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POLICE COMMUNICATIONS SYSTEMS:
Applications and Trends

A RESEARCH PROJECT

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INTRODUCTION

Information management is a new name for an activity that has a long and fascinating history. The needs of commerce of over 6,000 years ago resulted in the invention of written language to record important data needed for commercial transactions, mainly inventory and shipment tallies.[1] As time went on, more formalized methods of recording, such as accounting, improved the quality and accuracy of the data and the communication of that information over distances.

Over little more than the last century, business has become more mechanized and automated. The first use of punch-card equipment, an often cited land-mark event, by the U. S. Bureau of the Census in 1890 is the first known use of (at the time) "technology solution" by government. Other important inventions contributing to the evolution of information management were adding machines, calculators, bookkeeping machines, and typewriters. In 1946, the invention of the first stored computer program (ENIAC) marked the beginning of the explosive growth in data processing.

The evolution of the computer has been marked by rapid changes in technology. The first generation computers used vacuum-tube technology. The problems of heat dissipation, large equipment size, and frequent equipment breakdowns were common. Transistors used in the second generation resulted in smaller machines, greater reliability, and lower costs. Third generation equipment using inte-

1 Keller, Werner, The Bible as History, Second Revised Edition, William Morrow & Company, Inc. New York, New York, 1981, pp, 28.

grated circuits was much smaller, much more reliable, and less costly. The fourth generation computers use large scale integration, with thousands of circuits on a single chip. Clearly, trends toward reduced size, lower cost, and improved reliability, along with the introduction of new internal architecture, will continue.

Business first used computers to reduce costs by replacing clerical positions with automated operations.[2] Forward-looking management recognized that automation could lead not only to greater cost savings, but also greatly improved speed and accuracy. Law enforcement has, to a large degree, followed the lead of the business world. Control of computer centers was usually placed in accounting departments (i.e., Finance and Administration), since the first major applications were accounting-oriented. However, capabilities of the computer to perform non-accounting functions eventually resulted in the formation of independent information systems departments (many have noted that this simply shifted control from the "bottom liners" to the "bean counters", as evidenced by the frequent clashes over the control of information and the allocation of fiscal resources).

The early computers were expensive, and modifications to buildings were needed to provide air-conditioning capacity, under floor cabling, maintenance access, and a tremendous amount of electrical power. The economies of scale favored large computers in central data processing centers. As the successive

2 Weaver, Jr. William C., in the Houston Police Department's Assessment of Operations Relative to the Dispatchers Division and Computer Aided Dispatch (CAD), Section II, Houston, Texas, 1986, p. viii, 7-11.

generations of computers appeared, both the physical size and the cost of computers dropped dramatically. This has weakened the centralization concept, and some enterprises have distributed considerable computing power to remote sites through the use of small, efficient, reliable computers linked in a communications network (which, as another paradigm, shifted control of information from central to execution level decision makers). However, the central processing staff and a central DP facility have usually remained in place. Central applications development is less costly and makes better use of trained personnel, who are now the expensive resource.

Though the business world has had a long history of involvement with information technology, the public safety community's experience with automation and information management (i.e. computers) is clearly less. The first use of the computer in support of a public safety objective traces its roots back to the 1960s (St. Louis, Missouri). The next major development in communications and computer applications to public safety occurred in the early 1970s, largely funded by the federal government through the Law Enforcement Assistance Administration (LEAA).[3] Finally, the most recent innovation of information technology for a public safety concern was the implementation of enhanced 9-1-1 telecommunications systems in the early 1980s.

Clearly, the communications industry on the whole has had an explosive growth with the expansion of nationwide and worldwide communications networks since

3 President's Commission on Law Enforcement and Administration of Justice, *Report on Science and Technology*, 1967, Washington, D. C., U. S. Government Printing Office.

World War II. Improved verbal and data communication were provided at lower costs and greater reliability. Computer and communication technologies are now rapidly merging into an exciting new area of information management. The trend has been to "get-as-close to the customer" as one can in order to meet (sometimes anticipate) his information needs rapidly. Information executive after information executive, public and private sector, agree that, today, their customer base is more diverse, more demanding and have higher expectations than ever before. The combination of computer and communications technologies are providing new, relatively inexpensive, creative ways to support the needs of this diverse groups of users (public safety, commerce, etc).[4]

Basic requirements of doing business in the information age are still the same: record data accurately, collect them in a meaningful way, archive them for considerable lengths of time, retrieve them, summarize them, and present the results to a decision maker. The data must be transmitted quickly, accurately, and securely. They must also be authenticated and stored compactly and inexpensively.

This report examines several key technologies and how they apply to a law enforcement/public safety perspective. Just as the ability to manage data in a rapidly changing technology is a key issue in corporate survival, so, too, is the ability to manage information in a public safety setting.

4 Kiely, Thomas, "How to be a GREAT Client Server", CIO Magazine, Volume 6, Number 16, CIO Publishing Inc., August 1993, pp. 30.

The material presented within this report is meant to provide the reader with a preliminary glimpse into this complex area. It should help in the dialog with the professional in information management and direct you to more definitive works.

But first, like all man-made developments, public safety communications has had a long and fascinating history. A brief chronology of the major developments in police communications systems will be presented for the reader for two reasons: First, it is instructive to know our roots and understand how our forefathers used these "new" systems to improve operations. Second, we will learn that, though times and the conditions we face are different, the basic premise for these systems is still the same: Protect and Serve.

HISTORY OF POLICE COMMUNICATIONS

The factor that has played the greatest role in law enforcement is communication. The history of its development is not long and continuous for man has been "communicating" for centuries. To be sure, the ancient Romans and Greeks had established very efficient forms of communication. Further, it was not until the British Parliament enacted the sweeping reforms of Sir Robert Peel in 1829[5] that police organization became coherent enough to make use of formal communicative facilities (i.e, Watch and Ward, Town Cryer). This first police force, of uniformed constables, had a day-and-night responsibility for keeping the peace and apprehending lawbreakers. In 1845, New York City established a force modelled after the Metropolitan London Police Force. Soon, other American cities followed suit. The following cites major milestones of the development and sophistication of police communications systems:

The Telegraph

Almost coincidentally with the establishment of professional police departments came the application of the electric telegraph to police communication. The Wheatstone and Cooke telegraph had been installed on most English railroads between 1837 and 1842, and not long after the telegraph was completed on the Great Western road was its usefulness dramatically demonstrated. A murderer, fleeing the scene of his crime, boarded a first-class carriage at Slough

5 Germann, A. C., Day, Frank D., and Gallatti, Robert R. J., Introduction to Law Enforcement and Criminal Justice, Charles Thomas, Inc., Springfield, Illinois, Pub., 1969, p. 54

(England). Once on the transport, the man breathed a sigh of relief, certain that he had made good his escape. Unbeknownst to him, a teletype message detailing his crime and his identity had been "flashed" to the next rail station along the line. Within three minutes from being sent, a return message announced the arrival of the train and the arrest of the suspect. The publicity given to this single event had dramatic results which were clearly felt in police circles. Little did this suspect know that his capture, via the aid of the telegraph, had given birth to a new profession: **Police Communications.** In 1846, the Central Police Station at Scotland Yard was connected by wire to the Central Office of the Electric Teletype Company, and shortly afterward the district police stations were also connected.

Without question, the development of district telegraph service in London and of the telegraph communication exchanges in various cities of the United States enabled citizens to get in touch with the police stations.[6] The rapid construction of telegraph wires between important cities also provided a means by which various police forces *could have* cooperated on police matters, though they did not do so. It was not until the formation of the International Association of Chiefs of Police (IACP) in 1893 that the provincialism and exclusiveness of numerous American police forces began to break down. In fact, the lack of cooperation between local and state police departments in the "war against crime" was one of the main reasons that led to the formation of this association.

6 Costello, Augustine E., Our Police Protectors, Third Edition, C. F. Roper and Co., New York, New York, Pub., 1885, pp. 31

When the telegraph was first utilized by police departments, the practice was to use licensed telegraph operators at headquarters to transmit and receive the Morse code signals. In 1858, the firm of C. T. and J. N. Chester constructed, for the New York City Police Department, a dial telegraph which enabled "common" police officers, who did not know Samuel Morse's signal code, to send messages over the telegraph network.[7] The use of the dial telegraph was adopted rapidly by other police departments. The telegraph dial was soon improved by the ticker in Chicago in 1876, and all station keepers, who were by now called desk-sergeants, were "required to take up immediate study of the Morse system of telegraphy."[8]

Although the telegraph was adopted for communicating between the precinct stations and central headquarters before the middle of the 19th century, the problem of communication between the precinct station and the patrolman on the beat received little consideration until the 1880s. Each shift of patrolman was assembled at its precinct station before going on duty, the orders of the day were read, and the men were marched to their beats by their roundsman. From that time until the end of the shift, each patrolman was essentially dependent on his own resources and isolated from the rest of the force - except at periodic meetings with the roundsman or patrol sergeant (sound familiar?).

