : Automatic Vehicle Location

call : Indicates that a telephone voice contact is the initial preferred method of sharing incident information

auto : Indicates that an automated method is the initial preferred method of sharing incident information

2. Several of the PSAPs expressed concerns (i.e., ability to forward emergency calls, call-taker training, etc.) about a non-911 number for reporting incidents to TxDOT.
3. Most PSAPs suggested that motorists have difficulty providing the location for incidents and everyone supported the idea of installing reference location signs at frequent intervals similar to the ones used in Cincinnati (Figure 6).
4. Several PSAPs indicated that their systems are in danger of overload from wireless calls.
5. Every PSAP stated that the majority of wireless 911 calls are traffic related.

Chapter 3 - Development of an Implementation Plan

6. In general, the PSAPs commented that stalled vehicles and debris in the roadway are considered emergencies (i.e., a threat to public safety) and should be reported to 911.
7. Most of the urban PSAPs indicated that handling multiple calls (anywhere from 20 to 50 calls) for major traffic accidents is a big problem.
8. Most of the PSAPs handle multiple calls for the same incident but continue to verify the location and then thank them for calling.
9. Several PSAPs stated that it is common for wireless 911 calls to be routed to the wrong response jurisdiction because of the nature of wireless call transmission systems.

3.3.3.3 Dallas-Area 911 PSAP Freeway Coverage

One of the biggest challenges of providing public services (i.e., transportation, public safety, etc.) in the Dallas/Fort Worth Metroplex is the numerous governmental entities that occupy the area. In Dallas County alone, there are 24 municipal agencies with most having their own 911 PSAP, police, and fire departments. Five of these cities (Dallas, Garland, Grand Prairie, Irving, and Mesquite) have populations in excess of 100,000 persons according to the NCTCOG 1997 Population Estimates (9). There are also several other large cities within the TxDOT Dallas District outside of Dallas County including the cities of Carrollton, Lewisville, and Plano. Of all of the previously mentioned cities, 13 have the responsibility of responding to traffic-related incidents on TxDOT freeway facilities. In trying to determine priorities, methods, and potential benefits for establishing communications interfaces between the Dallas-area 911 PSAPs and the TxDOT Dallas TMC, the number of freeway miles in each jurisdiction is an important factor. Table 3 lists the freeway facilities and estimated total lane-miles that each of the 911 PSAPs in the Dallas area that are responsible for handling the investigation and removal of traffic incidents. The PSAPs are listed in descending order by the estimated total lane-miles of coverage.

3.3.3.4 Follow-up Meetings with 911 PSAPs

After conducting the telephone interviews and receiving interest in further discussion of the concept of sharing information between 911 agencies and the Dallas TMC, follow-up meetings were conducted between members of the research team and five of the 911 PSAPs (Mesquite, Garland, Plano, Irving, and Richardson). The primary objective of these meetings was to further discuss and brainstorm about a preliminary plan for establishing communications connections between their PSAP and the TxDOT Dallas TMC for sharing traffic incident information. A secondary objective of these meetings was to educate 911 personnel on the traffic management capabilities of TxDOT in the Dallas area. Appendix B of this document provides a detailed summary of the discussions and findings from each of the meetings.

Table 3. 911 PSAPs Freeway Response Coverage Summary		
911 PSAP	Response Freeways	Total Estimated Lane-miles
Dallas	SH 183, LP 12, IH 35E, SP 408, IH 20, US 67, IH 30, IH 45, IH 175, US 75, IH 635, & SP 348	694
Irving	SH 183, LP 12, IH 635, SH 114, SH 161, SP 348, & SP 482	179
Mesquite	IH 635, US 80, IH 30, & IH 20	122
Grand Prairie	IH 30, IH 20, & SH 360	120
Garland	IH 635, IH 30, & SH 190	91
Plano	US 75, SH 121, & SH 190	74
Farmers Branch	IH 35E & IH 635	64
Richardson	US 75 & SH 190	51
Carrollton	IH 35E	33
Coppell	IH 635 & SH 121	30
Duncanville	IH 20 & US 67	28
Lewisville	IH 35E	24
DeSoto/Lancaster	IH 35E	9

Continued reliance on the existing 911 system has the advantages of being already familiar to the public, free for cell phone users, and of little additional cost to the public. It does, however, make it imperative that this information flow---incidents and locations---be expeditiously captured by the TMC. The use of reference location signs on freeway facilities similar to the ones used in Cincinnati (Figure 6) will assist the 911 operators in zeroing in on an incident location and a quick response by the TMC with cameras could also assist in the 911 dispatcher's assessment of the situation and prompt deployment of appropriate resources to the scene. This means a reliable, preferably automated, connection must be made to each and every PSAP with freeway incident clearance responsibilities, so that incident information can be shared without creating a significant increase in workload for either 911 dispatchers or TMC operators.