7 O'Neill, Francis, What Science has done for the Police; or Modern Improvements in Police Methods. IACP Conference Proceedings, Volume 1, Number 10, 1903, pp. 67-72.

8 Ibid., pp. 71.

Consider the disadvantages of this system and the problems confronting the beat patrol officer. First, there was no way of knowing if the officer was diligently patrolling his (there were NO women officers back then) round. Every "popular" officer was quickly informed by his friends of the near approach of the roundsman. Second, the sharing of information about recent goings-on in the officer's beat was not possible. Nor was an officer available in the event of an emergency, unless he happened - by EXTREME coincidence - to be at the scene of the crime when it happened. If an officer on a beat needed help, he had great difficulty in getting it. He could use his voice, whistle or baton as a distress signal, but unless another officer was within earshot such signals were ineffective (which caused many beats to be very small). If the officer arrested a violent offender, additional problems were presented in that no method existed whereby he could call for a "paddy-wagon."

For centuries, people had thought of police work in terms of the petty constable or sleepy night watchman walking his round. The modern uniformed patrolman was merely viewed as a more efficient night watchman. What need was there for other police equipment than a badge and club, a pair of handcuffs and a whistle? (The gun came much later!) The chief duty of a policemen was thought to be making the rounds of his beat, suppressing crime by his presence (bigger was better), and apprehending criminals as he might "catch in the act." The need for a complex communication system which would serve as a central nervous system for the suppression and prevention of crime was not envisioned until after police organizations began to move from under the rigid control of political officials.

The first electric police communication system was installed in 1867, after the adaptation of the fire-alarm boxes to police purposes by the Gamewell Company (among others).[9] These police boxes used telegraphy and established one way communication between the officer and the precinct station. These devises were placed at strategic locations along the officer's route and were connected to headquarters or the precinct station. Some were placed against a wall or on a lamp post. Early versions favored specially constructed booths on curbs or street corners, in which the signal boxes were placed (Yes, it does sound like today's telephone booth!). Clearly, the introduction of the telegraphic police box ended the isolation of the officer on his beat and enabled him to utilize the reserve strength of the police force (early police stations had a barracks in the rear of the station where officers could sleep or a reserve force could be garrisoned). It did not, however, enable his headquarters to communicate with him. Nor did it place the officer or his department into better contact with the public. These advantages came later with the introduction and commercial application of Bell's telephone.[10]

The Telephone

The telephone was invented and perfected about the same time that the police began to adopt and install signalling systems. The telephone was to remain secondary and auxiliary to the telegraph for several years because it was in its developmental and experimental stages. Police departments did, however, have

9 The Milwaukee (WI) Fire Department still uses Gamewell boxes as a principal means of determining the location of fire alarms and as a means of communicating between fire stations and Fire Central.

10 Texas Advisory Commission on State Emergency Communications, Interagency Emergency Communications Instructors Training Course, Module 2: History of Public Safety Communications, State of Texas, Pub., 1992.

telephone exchanges soon after service was made available, especially in the smaller towns and cities which had not developed extensive telegraph service. At first, the police telephone did not differ greatly from the service as it was used by the public. Early pioneers of police telephone systems include:

City	Date	# Phones	Location
Washington, D.C.	1878	15 Lines	Headquarters, Superintendent's Home, Suburban community precincts.
New York City	1880	2 Lines	Two Precincts Removed in 1882 for Unknown Reasons

It is interesting to note that the New York City Police Department would remove their telephone "system" approximately two years after it was installed. However, after the following article appeared in the newspaper (circa 1887), the New York City Police Department joined the ranks of major cities with operating telephone systems:

> " ... this wonderful invention has been used for six years to connect the police central office in Brooklyn with the police stations ... and its advantages have been found too great to enumerate. If they (the New York police) wish to keep up with the times, they will put in telephones without delay. Doubtless the time may come when every patrolman's beat will be furnished with one of these instruments so that the policeman can at once give notice to the station of any occurrence demanding immediate attention."[11]

The telephone was used to supplement the deficiencies of the telegraphic police call boxes and thus establish - for the first time - two-way communication between the station house and the officer on the beat. According to available information, the first combination telephone and telegraph police call box was introduced in the city of Chicago (Illinois) in 1880 by J. P. Barett, then superintendent of the electrical department for the City of Chicago. The system

11 Editorial Section, New York Tribune, New York, New York, dated July 20, 1886.

was first installed in one of the most turbulent districts and *AT ONCE* increased the efficiency of the force, chiefly making it possible for rapid concentration of personnel at any trouble spot. So quick was its success that by 1893 more than 1,000 street stations had been installed all over the city, with several hundred private boxes besides.[12]

The value of the police telephone system was dramatically proven to the public by the prompt capture, through its use, of the perpetrators of a brutal murder. On the evening of September 2, 1989, two young men murdered Walter Koeller, while he was lying sick in his East Chicago boarding house. The suspects were spotted leaving the scene by the landlady, who screamed for an officer. Armed with a description of the suspects, provided by the landlady/witness, <u>in less than an hour</u> (that's right - an hour) every station in the city knew the type of crime and the description of the suspects. They were arrested by an alert officer several hours later in a railroad yard. Just a few hours after their arrest, Inspector Shea (Irish) had a full confession from both suspects about their involvement in the murder. In the words of the Chicago newspaper of the day, " *... by means of a new communication facility, a crime was cleared which might have remained a mystery, for had the men been successful in leaving the city, it is probable that they would have never been"* arrested.[13]

The Chicago system was quickly adopted by Milwaukee (1883) and Brooklyn (1884). Philadelphia soon followed in 1884. The next step in improving the telephone

12 History of the Chicago Police Department, Chicago (IL) Police Department's Police Museum brochure, undated publication.

13 Front Page, <u>Chicago Tribune,</u> Chicago, Illinois, September 2, 1989.

was the development of mechanical switching relays that could connect any subscriber to any other subscriber in the service exchange's area. Equipment was subsequently developed which would accommodate the grouping of lines of a large number of subscribers in front of the operator (the early switchboard or PBX). By 1896, there were several switchboard exchanges in use that could accommodate 5,000 to 6,000 subscribers (not a small feat for its day). Not surprisingly, the telephone began to rapidly replace the telegraph as the basic police communication system.

The Police Recall System:

From the need for a method by which headquarters could make known to the patrol officer on the beat its desire to communicate with him came the beginnings of a dispatch system. In the early 20th century, visual and audible signals were added to the police communication system by the ingenuity of a Los Angeles night watchman and the assistance provided by his wife. In 1905, Officer Charles Foster patrolled a section of West Adams Street on a bicycle, and was accompanied by a small fox terrier as his "partner." He arranged for the then Home Telephone Company to strategically install a series of red colored lights atop poles in his area. As part of his plan, Foster instructed his employees to promptly telephone his wife concerning any crime or community problem which should come to their attention. The lights were wired directly to Mrs. Foster's home and, *playing the role of desk sergeant*, she would signal her husband to call her to obtain the incident's particulars. Officer Foster's efforts mark the first known application to police service of the colored-light flashing system.[14] Mrs. Foster's assistance is also recognized as the first involvement of a civilian volunteer in police work - and police communications - as a police dispatcher. Initially only useful during the night time hours, the system that Officer Foster pioneered eventually improved with different types of electric globes and light reflectors that increased visibility by both day and night. Further improvements to the recall system made it possible to recall a single officer, several officers or all officers on duty at the time. The signalling system had the added benefit of actually decreasing costs to the police departments that used them.[15]

Motorization and Radio Communication

The development of wireless communication toward the end of the 19th century, together with the growing use of motor vehicles, gave rise to completely change police practices and techniques. In less than 50 years, the police profession had gone from using night sticks to signal each other to being able to communicate and travel great distances. Police officers had moved from foot patrol, the telegraph, call boxes, and signal equipment, to wireless communication and cars.

First came the car. The use of the motor vehicle as a form of transportation for police officers presented a universal means of rapid transportation, but greatly complicated the problem of fighting crime. Improvements to the vehicle

14 Leonard, V. A., Police Communication Systems, Publication of the Bureau of Public Administration, University of California, Berkeley, California, 1938, pp. 17-19.

15 Gravenor, E. A., A Modern Police Signal System, International Association of Chiefs of Police, Proceedings, Volume 18, Number 76, 1911, pp. 9

itself, in addition to mass production, made it possible for an amazing number of persons to become qualified drivers. Criminals, appreciating the possibilities of motor transport (they may be dumb criminals, but they ain't stupid, ya' know), soon found that speed and maneuverability offered by the automobile greatly assisted in their escape. Enter the mobile patrol force (without a means of communicating while in the car).

Radio (or Wireless) Communication

The first use of wireless communication in police circles mirrored its use in the (then) commercial environment: As a means of communication with police patrol steamers (vessels) by the Police Commission of New York City. Development of the wireless into a land-based system did not occur until after World War I (circa 1918).

The first radio station licensed for police use was granted on June 11, 1920, to the New York City Police Department (call sign K-U-V-S). Almost simultaneously in different sections of the country, individual departments began to experiment with this new and promising instrument of communications. Clearly, the early radios were crude, but the hopes of their agency were high.

However, as with any form of innovation, apathy, inertia, even opposition had to be overcome by the visionaries of police radio development. It is not surprising, then, that open skepticism met the first proposal to experiment with radio apparatus as a device for police communication. To some, it seemed impossible and very complicated. But to those who understood and appreciated its potential, they saw the radio as a smooth-running machine of great potential in suppressing crime and upholding law and order. Nevertheless, as late as March 1927, the following editorial appeared in a prominent American police publication:

> *"One of the bright prospects that appears to have become a disappointment is that of the use of radio as an auxiliary to police work. Yet it is not certain that the failure is a permanent one and the lack of results up to this time may prompt some genius to bring out an idea which will turn failure into success....Despite some very valuable instances of crime apprehension through radio alarms, the fact remains that the more profitable use of the radio is still a standing police problem."*[16]

The first **TRUE** attempts to use radio broadcasting in police work, information was sent "broadcast" over a commercial radio station which offered their services in the public interest (the fact that they advertised their broadcasting of police radio calls had nothing to do with it) or over some other private sector station operating in the public-domain entertainment frequency bands. The disadvantages were clearly obvious. Information about the activities of the police was received by everyone equipped with receivers tuned to that particular frequency, including the criminal, the citizen and the police officer.

Other disadvantages included the lack of understanding of police practices by the entertainment broadcasters. Broadcast radio meant entertainment, and many radio operators were reluctant to "break-in" while a particular song was playing, or while a popular (and profitable) product's commercial was being

16 It is believed that the source of this commentary on the effectiveness of police radio was the March 1927 Edition of the Police Chief magazine, a publication of the *International Association of the Chiefs of Police*.

aired. The time-interval (or queue delay) in putting the call on the air that it defeated any benefit the radio broadcast might have had.

Clearly, though there were many problems with (and competing interests between) the entertainment world and the police needs for radio communications, many commercial stations displayed a keen sensitivity to the needs of law enforcement in placing their facilities at the disposal of the police when the need arose. Eventually, police departments justified the need to install and operate their own radio transmitting facilities.

The years 1926 and 1928 represent a significant period in the history of police communications. Experimentation by agencies was widespread and many departments constructed transmitters and receivers from parts assembled with the aid of local (ham) radio amateurs.

The operation of a radio receiver in a moving vehicle presented an entirely different and perplexing problem. Little or no technical material had been written on this phase of radio reception. Needlesstosay, progress was very much trial and error. Road shock (the roads were terrible), constant change of position, interference of electrical circuits from the car and from external sources, signal fade, and other problems needed to be resolved.

One of the pioneer agencies in the field of police communications was the Detroit (MI) Police Department. Here, Commissioner William P. "Silver Bill" Rutledge seized on the idea of radio communications and the police early in 1921, just at the beginning of commercial broadcasting. Because the results were poor (an understatement if there ever was one!), the station was closed in the spring of 1927. In the fall, Commissioner Rutledge placed a former motorcycle officer, Kenneth Cox, in charge of radio development. Officer Cox, a former engineering student, had two highly experienced ham radio operators to assist him in the development of the project. By April 1929, he had completely re-worked the radio system, installed new equipment and developed a material that would later become one of the key operating components of the mobile police radio: the super-heterodyne fiber. The system developed in Detroit by Officer Cox and his assistants, of broadcasting over a short-range station, information to cruising police cars equipped with radio receivers tuned to that station alone is, in essence, the system in use throughout the law enforcement world today.

The value and speed of communication in the detection of crime and the apprehension of criminals was becoming increasingly recognized by police authorities throughout the world. Police radio stations and police operations (and police effectiveness) grew in leaps and bounds. The "rush to radio" was clearly on. This unexpected expansion of the new means of patrol communications was accompanied by even more astounding achievements in officer performance. Eventually, automobile reception was improved and transmitter effectiveness (and range) increased, which increased further the feats achieved by line patrol officers (it was said to be quite vogue to have the label *RADIO PATROL* prominently affixed to the side of all patrol cars as testament to the status and effectiveness of the agency).

However, it was not until the years of World War II that police radio communications, most notably field communications, would be developed by a company whose name is synonymous with the radio technology: *Motorola*.

America's entry into the war brought the country out of the Great Depression. Between 1941 and 1945 employment in the radio industry rose by a factor of five, while aggregate net earnings rose by a factor of 20. The new mechanized, mobile style of warfare intensified the development and application of radio communications and radar technologies. For the first time, the radio industry was designing and mass producing sophisticated electronic equipment (production of consumer radios had been halted by the War Production Board). Standardization of components, miniaturization, and the application of scientific talent to equipment design and manufacturing characterized some of the significant technological changes ushered in by the war. The wartime demands on technology and production transformed the radio industry into the electronics industry. The contributions of the Galvin Manufacturing Company (later to be renamed Motorola Communications Corporation) during the war years are many. The most significant to police radio communications include improvements in design, reliability and coverage of portable field communications units. Specifically, the Handie-Talkie or personal portable radio.[17]

The police radio is today recognized as the basic component of a police command and control system. Via the radio, police officers respond to calls, report their arrival, report their departure and respond to queries concerning their

17 Lubar, Steven, History of the Radio and Electronics Industry: A Background Report for the Motorola Museum, April 1988, pp. 9-13 and Schuster, Eric, Exhibition Guide to the Motorola Museum of Electronics, February, 1993, Section 5, pp. 1-3

location and status. Supervisors and managers can direct their subordinates to certain locations, instruct them to perform certain tasks and question them about various matters over the radio. Messages received over the radio provide police dispatchers with information on which patrol units are in and out of service and which units are believed closest to the scene of an incident. During a critical incident (high speed chase, crime in progress), the police radio becomes a tool for coordination and control.[18] Yes. It would appear that some genius had appeared on the scene and turned "... *failure into success*."

18 Sheehan, Robert, Cordner, Gary W., Introduction to Police Administration, Second Edition, Anderson Publishing Co., Cincinnati, Ohio, Pub., 1989, pp. 418-419.

POLICE COMMUNICATIONS SYSTEMS
Applications and Trends

Public safety communications and police command and control applications have been influenced by three critical factors: 1) the active role assumed by the state and federal governments (and, increasingly, municipal agencies) in encouraging the adoption of new technology based systems; 2) the availability and use of advanced computer systems and information technology to address public safety needs; and 3) a strong desire on the part of public safety agencies to improve performance of their communications, command and control systems.

Initially proposed as a research project, but later changed to a report format at the suggestion of Professors Killingsworth and Alexander, this report addresses six (6) major communications and information systems used in public safety operations. They are Computer Aided Dispatch (CAD) Systems, Mobile Digital Terminal (MDT) Systems, Automated Vehicle Location (AVL) Systems, Enhanced 9-1-1 (E/9-1-1) Telecommunications Systems, Geographic Information Systems (GIS) and In-Field Data Entry (LapTops).

COMPUTER TECHNOLOGY

Contributing to the growth in computer technology in public safety operations has been the steady decrease in the cost of computers, accompanied by increased computing capabilities. Device miniaturization and more efficient memory media have accelerated the change in computer technology. Computers no longer need to be used as systems unto themselves, but can be effectively used as components of larger systems - such as command and control applications.

Despite the implementation of the technology, the large majority of computers used by public safety agencies still perform routine applications in which technology is used to carry out straightforward, repetitive information processing activities (maintaining traffic records or real-time inquiry files). When computer use extends to non-routine efforts - such as resource allocation models or computer aided dispatching (CAD) systems, in which the machine begins to become a tool for decision making, control and strategic planning[19] - the results have been (unfortunately) disappointing.

19 Casey, Michael T., "Computer Aided Dispatch and the User," APCO Bulletin, Associated Public Safety Communications Officers, Inc., South Daytone, Florida, November, Pub., 1979, pp. 10-11.