Figure 8 provides a representation of the most critical information sharing linkages from the TxDOT Dallas TMC to Dallas-area 911 PSAPs that would need to be established for incident detection coverage on the majority of freeways within the Dallas District. Figure 8 also shows two-way information sharing capability between the Dallas TMC and 13 911 PSAPs listed in

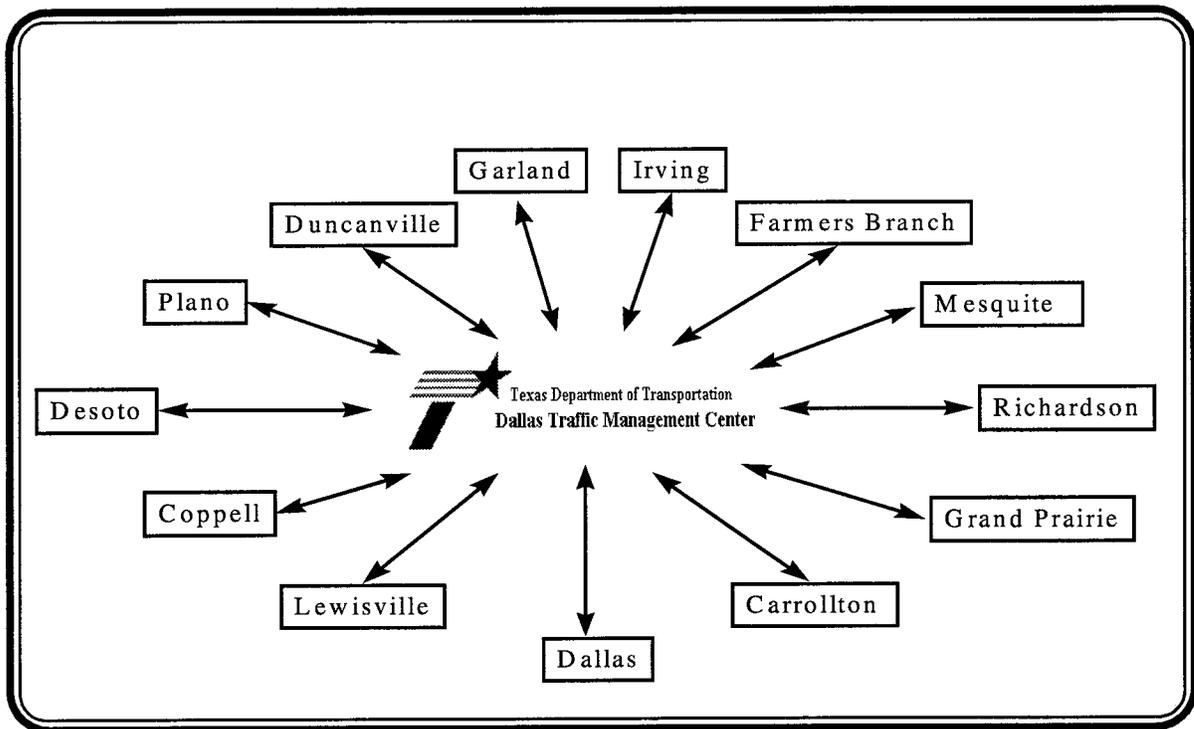


Figure 8. Conceptual Diagram for Information Sharing Linkages Between the Dallas Traffic Management Center and 13 Dallas-Area 911 Centers

Table 3. One of the most important developments from these meetings was that it appears as if interim communications interfaces can be established soon without significant modification to either the 911 or Dallas TMC existing systems. For example, the city of Plano PSAP is willing to page the TxDOT Dallas TMC when they are aware of a major incident occurring on a freeway facility in their jurisdiction. This type of communication interface can be quickly and inexpensively established because each party already has the equipment, in this case alphanumeric pagers, available and the cost is already being paid for other uses. Another important development was that if an easy interim method, such as notification via pagers, did not exist, then a more permanent solution would probably be available when the 911 PSAP upgraded their current CAD system to a newer and more sophisticated system in the future. Each of the five PSAPs indicated they were in various stages of replacing their existing CAD system and that communications links would be easier to implement once new equipment was procured.