COMPUTER AIDED DISPATCH (CAD)

Computer Aided Dispatch (CAD) systems involve the computer in the process of handling service calls from the public, in making decisions as to which unit(s)/officer(s) should be dispatched to an incident, and in making appropriate adjustments in the status of other units, as necessary. CAD systems do not - by themselves - completely automate the normal handling of service calls from the public, but instead make use of their unique capabilities to enhance the receipt and handling of calls for service.

CAD systems generally assist the receiving operator (call taker) by verifying incident-related information to the extent possible and checking to see if certain required information has been entered. Most CAD systems also automatically determine the service area in which the incident is located and assigns a case/incident/event number and priority to each call. If the address has a dangerous or unique history about it, the system also displays this information to the call taker and (generally) records the same data to the dispatched call record. After acceptance, the incident is then routed to the appropriate zone or area service dispatcher for assignment to a field resource.

Based on the status and anticipated locations of available units (or information received from other system inputs), the CAD system typically recommends to the dispatcher several possible units/officers to dispatch (depending on the type and urgency of incident being dispatched). Once dispatched, the CAD system automatically records the dispatched time, the time the unit arrives on the scene, and the time the unit becomes free (in-service).

CAD systems also assist the dispatcher (and management) by keeping track of the status of all incident and all units, and provides the dispatcher with instant recall of dispatch data.

Without question, a CAD system serves as the heart of the command and control process. It provides direct assistance in the dispatch process through the incident and dispatch-related information it provides, and allows public safety agencies the potential for increased control over their command and control operations. Further, because CAD automates much of the dispatch process, it provides a basic framework for bringing together many other communications, command and control (C^3) related technological innovations. Clearly, the trend has been for agencies to install CAD before MDT and AVL/M systems, and CAD has been more widely accepted than either MDT or AVL/M (see Note below).

NOTES:

MDT systems are widely accepted in law enforcement operations as a communications, information and productivity enhancement tool. They enjoy a high degree of user recognition of their potential and their worth as 1) user interaction with these systems is high, and 2) personnel readily recognize their value to their operations and the systemic contributions to personnel safety offered by these tactical systems.

AVL systems, <u>on the other hand,</u> do not enjoy the same level of acceptance. AVL serves no other "useful" purpose than to report the location of a field asset to Headquarters. Though their contributions to the efficiency of the dispatch process is clear, line personnel - especially police personnel - view an AVL system as a high technology "snitch."

A Operations Overview of CAD

Computer Aided Dispatch (CAD) Systems perform three fundamental activities: 1) It receives commands from users and, typically, receives messages from remote systems; 2) It processes commands and messages, and maintain the system database (files); and 3) It sends messages to users and to remote systems.

CAD systems are comprised primarily of three physical components: the computer(s), the network(s), and the terminals. While actual system configurations vary, all configurations possess the following central components:

- o The computer is at the center of the CAD system. It is the component that processes and stores all information communicated through the network. It also electronically supervises system activity.

- o The <u>computer</u> performs predetermined routines or procedures in response to commands (instructions) received from a system user terminal (call taker, radio dispatcher, remote user, etc) via the communications network. These routines and procedures are a part of what is referred to as computer programs, or "software". The software (programs) instruct the system on how to function[20].

- o The <u>network</u> is the communications component that connects the users to the computer and provides access to remote computers and communications systems. For example, a remote system might be a Records Management System, remote criminal justice and motor vehicle data base, an Enhanced 9-1-1 telephone system, or a mobile digital communications system (MDT).

- o The <u>terminal</u> is the component that allows a user to communicate with the computer as well as to communicate with other users and other information or communications systems. Typically, the terminal is the user workstation comprised of a video display and keyboard, but may also include components such as a printer, or a mobile data terminal (MDT).

20 Capron, H. L., <u>Computers and Data Processing</u>, Benjamin/Cummings Publishing Company, Hartford, Connecticut, 1982, pp. 281-282.

Computer Aided Dispatch (CAD) systems are implemented by public safety agencies in order to bring stability and a high degree of efficiency to their critical communications and command and control objectives. Clearly, standardization, simplification and flexibility are the central concepts of state-of-the-art CAD systems.

Properly designed and implemented, CAD systems afford management unparalleled flexibility in providing for dynamic calls for service requirements and resource management needs. Consider the following implementation benefits (see Attachment A for additional information):

- CAD systems incorporate the flexibility to modify response suggestions as the agency's demands and field resources increases or decreases.
- CAD systems provide the ability to create a unique incident definition and incident response plan for each service demand presented to the agency.
- CAD systems provides communications personnel with a dispatch priority for each incident type and support manipulation of priorities within specific, tightly controlled parameters.
- CAD systems - as a decision support tool - assist the communications operator with the ability to set a different overtime warning at each change of incident status (i.e., waiting, dispatched, enroute, onscene, closed) for each incident managed by the agency.
- CAD systems support communications personnel in maintaining responder (officer) safety, hazardous materials information and contingency plans, and other key location history data for variable time periods based on location.
- Finally, CAD systems maintain a detailed audit trail of each operator transaction performed to a call for service, field initiated activity or field movement (traffic stop, inspection, etc).[21]

21 Planning Research Corporation, Functional Description, Computer Aided Dispatch, San Francisco, California, Pub., July 1990, pp. 1-6

CAD systems provide the framework for bringing together many new tools through the partial automation of call answering, incident processing, and unit dispatching activities of the public safety communications center[22]. CAD systems automatically match the address of a call-for-service though a computerized geographic file, and instantly recalls pertinent information related to the incident, the location or both. This information, either strategic or tactical in nature, improves the decision-action dimension of the public safety communications operator.

Call Taker Operations

Complaint entry operation is one of the most significant aspects involved in the operation of the CAD system. The operator's workstation (in the generic sense) is usually built around the usage of a single (normally) color terminal and a 110 key keyboard as the primary user interface.

A. *Location Processing* - The ability to ensure that the proper location of incident is logged (dependent on information available to the operator and known by the caller). CAD systems check for duplicate calls to the same location, the status of calls already generated a defined geographic area (i.e., beat, zone), and the case number and code type given to the call.

   NOTE: Location processing is much easier when an E/9-1-1 call's ANI and ALI information is available (See E/9-1-1 for additional information). In this case the location of the call and the phone number used to place the call is automatically given to the entry clerk.

B. *Automatic Assignment of Case Number* - CAD systems automatically assigns a case number to all incidents requiring dispatch of a field unit or archiving tactical or strategic information for later use.

22 Andriole, Stephen J., Black, Harlan H., Information Technology for Command and Control: Methods and Tools for System Development and Evaluation, IEEE Press, New York, New York, Pub., 1991, pp. 170.

C. *Ability to Supplement a Event/Call* - Operators have the ability to supplement existing and OPEN calls for service. Entries made are automatically appended to the incident. Call status which may be supplemented are: **WAITING, DISPATCHED, ENROUTE, ARRIVED, HELD FOR UNIT, HELD FOR TIME.**

D. *Ability to Cancel Event/Call* - The call taker also has the ability to cancel an existing call that has not been dispatched by knowing the call case number or the call's physical location.

E. *Ability to File an Advisory Event/Call* - A formalized method for "putting it on the record" without the physical dispatch of a unit. This format is used to assign a case number where no action is to be taken but only information is to be recorded.

F. *Automatic Routing to Appropriate Dispatcher* - After all information is obtained and the call slip is generated, the CAD system will automatically send the call to the appropriate area or zone radio dispatcher. This routing is based on directions found in the geographic database.

G. *Event/Call Acceptance Verification* - After all information is collected by the operator, entered into the CAD complaint mask, and the operator has instructed the system to act on the information supplied, the CAD system processes the information, checks for jurisdictional compliance, and, if appropriate, sends the call to the area/zone dispatcher for assignment[23].

Radio Dispatcher Operations

Unlike complaint entry operation, which focuses on the successful completion of one incident before initiating the next in line, radio dispatchers are responsible for processing and managing multiple incidents and coordinating and monitoring the activity of an area's compliment of field personnel.

Depending on the area serviced, a single radio dispatcher can be responsible for a wide range of units with an equally wide array of specialization and need.[24]

23 Weaver, Jr., William C., Differential Police Response - Group I Task Force Report, Houston Police Department, February 1991, pp II/1.

24 Weaver, Jr. William C., Communications, Command and Control of the Houston Police Department: A Executive Overview, January 1987, pp. 11-15.

The radio dispatcher is assisted by a panoply of communications and computer support designed for speed, accuracy and dependability.