Based on the telephone interviews and follow-up meetings, it is apparent that there is a willingness and the technological capabilities exist or will exist in the near future for communications between local 911 PSAPs and the TxDOT Dallas TMC. Four PSAPs have indicated that a phone call would be possible to notify TxDOT of freeway incidents in their jurisdiction. Another four PSAPs have indicated that there currently is some automated method (fax, page, e-mail, or other) available to contact TxDOT. The final two PSAPs don't know at this time if there is a short-term method available for the sharing of incident information with

TxDOT. Another potential short-term communication method is having the TMC purchase the Mobile Data Terminals (MDT) of the 911 PSAPs with the most freeway lane-miles (Dallas, Irving, Mesquite, and Grand Prairie) so that incident notification is received as units are dispatched to the scene. An MDT (example, Figure 9), is basically a handheld or rack-mounted device that public safety dispatchers use to notify their field personnel of assignments for responding to reported incidents. Normally, police, fire, and sometimes EMS personnel receive incident data (location, type, special notes, etc.) over a wireless radio communications link from the 911 PSAP dispatcher CAD terminal to their MDT.

One of the prominent weaknesses of the previously mentioned interim communications methods is that it is primarily a one-way information exchange that benefits the TMC. While notification of the TxDOT TMC of freeway incidents may provide the PSAP with some benefits (i.e., DMS warn motorists as they approach an incident or divert some traffic from the scene, Courtesy Patrol may assist police with traffic control, etc.), eventually, more sophisticated communication linkages between the Dallas TMC and major 911 PSAPs might be desirable so that incident information and other data can be more rapidly and reliably exchanged. This might mean a dedicated Integrated Services Digital Network (ISDN) line connection for video transmission, or even a fiber-optic line for the major (i.e., Dallas 911) centers. Sharing incident information should involve a two-way exchange so that both the TxDOT TMC and public safety agencies receive significant benefits. As previously mentioned, the information sharing should be automated to the extent possible so that it does not add any significant amount of work to either the 911 dispatchers or TMC operators. In the future, the information sharing might involve the TxDOT TMC relaying video images from cameras along the freeway over a communications link to the PSAP dispatcher. Other available real-time traffic data on incident specifics, suggested routing of response vehicles to the scene, incident severity, etc., might be shared if this information is available and desired by the PSAP.

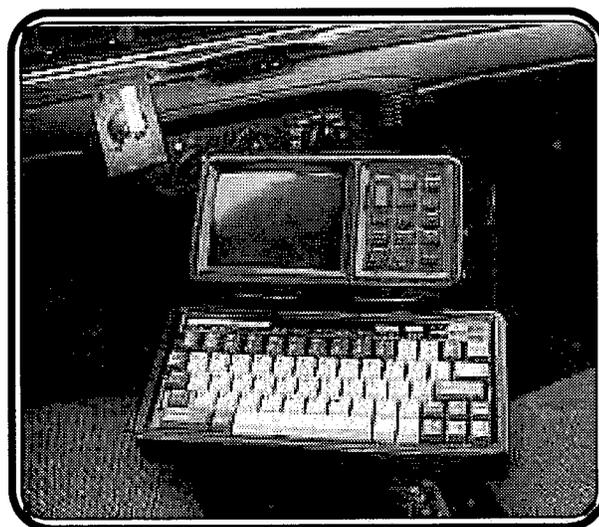


Figure 9. Mobile Data Terminal

3.3.4 Component #4: CCTV Cameras for Incident Verification

The final recommended component of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan is having CCTV cameras deployed for verification of incidents. Based on other research studies, an important facet of incident management is the use of CCTV for incident verification. Verification of incidents is important to both the TxDOT Dallas TMC and local 911 PSAPs because visual confirmation allows for the best assignment of resources. This plan recommends that CCTV be deployed along key freeway segments in accordance with implementation strategy of the Dallas Area-Wide ITS Plan.

CHAPTER 4

SUMMARY OF RECOMMENDED IMPLEMENTATION PLAN

This chapter summarizes the estimated costs and potential funding sources for the recommended Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas. Section 4.1 provides the estimated costs for each of the four components described at length in Chapter 3. Section 4.2 presents several potential funding sources for the plan.

4.1 ESTIMATED COSTS FOR DRIVER-BASED CELLULAR/PCS INCIDENT DETECTION SYSTEM IMPLEMENTATION PLAN COMPONENTS

This section is divided into four subsections which present the estimated costs for implementing the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas.

4.1.1 Estimated Cost for the Driver Education Program Component

The driver education program component is estimated to have a fairly insignificant cost of approximately five to ten thousand dollars. This estimation is based on using the existing TxDOT Dynamic Message Signs to display short educational messages, distribution of brochures, and utilization of existing components of already existing programs.

4.1.2 Estimated Cost for the Reference Location Sign Component

The reference location sign component is estimated to cost between \$620 to \$1,860 per km (\$1,000 to \$3,000 per mi) for the approximately 480 km (300 mi) of the Dallas freeway system that would need the signs. These cost figures are based on the cost of actual existing systems in Cincinnati, Rochester, and St. Louis. If the higher end of the cost per kilometer or mile is used, a total cost of approximately one million dollars could be expected to deploy reference location signs on the entire Dallas freeway network.