Command and Control: *The Dispatcher's Workstation*

The radio dispatcher's workstation is (normally) built around the interconnection of a high resolution color terminal(s) and a 110 key keyboard as the primary user interface (some vendors are using mouse drivers in addition to a keyboard interface). Actions input from the keyboard drive what information and status changes are displayed on the dispatcher's terminal(s). This action-update-status-action interchange is a key responsibility for the area radio dispatcher. Clearly, the radio dispatcher's responsibilities can be segmented identified as Dispatch Processing, Unit Monitoring, Field Status Information, Assignment of Case Numbers, Information Resource, Ability to Enhance/Cancel Complaint, Ability to Append Location Information, Ability to Access Key Response Files, ReDirection of Incidents to Appropriate Area, and Other Communications and Information Support. A brief description of each follows:

A. *Dispatch Processing* - The responsibility to dispatch calls for service by priority and unit availability is the primary focus of the area dispatcher. His/her job is made easier by specially designed programs which monitor pending assignments and presents them to the dispatcher for dispatch consideration based on a logical numeric based priority schema.

B. *Unit Monitoring* - In addition to the dispatch of field units, radio dispatchers are responsible for "following" the operations of each field officer within his/her area of responsibility. Detailed procedures and standing orders have been developed to ensure that field personnel maintain communications with their dispatcher and appraise the area dispatcher when their status or location changes (excluding obvious exceptions).

Monitor functions are made easier by a number of user defineable timers which notify the dispatcher to check on the status (safety) of a field unit in relation to specific dangerous or high risk activities (traffic stops, pedestrian checks, etc). These timers, and the dispatcher, maintain continuous watch over field activities until the unit/officer has completed the assignment or task which invoked the timer.

C. *Field Status Information* - In addition to unit monitoring, the radio dispatcher is also responsible for ensuring that information from the field concerning hazardous and/or dangerous conditions is passed to the appropriate response agency for disposition. Field conditions such as inoperative traffic lights, flooded or frozen street surfaces, debris in roadways, burst water mains, and literally anything that could pose a hazard to pedestrian and vehicle traffic is relayed to the dispatcher for corrective action.

D. *Assignment of Case Numbers* - The CAD system assigns case numbers to all incidents requiring dispatch of a field unit, as well as critical and/or sensitive incidents discovered or initiated by in-field personnel. It is the dispatcher's responsibility to accurately record the occurrence and disposition of these incidents, as well as correctly classify any improperly coded event.

E. *Information Resource* - Any radio dispatcher, given proper security clearance, is capable of accessing a number of key databases to assist field personnel in their investigations. They include, but are not limited to, NCIC, NLETS and InterPol.

F. *Ability to Enhance/Cancel Complaint* - The radio dispatcher can cancel response to an incident, as well as enhance response to any incident. The radio dispatcher has access to a significant amount of incident, unit and field information and can easily discern possible duplicate incidents, or incidents originally reported as minor but now may pose a threat to life and/or property.

G. *Ability to Append Location Information* - The dispatcher can append important tactical and/or strategic information to specific or general service locations (as in the hundred block or the exact address) for access at a later date.

H. *Ability to Access Key Response Files* - Each radio dispatcher has access to a full range of specially developed information files designed to support and compliment actions required in the field. These include chemical specific HAZMAT response information, various user defined files (PHONE, INFO, ALARM) and key local want/warrant information (GB, Message Center Interface).

I. *ReDirection of Incidents to Appropriate Area* - The dispatcher has the ability to re-direct incidents to another dispatcher for handling, or correct improperly directed complaints for the appropriate area dispatcher's processing.

J. *Other Communications and Information Support* - The dispatcher has additional information and communications systems at his/her disposal and can call them into action when needed. These include offense report information systems, direct communications with divisional and/or administrative offices of any unit in the Department, and communications to any unit in the field.[25]

Special Communications Equipment

Working independently of the CAD system (though it can be an integrated into it), each radio dispatch position is equipped with a wide array of communications capabilities specifically designed to support field operations.

Radio and Telephone Communications

- *Radio Communications* - The full spectrum of radio communications channels assigned to the agency is provided to each dispatch position and can be called into play on demand. Individual channels, channel combinations, or full and total systems activation is possible through the radio interface (i.e., alpha numeric keypad, touch-screen, button selector console).

- *Telephone Communications* - Each position also has access to a full range of telecommunications capability. Individual dispatch positions can be assigned a specific number of telephone lines and, when the position is activated, these lines and channels are automatically "enabled" for that position's exclusive use. This enables maximum utilization of the agency's telephone lines and ensures constant access to external communications lines by operations personnel.

Advanced Training Systems: On-Line Tutorial Assistance

The Houston Police Department was one of the first public safety agencies in the United States to develop a comprehensive, interactive call taker and radio

[25] Weaver, Jr., William C., Differential Police Response - Group I Task Force Report, Houston Police Department, February 1991, pp II/12-14.

dispatcher tutorial training program. This on-site training delivery system provides continuous 24 hour training access to personnel assigned to the various operations shifts. Increasingly, tutorial training systems are being implemented by agencies in the dispatching systems for their cost effectiveness, and their demonstrated utility in maintaining dispatching skills and effectiveness.

Clearly, the tutorial training delivery system reduces the time required to begin production training of new personnel (beyond the operation of the workstation and into work specific areas). The tutorial also affords the added benefit of being on site, where personnel can selectively train during slow activity periods and, if necessary, pause training and return when work demands permit.[26]

[26] Houston Police Department, Bid Specification - Computer Aided Dispatch System, September 1984, Attachment A, Section 6, pp. 217.

CONCLUSION

The first full time computer "assisted" dispatching system was installed in the St. Louis (MO) Police Department in 1963. This crude system simply streamlined the manual method previously used by the Department and did little to "automate" the dispatch process. It was not until focused research and funding by the Law Enforcement Assistance Administration (LEAA) in the early 1970's, as a result of recommendations in the Task Force Report: The Police, that true *automated* systems, as we now know them, started to appear on the police communications landscape.[27]

Since that time, systems have evolved from cumbersome, complex computerized conveyor belts that did little more than electronically "move" a call from the call taker to the radio dispatcher, to the current state-of-the-art high performance, full function, decision support systems and tactical operations platform of today. CAD systems have been well received in the departments that use them and, depending on who you talk to, the system has met its original implementation objectives. Clearly, Tien and Colton (1979) indicate that the use of CAD technology is undoubtedly a permanent part of law enforcement operations.[28] Additionally, the authors also point out that many departments have not realized the full potential of their police CAD system due to a number of reasons. These include ineffective (or non-existent) needs assessment;

27 The President's Commission on Law Enforcement and the Administration of Justice, Task Force Report: The Police, Arno Press and The New York Times, 1971, pp. 86-88.

28 U. S. Department of Justice, A National Assessment of Police Command, Control and Communications Systems, National Institute of Justice, Grant 78-NI-AX-0144, pp. ix.

poor identification of the philosophy and approach of C^3 applications; the agency's preparation of the Request for Proposal (RFP) identified current needs and had little consideration for expansion, technical developments in the field, and advanced operations; the agency relied on unsubstantiated or over-exageratted performance claims of the system (software) vendor; inability of the vendor to meet measurable levels of performance and/or reliability (without the leverage of liquidated damages); designing and implementing a CAD system without the considered input of operations personnel (who, after all, must use the system); and system stasis, or the inability to upgrade and/or revise the system to meet current demands.

Functionally, an effective public safety communications, command and control system must be able to monitor, *on an immediate and tactical basis*, the status of available resources so that appropriate actions can be taken to respond to the strategic needs that are identified. Additionally, on a longer-term or strategic basis, the system must be able to manage the available resources so as to ensure their productive deployment and use. In summary, the four basic functions of a public safety communications, command and control system are needs identification, field status monitoring (the full range of field dynamics - from field units to field conditions to changes in incident urgency), response/adjustment, and resource management.[29] Managers should keep these key issues in mind in defining functional requirements, issuing and RFP, and evaluating the proposals - and claims - submitted by vendors and consultants.

29 idib., pp. 30.

MOBILE DIGITAL TERMINAL (MDT) COMMUNICATIONS

Mobile digital communications provides a non-verbal means of transmitting messages between the communications center and specially equipped field units, and an automated method of accessing key public safety information files. Initially designed as a communications system, MDT systems have evolved into communications and information systems. The differences between the two are important, because the differences drive the underlying motivations (and project priorities) for implementation:

> Communications System: Facilitates communications among and between field personnel, their supervisors, and the Communications Center; designed to support tactical operations, and may involve one- or two-way communications,[with communications access to other operating systems (i.e., main frame systems)], and may be within a closed or open system.
>
> Information System: Include the communications functions and capabilities listed above, with additional access to key operations and user databases, database query capability for field decision support; may have some elements of automated data collection and report generation.[30]

Nevertheless, the basic elements of a Mobile Digital Communications system are a mobile digital terminal (MDT), which, depending on the sophistication of the particular system, could be a simple set of lights and status keys or a general alpha-numeric keyboard with a cathode ray tube (CRT) display. The system provides mobile patrol and investigative vehicles with rapid access to local, state, and national law enforcement file. The mobile terminals provide a flexible communications system for the transmission of administrative messages between officers, administrative and supervisory personnel, and communications support staff. Clearly, line personnel receive benefits from the use of the system in the following areas:

30 Sohn, R. L., Application of Computer Aided Dispatch in Law Enforcement - An Introductory Planning Guide, 1975, pp. 5.

Convenient and rapid access to datafiles: The officer is able to access a variety of persons, vehicular, stolen property and wanted suspect information[31] when he/she wants without the intervention of a radio dispatcher.