4.1.3 Estimated Cost for the 911 PSAP to TMC Communications Interfaces Component

The 911 PSAP to TMC communication interfaces component cost is difficult to quantify until actual communications mediums are selected. A general approximation of the cost of short-term (i.e., electronic mail, pager system, facsimile, etc.) solutions is that a minimal cost would be incurred because most of these systems are already in place and the added cost would be negligible. The more long-term, sophisticated communication linkages such as ISDN lines and procurement of new equipment such as MDTs and computers, would be a more substantial capital and operations cost.

4.1.4 Estimated Cost for the CCTV Camera Component

As mentioned previously, the plan for the CCTV camera component of this plan is to follow the recommendations contained in the Dallas Area-Wide ITS Plan. The costs for deployment of CCTV cameras in that plan are approximately 12 million dollars.

4.1.5 Total Estimated Cost for the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas

Table 4 provides a summary of the estimated costs for each of the components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas. The total aggregate cost of the system is approximately 13 million dollars with all of the recommended components. If the components related only to the enhancement of incident detection are considered (i.e., all components except the cameras for incident verification), the cost of implementing the system would be reduced to approximately one million dollars.

Table 4. Cost Estimation for Components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas	
Elements of the Cellular 911 Detection System	
Element	Estimated Cost
Cellular/PCS phones	Free to TxDOT but motorists pay for phones
Cellular service providers - call to 911	Free to TxDOT and also free to phone users
911 PSAPs/dispatch infrastructure	Free to TxDOT - funded by surcharges on phone users (both cellular and landline)
Public education campaign - brochures and dynamic message signs ^a	Minimal cost to TxDOT....estimated to cost between \$5,000 and \$10,000
Reference location signs	\$620 to \$1,860 per km (\$1,000 to \$3,000 per mi) Total cost of approximately \$1,000,000 dollars if deployed on the entire Dallas freeway network
Information relays from 911 PSAPs to Dallas TMC <ul style="list-style-type: none"> ▶ phone call ^a ▶ digital pager ^a ▶ facsimile ^a ▶ electronic mail / modem transfer ^a 	Free to minimal cost to TxDOT for short-term communications interfaces
CCTV cameras for incident verification	Approximately \$12,000,000 according to the Dallas Area-Wide ITS Plan estimates

^a TxDOT already has these systems in place for other uses; therefore, incremental costs for detection were estimated to be minimal.

4.2 POTENTIAL IMPLEMENTATION PLAN FUNDING SOURCES

There are a number of potential funding sources for implementing the recommended components of the Driver-Based Cellular/PCS Incident Detection System Implementation Plan for Dallas. It is believed that if TxDOT rapidly deploys cameras throughout the region, the PSAPs could gain significant benefit from receiving that video in reducing response time to freeway incidents. It is possible that this potential benefit might create a willingness on the part of the 911 system to share, or even absorb, the costs of the fiber or ISDN line connections to TMC cameras. Funding for the 911 system depends on serving the public good, and this expense may be justifiable to those who establish funding rates from cell phone and land-based telephone subscribers to 911. This leaves only the freeway location signs as additional expenses, compared to the traditional passive freeway incident detection system, since cameras are already planned on 1 mi centers along all freeways. The following list provides several potential funding sources for implementation of the recommendations of this research:

1. Congestion Mitigation Air Quality (CMAQ) funds - CMAQ funds have traditionally been used in the Dallas/Fort Worth area for the funding of traffic management and ITS projects. CMAQ money was used in St. Louis, Missouri, to fund the deployment of their reference location sign system. Reference location signs are the primary funding need for this implementation plan.
2. Dallas District operating funds could be used to fund minor expenditures such as the acquisition of communications equipment (pagers, computers, modems, etc.).
3. Funding of the public education campaign to teach motorists proper use of 911 and how to use reference location signs could potentially come from several funding sources: (1) TxDOT statewide public education funds; (2) joint funding from local 911 PSAPs; and (3) joint funding from local wireless service providers. However, existing dynamic message signs could provide educational information at little to no additional cost.
4. The funding of dedicated hard-wired communication linkages (i.e., ISDN, fiber, or others) may also potentially come from several funding sources: (1) CMAQ funds; (2) Surface Transportation Program (STP) roadway funds; (3) joint funding from local 911 PSAPs; and (4) joint funding via a public/private partnership with local telecommunications providers.

REFERENCES

1. Press release on Cellular Telecommunications Industry Association Home Page. "Wireless Industry Sets New Growth Record: 11,270,301 Net Subscriber Growth in 1997," April 1, 1998. [<http://www.wow-com.com>].
2. Sutton, Judy. Chicago Market's Wireless Penetration Rate Estimated as High as 25 Percent, *Marketing News*, Vol. 32, No. 4, p. 2.
3. Mussa, R.N. "Evaluation of Driver-Based Freeway Incident Detection," *ITE Journal*, March 1997, pp. #33-40.
4. McLean, C.H. *Cellular Phones - A Key Traffic Management Component*. ITE 1991 Compendium of Technical Papers.
5. Christenson, R.C. *Evaluation of Cellular Call-in Programs for Incident Detection and Verification*. Graduate Student Papers on Advanced Surfaced Transportation Systems, Report Number SWUTC/95/72194-4, December 1995.
6. Carvell, J.D., Jr., E.J. Seymour, C.H. Walters, and T.R. Starr. *Dallas Area-Wide Intelligent Transportation System Plan*, Research Report 591-1F, Texas Transportation Institute, Texas A&M University, College Station, Texas, February 1997.
7. Files, Jennifer. Mobile Phone Calls May Not Reach The Help You Need, *Dallas Morning News*, Section F - Personal Technology, July 21, 1998.
8. Wireless Week Home Page. [<http://www.wirelessweek.com/>].
9. *1997 Current Population Estimates*. North Central Texas Council of Governments Research and Information Services, April 1997.
10. Emmett, Arielle. Not By Accident: The Trial of a New Wireless Subscriber Locator Technology May Enhance the "Golden Hour" for E-911 Service, *America's Network*, March 1, 1997.
11. Federal Communications Commission Home Page. [<http://www.fcc.gov/>].
12. North Central Texas Council of Governments Home Page. [<http://www.dfwinfo.com/>].
13. Terrell, Kenneth. "Help, 911! Where am I?" *U.S. News and World Report*, June 22, 1998.

14. Dispatch Monthly Home Page. [<http://www.911dispatch.com/>].
15. Pigman, J. "Preliminary Evaluation: ARTIMIS Reference Signs," Kentucky Transportation Center Report No. KTC-95-11. University of Kentucky, Lexington, Kentucky, June 1995.
16. Mr. Leon Walden. Kentucky Transportation Cabinet. Survey conducted on October 23, 1997.
17. Mr. Larry Sherman. New York State Department of Transportation. Correspondence received on August 27, 1997.
18. Mr. Tom Dollus. Missouri Department of Transportation. Telephone interview conducted on June 10, 1998.
19. Cullison, J., C. Poe, and K. Mastako. Intelligent CAD: A Concept to Improve Interagency Communications and Emergency Dispatch Procedures. Texas Transportation Institute, Research Study No. 404041-2, Draft Project Deliverable 1, January 1998.
20. Texas Department of Transportation, Traffic Operations Division. *Traffic Management Center Advanced Traffic Management System Operations Concept Document*, Preliminary, December 1997 Version.
21. Texas Department of Transportation, Highway Design Division. *Operations and Procedures Manual*, Part IV, Interim Metric Version.
22. National Emergency Number Association Home Page. [<http://www.nena911.org/>].
23. State of California Office of Telecommunications: Cellular 911 Task Force Home Page. [<http://www.telecom.ca.gov/offices/911network.htm>].
24. Lopez, Sonya. Greater Harris County, Texas 9-1-1 Emergency Network Launches Campaign to Educate Cellular Phone Users, *Houston Chronicle*, May 14, 1998.

APPENDIX A

911 PUBLIC SAFETY ANSWERING POINTS: OVERVIEW OF OPERATIONS

Basic Pictorial Overview and Description of 911 PSAP Operations

Mobile Data Terminal

A Mobile Data Terminal (MDT) is a vehicular-mounted digital communication terminal that uses an external mobile radio to provide users with a reliable, secure, two-way digital communication link between a vehicle and a base station. Most MDTs are capable of transmitting up to 14 types of status messages, an emergency message, or text messages up to 960 characters in length. Most are also capable of storing up to 90 forms locally and 10 text messages. The text messages are sent as a 320-character message with the accompanying text sent in a second 320-character transmission. MDT equipment allows for the rapid dispatch of all response units and also allows these units to send and receive additional information almost instantaneously that would otherwise require several minutes to transmit over a voice channel.

Overview of Equipment and Personnel in a Typical 911 Public Safety Answering Point

A public safety answering point (PSAP) communications center is a very particular place-full of electronics for radios, recorders, and computers. It creates a very special workplace that a dispatcher must become accustomed to in order to excel. Notice the close proximity between dispatcher stations in Figure A-1. In some larger agencies, call-takers and radio dispatchers work in separate areas, rooms, or even on different floors. However, some interaction between dispatchers is an advantage.