Digital dispatching capability: The officer can receive call for service and other assignments over the communications network. As a result, the officer can review all information related to, for instance, a call for service assignment and make tactical decisions regarding approach to the scene, identification of the complaining party, etc.[32]

Digital communications between mobile terminals and fixed terminals: If properly designed and implemented, field personnel can have unrestricted access to all administrative offices within the host police agency and within various concerned levels of city government (Citizen's Assistance Office, Emergency Management staff, Crisis Management centers, Airport Communications Centers, etc).[33]

Mobile-to-mobile digital communications: Mobile-to-mobile communications provide for improved officer safety, reduced load (and congestion) on conventional radio (voice) channels, and improved communications security.[34]

The MDT (the terminal itself) installed in vehicles is a rugged device specifically designed for the harsh vehicular environment encountered in law enforcement (temperature extremes, rapid starts/stops, etc). A highly visible, glare free display screen and a keyboard which cannot be damaged by liquid spills or dust contamination are two important features of any terminal selected for use by an agency.

32 National Crime Information Center (NCIC) Operations Manual, 5th Edition, U. S. Department of Justice, U. S. Government Printing Office, Washington, D. C., Pub., April 1991.

32 Houston Police Department, CAD Operations and Training Manual, Houston (TX) Police Department, Pub., January 1987, pp. 45.

33 Weaver, Jr., William C., Notes from Strategic Planning Work Shop, Houston Police Department, undated.

34 Houston Police Department, Bid Specifications, Mobile Digital Terminal (MDT) System and Related System Components, Houston (TX) Police Department, November 1982, pp. 7.

An MDT System Operations Overview

Reducing congestion of public safety voice radio frequencies has been a primary reason for implementing MDT communications systems in public safety applications. A second major reason for the interest in MDT communications is that many law enforcement, criminal justice, and public safety databases are computerized. A field unit equipped with an MDT can **AUTOMATICALLY** access these databases, perform various inquiries on demand, and generally interface with these systems at will without the intervention and assistance of an outside party (i.e., radio dispatcher). Other objectives[A] of MDT systems include:

- *To reduce voice congestion and expand communications capability of existing radio channels - using digital signals which have a higher transmission rate than voice signals.*
- *To increase personnel effectiveness through easier access to remote data files, which has the potential in resulting in more criminal arrests and property recoveries (to name a few).*
- *To increase dispatcher effectiveness by relieving the service dispatcher of routine data inquiries, field status updates, message repetitions, and/or dispatches of some non-critical calls for service (as high as 70% of total volume).*
- *To increase field personnel safety through an easier data base access, increased communications capability, and an EMERGENCY button on installed units.*
- *To improve message security using digital signals which are more difficult to decipher than voice messages.*
- *To improve accuracy and decrease message repetition.*

A - The implementation of any system, <u>especially one that impacts officers' productivity,</u> should be carefully implemented only after the input of end-user personnel has been sought. Experience has shown that "ram-rodding technology down the throats of officers" will render useless the best of systems and prove to be a waste of valuable resources, regardless of the laudable initial intention of the agency.

- *To allow selective routing of messages using terminals which can be addressed collectively or individually, on an as need to know basis.*

- *To allow unattended message reception using terminals that record and retain messages while personnel are out of their vehicle.*

Depending on the sophistication of the system, MDTs can perform the following functions without consuming valuable voice radio channel air-time and at the officer's discretion:

Forms Processing: Because the MDT is (normally) closely coupled with the agency's CAD system, forms processing allows the unit to easily submit queries and database information requests to the host computer without having to remember lengthy commands.

Event Initiation: Unit initiated incidents. Officers may enter on-view or self initiated activities. Individual status and location information is automatically on their controlling dispatcher's terminal.

Event Updating: Officers may update active (being serviced), closed (completed) or currently assigned events. The event record is updated and time stamped with the updating officer's unit identification.

Event Search and Recall: Allows the unit to recall or search for specific incidents by a given criteria. Event information may be recalled by any number of criteria, including date and time of occurrence, event number, assigned unit, disposition, etc.

Event Holding: Allows the unit to review pending/unassigned calls for service in his/her area of responsibility.

Digital Dispatching: Will send dispatch information to units automatically during the dispatch. Full location information is available, including location/premise hazard information (if any). All units assigned to the event have access to the same information, thereby increasing coordination, planning and knowledge of the event.

High Priority Notification: Automatically informs area units of location of incident, similar to a general broadcast or all points bulletin.

Unit Status: Supports unit status changes via the MDT. The dispatcher's status display is automatically updated. Again, the event record is also updated to complete the audit trail process.

Emergency Status: An emergency key is provided to indicate an emergency or other high priority situation. Can be activated by officer or citizen.

On/Off Duty: Generally restricted to supervisors. Allows the supervisor to manage his/her field staffing by logging on/off units, changing work assignments, and other personnel management actions.

Security: Access to the system is normally validated through a detailed user sign-on screen, complete with user identification and personal and system passwords. Some systems have a time-out feature that requires the user to log-on during after an extended period of inactivity.

Database Access: Form based and free-form driven queries. Forms allow the officers to perform multiple database queries via a single transaction; Free-form queries allow the officer to access databases not supported by a forms interface on the MDT (i.e., telephone numbers, hazardous chemical information, other information systems, on-duty skills assessment).

Messages: Most sophisticated systems have the ability to schedule messages for officers by unit number or employee number, similar to Electronic Mail (E-Mail).[35]

System Configuration

To be sure, the implementation of any public safety communications system is not a minor undertaking. As with all specialized systems, numerous vendors tote their company's product as THE solution to your communications and dispatch management problems. Clearly, reliability of the system, the track record of the vendor and the ease of use of the system are perhaps the three (3) most important elements in selecting a vendor.

Regardless of the vendor selected, certain common characteristics of an MDT system apply. These have to do with the physical architecture of the system and include the following:

35 Broward County Sheriff's Office, Communications Project Report, Broward County (FL) Sheriff's Department, Pub., January 1988, pp. 23-25.

- Host Computer(s): Generally employs two (2) computers to run the MDT application software. One computer has control of the system; the other is used as a report generator and "hot-stand-by" should the primary computer fail.

- MDT Controllers: Decodes and queues received messages, detects errors on received messages, transmits control over telephone lines or microwave links; acknowledges error free MDT messages, and encodes messages between the host computers and the mobile terminal.

- Transmitter Interface Unit (TIU): Provides encoding and interface between the transmitter and the communications line (telephone line or microwave link).

- Receiver Interface Units (RIU): Provides decoding and interface between the receiver and the communications line.

- Data Modems: Used in remoting the TIU and RIU functions. Can be analog, digital or both.

- Equipment Cabinets: Used to house the MDT Controllers and Modems at the central control site and should be equipped with forced air ventilation and positive air flow.[36]

36 Houston Police Department, Bid Specifications, 800 Mhz Mobile Digital Terminal (MDT) System Project, Houston (TX) Police Department, May 1985, pp. 35-38.

AUTOMATIC VEHICLE LOCATION (AVL) SYSTEMS

An automatic vehicle locating (AVL) system is an assembly of technologies and equipment that permits centralized and automatic determination, display, and control of the position and movement of vehicles throughout a defined geographic area. Generally, the area in which the vehicles (also called field assets) are to be monitored has been equipped with special monitoring or sensing positioning equipment (passive or active sensors). Clearly, the application of AVL engineering is not limited to road only vehicles confined to metropolitan areas. When properly equipped and engineered, any surface and some airborne, mobile vehicles (ships, planes, trucks, etc) can be automatically and continuously located. In fact, current state-of-the-art AVL technology offers the ability to "transport" AVL technology to tactical operations areas (i.e., battlefield) and continuously locate troop and vehicular movement. For instance, *Operation Desert Storm* used such a portable system to discern the location of foot and mobile military field assets. However, the predominant applications of automatic vehicle locating systems are those that arise from urban public safety, public transit, and commercial transport needs, which are most often support by the use of road vehicles.