Figure A-1 shows three radio consoles arranged side-by-side. Each is configured identically for radio, computer-aided dispatch (CAD), and telephones. There is also a TTY on the top of the middle console for communicating with the hearing impaired. Each console also has a instant playback recorder, an speaker intercom system throughout the headquarters building, a E911 display, and a set of drawers for papers and other supplies.

Notice that two consoles have a supply of incident cards to be used in case the CAD system is not working. The left console has several reference binders for the state and federal teletype system and criminal justice databases (wanted person, vehicles, missing persons, etc.).



Figure A-1. Typical 911 PSAP Dispatcher Stations

The single console shown in Figure A-1 has several different types of equipment. On the rear wall are several receiver modules for directly connected alarms from businesses. The console itself is divided into three sections, left, center, and right:

Left (top to bottom): instant recall recorder, building intercom, radio control panels (2 levels), cards for manual dispatching operations, file drawer.

Center: TTY device keyboard, primary CAD screen, main radio modules (2 levels), CAD keyboard.

Right: two portable radios for emergency operations are behind the E911 ANI/ALI display, secondary CAD screen, 100-button telephone panel, and speed dialer.

The headset plugs into the box mounted below the desktop on the right side of the console. This particular console has a non-adjustable desktop, but many other manufacturers offer workstations that can be adjusted up and down, and angled to accommodate the dispatcher's preferences.

Typical 911 Call-Taker Station

Figure A-2 shows a typical 911 PSAP call-taker workstation. A call-taker is also commonly referred to as an operator. The typical station is designed to keep noise to a minimum. Workstations are typically grouped into pods of four, with either a structural support or a surface and potted plant in the middle.

Typical 911 Dispatcher Station

Figure A-3 on the following page shows a typical 911 radio dispatcher's position. From left to right: the telephone control console and 911 display, the 800 MHz trunked radio "last unit broadcast" display, the CAD status screen, the CAD working screen, the radio control screen. Just below the radio control screen is a speaker for a radio when the dispatcher's headset is plugged into the phone system. Notice that the radio control screen has a keyboard that is out of the way and not used. Instead, it's controlled by the trackball near the dispatcher's left hand. The center button above the trackball is the "transmit" button, but there is also a foot pedal for the same function.

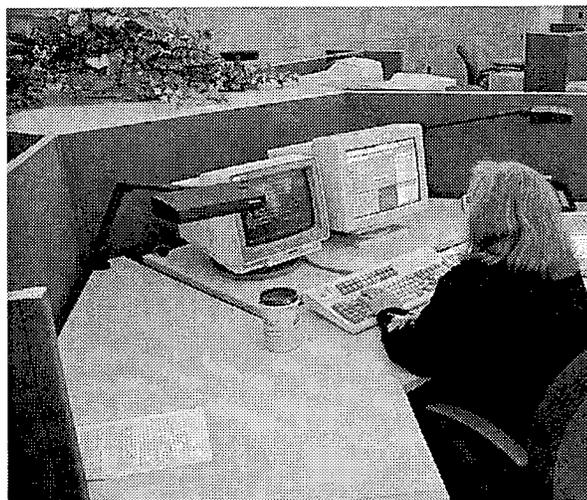


Figure A-2. 911 Call-Taker Station



Figure A-3. Typical Dispatcher Station Layout

APPENDIX B

**SUMMARIES OF MEETINGS
WITH LOCAL 911 REPRESENTATIVES**

City of Mesquite 911 Meeting Summary

A meeting with a representative of the city of Mesquite 911 PSAP was conducted on June 11, 1998. This meeting lasted approximately 1 hour and 30 minutes and covered a variety of topics. The following list provides a summary of the significant findings and observations from the meeting:

- The physical layout of the communications center was 1 room with 4 phone operator stations and 2 dispatch stations. Typically, the center is staffed with 2 operators, 2 dispatchers, and a supervisor. There are 7 lines available for the incoming 911 calls. If these lines are all in use, 911 calls will roll to the regular lines;
- The operators take the incoming calls and enter the required information. They assign a priority based on the given information and then determine if the call goes to the police or fire dispatcher or both and “screen dump” the Computer Aided Dispatch (CAD) information form to the appropriate dispatcher(s);
- The dispatcher(s) use the radio and the Mobile Data Terminals (MDT) (800 MHz) to send the necessary unit(s) to the incident site. The MDT just receives the initial call information. It is not updated by 911. The officer in the field can update and use this at the site or use the radio. There is no set standard operating procedure. The information is sent only to the assigned unit(s) MDT, but other units may manually call up the information from their MDT;
- The communications center is in the process of updating their CAD system. A vendor has been selected and system specifications have been submitted. There is a willingness to incorporate incident sharing capability with the TxDOT TMC into the new CAD system. The incident sharing capability will be a system design change and will therefore require a retrofit that will add a moderate cost to the original system’s expense. This cost might be picked up by the city, however, if the vendor exercises the option to charge a \$10,000 flat fee for specifications changes and some joint funding would probably be necessary; and
- A summary of calendar year calls for service which revealed that Mesquite 911 received calls on 847 major accidents, 2,095 minor accidents, and 901 unknown major/minor accidents in 1997. These statistics are for all facilities (freeway, arterial, local, etc.).

City of Garland 911 Meeting Summary

A meeting with a representative of the city of Garland 911 PSAP was conducted on June 11, 1998. This meeting lasted approximately 2 hours and it covered a variety of topics. The following list provides a summary of the significant findings and observations from this meeting:

- The physical layout of the communications center was 2 rooms with 4 call-taker stations in 1 room and 4 dispatch stations in the second room. The police response is divided into 3 dispatch stations: the first for calls north of Miller Road, the second for calls south of Miller Road, and the third for criminal, motor vehicle, and other database searches. The fourth dispatch station is assigned to the Garland Fire Department;
- The call-takers receive the incoming calls and enter the required information which for cellular calls requires more manual entry. They assign a priority based on the given information and then shunt the information over a local area network (LAN) to the appropriate dispatcher(s);
- The dispatcher(s) uses the radio and the Mobile Data Terminals (MDT) (800 MHz) to assign the necessary unit(s) to the incident site;
- The current CAD system will hopefully be replaced in the next 12 months. The new CAD system will be a Windows NT operating system with Intergraph mapping capabilities. It is likely that the new system will allow for external notification to TxDOT by some sort of automated medium such as alphanumeric pager or computer modem;
- There was an indication that the communication between the PSAP and TxDOT needed to be bi-directional. This is especially important when the city does not have the necessary resources (i.e., sand, upright air bag system, etc.) to clear the incident scene and needs to request these from TxDOT;
- The 1997 communications center summary statistics (i.e., number of calls, dispatch time, and total response time) for the police department is provided in Table B-1 below. In Garland, a major accident (i.e., an accident involving serious injuries or substantial property damage) is classified as a Priority I call.

Table B-1. Garland Police Department Summary Statistics			
1997 Averages	Priority		
	I	II	III
Average Dispatch Response Time	1.60	6.61	16.85
Average Patrol Response Time	4.56	6.01	6.61
Total Response Time	6.15	12.62	23.46

City of Plano 911 Meeting Summary

A meeting with a representative of the city of Plano 911 PSAP was conducted on June 15, 1998. This meeting lasted approximately 2 hours and it covered a variety of topics. The following list provides a summary of the significant findings and observations from this meeting:

- The physical layout of the communications center was 1 room. The room contains 5 operator stations in a hub-like arrangement and 6 dispatch workstations (3 police, 2 fire, and 1 supervisor). There are also 2 large television monitors, 1 for police and 1 for fire, mounted from the ceiling that display all of the active incidents and calls for service;
- There are 18 lines available for incoming 911 calls and operators are sometimes allowed to answer some of the non-emergency lines to the PSAP;
- The call-takers receive the incoming calls and enter the required information into the CAD system. They assign a priority based on the given information and then send the information electronically over a local area network (LAN) to the appropriate dispatcher(s). The appropriate dispatcher is determined automatically by the CAD software based on the assigned incident code (e.g., code 33 - burglary in progress would only be routed to the police dispatcher);
- The CAD system has exit number and reference mile marker information for the section of US 75 entered into the database so that operators can quickly locate a reported incident if a person provides them this information. The representative suggested that more prominent and frequent signs for location referencing would be helpful and that a public education campaign would have to be done;
- The dispatcher(s) uses the radio (2 voice channels) and the Mobile Data Terminals (MDT) (1 channel) to assign the necessary unit(s) to the incident site. Plano is looking to upgrade the communications system to Cellular Digital Packet Data (CDPD) or trunked radio and is also considering switching to laptops instead of MDT;
- The Transportation Department in Plano currently has cameras at 3 intersections;
- There is an agreement with GTE Wireless and Southwestern Bell Wireless for identification of cellular towers in Plano so that this information is displayed on the initial screen when a cellular 911 comes to the PSAP;
- The percentage of wireless calls ranges anywhere from 18 to 25% of their total 911 call volume. Their total 911 call volume for 1997 was 111,850, therefore approximately 24,000 of the 911 calls came from wireless telephones;
- Some police and fire personnel and all 911 supervisors have alphanumeric pagers. The PSAP has a teletype machine that is separate from the other communications equipment

that can be used to compose a message for the pagers;

- Wrecker service for Plano is bid every 3 or 4 years and is provided by 1 wrecker service;
- The current 911 telephone answering and switching system is being upgraded this year. The CAD system is planned for upgrade in the next 2 years; and
- Agreed that the logical course of action was to come up with requirements for TMC to PSAP communications so that the vendor of the next generation CAD can incorporate them into the communications software. In the interim, notification of TxDOT of freeway incidents might be feasible via the teletype alphanumeric pager for major accidents on freeway facilities.