Automatic vehicle position and movement determination is relatively simple: Vehicle location is accomplished by a process of periodic inquiry and response, initiated and controlled from what is designated as the central control facility, usually the Communications Center. The location of each of many operating vehicles is reaffirmed after the lapse of what is usually a preset interval of time, called a *sampling interval*. The length of this sampling interval is determined by the tasks assigned to the participating vehicles (location identification priority) and the number of vehicles in operation. The actual automatic position updating process is a series of steps, each providing a new unit location or a reaffirmation of a previous position when a unit has been stationary during the sampling period.

The position determination rate, also known as the *polling rate*, may be altered by the central control facility. A key operating flexibility of advanced AVL systems is the ability to increase or decrease the number of polled vehicles designated for AVL system monitoring. The ability to specifically designate which operating vehicles are to be kept under continuous system control provides an overall system capability that can be both responsive to routine system operating conditions by equalizing the polling rates on all operating vehicles or quickly switch to a continuous tracking mode on one or a few vehicles during unexpected emergencies or during specific tactical operations (i.e., sting operation, decoy vehicles).

Display of vehicle location data is most often accomplished by means of a (usually color) CRT, installed in the central control facility. It displays area and district street maps, overlaid with individual vehicle positions that evolve dynamically as the disposition of the polled vehicles change. Supplementary presentation aids may take the form of text, tables or printed tables of single unit movements that present street locations that have been passed and/or the time of passage.

Automatic vehicle location systems are installed for generally two reasons: **First,** they have a demonstrative impact on the monitored vehicle's operator actions, and **Second,** they provide significant secondary and tertiary benefits beyond just position information.

The type and criticality of service performed by the vehicles dictates the nature of the location control exercised. The method of AVL implementation is, however, universal: a radio link between a dispatcher at the central control facility and each to-be-polled unit. Similarly, the calculation of the position of the polled units is also standard: Mathematical calculations, generally through triangulation, are performed by the system to determine the last known position within the area monitored. In addition to conveying command instructions to the mobile units, the radio channel is very often used to carry vehicle-generated location data to the central control facility. These uplink-vehicle-position data vary in quantity and kind, depending upon the type of location technology used, and the complexity of the AVL subassembly carried by the vehicles (the actual location sensor or transmitter).

NOTES:

For an exhaustive analysis of AVL system use and methodologies, see *G. Larson, 1976; G. Larson and Simon, 1978; Hansen and Leflang, 1976; Doering, 1974; Mitre, 1973*, and *Aerospace Corporation, 1976.*

Major Applications of AVL Systems

The ability of automatic vehicle locating technology to maintain an automatic and, essentially, a continuous track at a central control point of a diverse, mobile fleet of vehicles has generated a range of potential applications. These applications may be classed into two broad categories: **Dynamic Fleet Dispatching** and **Protective Services.** Dynamic fleet dispatching, because of its impact on private and public sector operations, has received the greater emphasis in research and development and, not surprisingly, involves the lion's share of applications in use today.

Dynamic Fleet Dispatching

Dynamic fleet dispatching is most often associated with public safety operations, in particular, daily police and emergency vehicle dispatching functions. The ability to assign or reassign an active patrol unit, based upon an accurate knowledge of the current position of all in-field units, offers (potential) benefits that result from a decrease in emergency response delays and increased officer safety. *Conceivably,* decreases in emergency response times can be translated into more cost-effective service delivery systems through reductions in the size of a fleet allocated to specific areas of operation (i.e., zones, sectors, beats), lower operating costs per vehicle per mile travelled, and more effective utilization of vehicle resources through and a more effective distribution of vehicular assets within all service areas, **without** deterioration in service capability. Other, unplanned benefits may also arise as by-products of an AVL system: Radio dispatcher training and "canned" performance exercises can augment existing tutorial training systems with the addition of historical "tracked" data; Management and emergency response planners can reconstruct field status prior to, during and after major incidents as part of post-incident assessments; and Finally, internal investigations resulting from violations of operating directives can be effectively augmented through the use of accurate vehicle (officer) location information (i.e., beat integrity violations). Further, AVL technology offers the ability to "co-op" multiple agency resources and determine agency shared costs when the AVL system supports two or more independent public (or private) entities.

Beyond public safety applications, dynamic fleet dispatching is also of potential importance to 1) public transportation agencies such as those responsible for taxi and public transit i.e., bus, MetroLift, services, 2) municipal and privately owned public utility services, and 3) commercial fleet operators engaged in business/consumer product pickup, delivery, mail, and parcel transport services (i.e., hot shot delivery systems). In private sector applications, it is foreseeable that dynamic dispatching, based upon an accurate knowledge of each mobile unit's position, can contribute to decreases in vehicle response delays and increases in transport load factors. In public sector applications, shorter unit travel and response times for all levels of calls for service can be realized, in addition to providing management with increased control over vehicular field movements. Both achievements should favorably affect transport and service system-wide operating costs and capital requirements. These concomitant advantages to the use of AVL technology may become keenly apparent to taxi and to utility maintenance services operators responsible for the dispatch of large fleets of telephone, electric power, natural gas, and water utility service vehicles, either publicly or privately owned, over major metropolitan areas and that in the process consume significant amounts of time and energy resources.

Covert Police Operations and Protective Services

Covert police functions may also benefit from automatic vehicle location technology. Covert police and law enforcement/criminal justice agencies frequently must operate in disguise and occasionally under difficult, sometimes severe, communication constraints. A significant improvement in undercover officer safety is realized through the application of AVL technology when it is used to maintain a continuous track on unmarked mobile units on covert assignments. Clearly, an agency can more effectively "tail" a "decoy vehicle" after it has been equipped to interact with the monitoring Department's AVL system (i.e., auto theft sting operations, cocaine buy/busts). One can, from a secure distance, track the suspect vehicle to its end destination. And, the resulting track data can be used as convincing - and convicting - *de facto* evidence in criminal prosecutions.

Somewhat less apparent is the potential application of automatic vehicle location technology to the protection of road-hauled cargo. Valuable truck-carried cargo is constantly exposed to theft that can occur at any time during its transit. Automatically maintaining track on cargo-carrying vehicles throughout their movement in an operating area should provide two tactical protective advantages: First, if a vehicle operating under AVL system control is diverted from its scheduled route, an alert warning issued by the fleet dispatcher to the local police could initiate a rapid search for the "diverted" cargo. Second, a commandeered cargo carrier could become a very difficult object to conceal if its automatic vehicle locating system mobile unit remained activated. Thus, well-concealed and protected AVL system mobile equipment could provide clear and distinct tracking markers to aid the user in assisting police intercept and arrest operations. Further, such joint private sector-police operations are becoming increasingly common where the agency has AVL capability, due in large measure to the success AVL system have in tracking mobile targets.

Dominant AVL Methodologies

The methodologies of monitoring a large number of mobile vehicles have evolved largely from navigation technology.[37] However, unlike navigational system requirements, surface vehicle location needs do not include a presentation in each unit of an automatically determined position (as in a radar display). Rather, a location estimate from each vehicle or sufficient information to calculate its location must be provided to the central control facility. As a result of these distinctions, certain economies of scale and of investment are realized, principally with respect to the complexity and cost of the vehicle-borne apparatus. The generally recognized pressure to reduce total automatic vehicle location system costs, markedly influenced by the number of in-vehicle transponders or receivers required to outfit the monitored fleet, has favored

37 Beam, Walter R., Command, Control and Communications System Engineering, McGraw-Hill Publicshing Comapny, New York, New York, 1989, pp. 121-125.

the adoption of certain navigational techniques and adversely discouraged the use of others (LORAN-C, Intel-Sat, etc). Consequently, three generic navigational methods have become the roots for the presently available automatic vehicle location systems: dead reckoning, proximity detection, and radio signal time-difference-of-arrival determination.[38]

Dead Reckoning

Uses distance travelled and change in direction to determine approximate physical location. The devices frequently used to perform these measurements are *odometers and compasses.* Both instruments operate simultaneously to yield a continuous measure of the vehicle's travelled course relative to an initialization point.

NOTE: Experience has shown that AVL systems using dead reckoning as an implementation methodology can be easily confused if the vehicle operator causes the vehicle to make a series of rapid right or left turns, most common during high speed police pursuits. The vehicle simply "disappears" from the display screen and does not "reappear" until the on-board reference values have been reset.

Proximity Detection

Uses the navigational principle of fixed reference steering. Permanently installed radio frequency devices are distributed throughout the vehicle fleet operating area (normally limited to slightly more than the agency's principal jurisdiction). These devices, known as *radio frequency signposts* or simply *signposts*, are numerous and accurately positioned along the <u>possible</u> paths of vehicle movement (the more random the path, the more signposts are required). The number of signposts required are determined by the desired system positioning accuracy times the number of paths to be covered and the distance(s) between signposts per mile.