City of Irving 911 Meeting Summary

A meeting with a representative of the city of Irving 911 PSAP was conducted on June 15, 1998. This meeting lasted approximately 1 hour. The following list provides a summary of the significant findings and observations from this meeting:

- The physical layout of the communications center was 1 room. The room contained 4 operator stations and 2 dispatch workstations for the police department. The police dispatch is split into two sections (i.e., north of SH 183 and south of SH 183) at night during peak call times. The fire dispatch is located in another facility several miles away. Not having fire and police dispatch co-located together has caused some problems and in some cases delayed the response time;
- There are 10 lines available for incoming 911 calls and the PSAP handles approximately 500,000 calls per year;
- The problem of location reporting from motorists with wireless phones seems to be heightened by the lack of landmarks. There is also a problem in jurisdictional boundary areas like near the Trinity riverbed where on the west side Irving responds, in the middle Dallas County responds, and on the east the city of Dallas responds;
- Suggested that *999 is a bad idea because this could just be delaying the necessary response from the properly trained public safety personnel;
- The Irving police use laptop computers instead of Mobile Data Terminals. The laptops provide an advantage over the MDT units because they have a greater information storage capability (e.g., can store a map of the area on the harddrive) and they allow the officer to query databases from their vehicle without having to call back to the dispatcher and use valuable voice radio time. The data is sent to the laptops in the field via a 800 MHz frequency that is restricted to 6 miles outside the Irving city limits;

- The current Tiburon CAD system is being upgraded with funds available during the latter part of 1998. The new CAD software should have the capability to notify TxDOT when the operator uses certain “activity” codes that indicate that the incident involves a freeway accident; and
- The logical course of action seems to be for TxDOT to specify what information they need from the Irving PSAP and then a practical link can be established. In the interim, a modem link could probably be established that sends an incident log form to TxDOT in the event of a traffic incident on a TxDOT freeway facility.

City of Richardson 911 Summary

A meeting with a representative of the city of Richardson 911 PSAP was conducted on June 19, 1998. This meeting lasted approximately 1 hour and 30 minutes. The following list provides a summary of the significant findings and observations from this meeting:

- The Richardson communications center was located in a separate building with the 911 PSAP equipment in 1 large room. The room contains 4 operator stations in a hub-like arrangement (a minimum of 2 are on duty at all times) and 6 dispatch workstations (3 police, 2 fire/EMS, and 1 supervisor). There are also 2 large television monitors; 1 has weather channel and the other scrolls through the cities cable camera system. The camera system consists of 30 cameras on cable links with some of the cameras monitoring the freeway (US 75 Central Expressway); however, most are placed at major arterial intersections. The cameras are primarily controlled by the traffic division; however, 911 dispatchers have the ability to control and position the cameras during incidents;
- Also suggested that the *999 idea would not work well and that the information should be first reported to the appropriate public safety and then, if necessary, the dispatcher can let other agencies such as TxDOT know;
- Richardson has a policy and methodology to notify neighboring cities via radio and/or phone; however they do not have pagers;
- Indicated that reference location signs would be good because the majority of the people do not know where they are when they call to report a traffic incident;
- There are a variety of CAD systems throughout the region that could make integration into a common information sharing database difficult. The city of Richardson uses CAD equipment manufactured by Applied Micro Technology. The cities of Coppell and McKinney and the Collin County sheriff all use the same CAD system;
- Police response personnel are dispatched by voice over the radio and via messages sent to their MDT. Fire and EMS personnel are dispatched by voice over the radio and they

receive, via modem, a printout of the CAD call screen to the fire station which allows them to take a hard copy of the incident information with them to the incident site;

- There are several planned equipment upgrades for the Richardson PSAP. The CAD equipment will be replaced at the beginning of 1999 and both the police and fire will be changing from MDT to laptops soon. The laptops will allow field personnel to receive coordinates of an incident via the CAD which will link to a map a display of the physical incident location. These new computers will also have the capability to store records on hazardous materials and other important operational data;
- Suggested that it would be nice to have TxDOT make portable CMS signs available for major freeway system incidents; and
- The logical course of action seems to be for TxDOT to specify what information they need from the Richardson PSAP and then an appropriate communications link can be established. In the interim, a modem link like what they currently use to dispatch fire and EMS personnel could probably be established to send an incident notification to TxDOT in the event of a traffic incident on a TxDOT freeway facility.