All mobile units are equipped with means to interact with each signpost upon approach. The equipment carried by the vehicles and incorporated into each signpost varies with the design, and may be classified into one of two methods: **Direct** or **Inverse** proximity. These category designations refer to the behavior of the terminal that transmits the vehicle position estimation data to the central control facility. *If the central control facility receives signpost passage data from each vehicle*, the designation <u>direct</u>

38 Ibid, pp. 123.

proximity system applies. However, *when these data are received via fixed signposts within the deployment area* the proximity system is know as <u>indirect</u> configuration.

<u>Direct Proximity:</u> Typically includes signposts that contain radio frequency transmitters that continuously broadcast very low power, coded signals. These coded signals provide a unique identification for each signpost.

All participating vehicles must carry specialized radio receiving equipment that can detect and decode the transmissions from any signpost when the vehicle is within the zone of signpost coverage (usually a diameter of 50-200 feet). The decoded signpost identity symbol is subsequently transmitted to the central control facility. An associated computer relates the signpost code designator with a geographical location and notes the time of signpost passage by placing a reference point for the vehicle on the appropriate display screen.

<u>Inverted Proximity:</u> Differs from a Direct Proximity application in two major respects: The vehicle neither senses the signpost presence and the vehicle does not communicate its estimated position to the central control facility. Rather, each vehicle operating in the system transmits a uniquely coded unit identification on a radio channel designated solely for automatic vehicle locating use. The vehicle transmission is continuous and at a very low power. Each signpost is equipped with a receiver tuned to the designated radio channel. Reception of the vehicle transmission causes the signpost to relay the vehicle identification symbol to the central control facility where the time of receipt is recorded and the symbol is correlated with a specific signpost whose location is known and displayed on a CRT.

For either configuration of an AVL proximity system, vehicle movement is presented as a series of step-position changes occurring <u>between</u> signpost locations. Obviously, the greater the distance between signposts, the lesser the reporting accuracy.

Radio signal time-difference-of-arrival determination:

Uses the time required and the distance travelled by a radio signal to a receiving source(s) as the primary method to calculate a vehicle's estimated location within a specific area of operation. Essentially, the system involves the use of a several geo-synchronuous satellites or ground based radio antennas to receive each reporting vehicle's transmitted radio signal and unique identification code. The signal is transmitted to the receiving source which, knowing the latitudinal and longitudinal dimensions of the coverage area, uses this information to calculate the location of the polled vehicle based on the time required for the transmission to reach its receiving source(s).

These systems can be designed to present a high degree of accuracy, and can report a vehicle's location as close as one meter (slightly more than three feet).

Agency Performance and AVL System Accuracy

Fixed route public transit and random route, fleet dispatching operations are potential metropolitan area users of automatic vehicle location technology. The importance of AVL technology to either service application rests upon the benefits it *may* provide as measured by 1) improved public service, 2) reduced capital investment and fleet system operation costs, or 3) increased public safety. It is the promise of enhancing public security that identifies public safety agencies as the dominant potential users of AVL technology for dynamic fleet dispatching. Although police agencies may benefit from the use of an automatic vehicle locating system in a direct and very visible manner, they are not the only tax-supported organizations that may effectively use this technology. Among others are emergency ambulance services and disaster response vehicles, which can be redeployed while on assignment and which may engage in (limited) patrol operations. Knowledge of the correct location of each field asset during a critical period of time can have a direct and significant influence upon the public welfare.

Improved customer service and lower capital and operating costs are important business considerations to commercial and public utility fleet operators. In addition, public safety is increased by the ability of commercial and utility operators to provide more rapid response to catastrophic interruptions of the water, energy, and communications facilities in a large metropolitan area.

It is necessary to measure the effect of automatic vehicle locating technology upon the operations of a fixed-route public transit, random-route public safety, and commercial fleet dispatching systems before attempting to conclude what contribution the technology may offer to each service function. The remainder offers an assessment of the influence AVL systems accuracy can have upon fixed route mass transit operations as presented through a determination of the interdependence existing between the location error variance and either vehicle headway or layover reserve. The assessment is also extended to random route dispatching operations for which response time to a service call is measured as a primary output of AVL system accuracy. For public safety vehicle operations, the additional aspect of officer safety is also reviewed by analyzing the performance of AVL system-supported dispatching of backup vehicles to an officer-in-distress request. By this method it may be shown that system location accuracy and vehicle response time are again closely related performance variables.

The presently available automatic vehicle location technology offers several methods for determining vehicle location and time of passage relative to a selected number of fixed route markers. The alternate automatic vehicle locating techniques vary in accuracy. For this reason, it becomes necessary to examine the interrelationships that exist between fleet movement control and automatic vehicle locating system accuracy.

FUNDAMENTAL CONSIDERATIONS

Random route vehicle dispatching operations are encountered in both government and private sector activities occurring within most industrialized and metropolitan communities. Police, ambulance, maintenance, and paramedic functions are the most frequently encountered and are the best known examples within the domain of governmental activities. Equally well known, though belonging to the private business sector, are taxi, short-haul delivery, public utility maintenance, and dial-a-ride or ride-share services. For the management of a vehicular fleet, the issue is commonly how to dynamically assign the available vehicles within the geographical area requiring service. The following question is clearly key in determining service standards: Should unit movements be rigorously confined to fixed zones or should assignments to overlapping territories be permitted when either close proximity to a service request or adjacent unit unavailability occurs? If the latter is favored, then the second question arises: How can this method of dispatching be implemented without the availability of accurate unit location data as a function of time? Thus, in answering the second question, managers are forced to examine the applicability of some form of automatic vehicle locating technology to their fleet dispatching operations.

The methodology of mobile unit assignment and movement, called patrol assignment in police work and territory assignment in commercial and industrial applications, reflects the incorporation of an automatic vehicle locating system. When no accurate, current data on unit location are available to the dispatcher, vehicle movement will (generally) be restricted to a small zone of the deployment area when a unit is not responding to a service request (called beat or zone integrity). The available/unassigned units may even be required to stop at known locations until assigned to a service request. With the availability of automatic vehicle location data, fluid, at-will unit movement represents no impediment to a rapid assessment of field position. Units may move throughout the deployment area, with the area dispatcher fully aware of their respective locations. It is this flexibility of movement, always under scrutiny of a dispatcher possessing the capability of immediate reassignment, that produces the unit response time savings. Two particular factors are contributory. One, with automatic vehicle locations system data available on all units, any vehicle may be dispatched within the deployment area with a high degree of assurance that it is the closest available mobile asset to the point of need and thus will consume the least travel time and energy reaching the intended destination. Second, it is unnecessary to wait for the conclusion of a service call before reassigning a unit operating in a dedicated zone to another call in the same zone. Rather, an available vehicle in an adjacent zone may be called, or the next adjacent if the first is busy. By this procedure, a reduction in average unit response time may be affected for, commonly, the contribution of average service time to the average unit response time is much larger than average travel time. The average response time is the sum of two terms, one proportional to the average queue delay in assigning the call to the selected mobile field unit(s) and the other proportional to the time required to reach the desired destination.

TRAVEL TIME FOR EMERGENCY INCIDENT SEARCH

Law enforcement agencies are beginning to provide patrol units with a means for transmitting an extreme emergency alert signal such as might be required if an officer were seriously injured, yet within reach of his radio, or if he were disarmed and threatened, yet able to inconspicuously activate a radio burst emergency transmission.[39] Emergency radio transmissions for use in situations of extreme personal peril, unlike normal voice radio discourse, typically are brief bursts that contain only a unit identification number and the alert warning. Historically, key unit position data are included. Rather, the central dispatcher must employ some other method to estimate the location of the distressed officer in order to direct an assisting unit to the officer's aid. Absent the use of an automatic vehicle locating system, the distressed officer's location must be estimated from a knowledge of his previous location, his normal assignment areas, or his last radioed location. Some radio coverage systems allow a technician to identify the location of the radio receiver that detected his emergency trigger transmission, thus narrowing the field of search (somewhat). Either method is time-consuming and clearly inferior to the advantages offered by an AVL system. With an automatic vehicle locating system in use, the derived position estimate will provide the dispatcher with the necessary geographic location information. This ability of an automatic vehicle locating system to expand the security provided by the use of a radio emergency trigger in police work is an important contribution to both officer safety and crime prevention.

[39] Conversation with Mr. Ed Lewis, Senior Account Manager, Motorola Communications Corporation, September 20, 1993, Hand-held Product Functionality and Technical Systems Design.

A second, though demonstrably less frequent, situation may be identified wherein an automatic vehicle locating system is able to provide a unique and vital function in public safety work. On rare occasions will a patrol unit be attacked without warning and the personnel incapacitated. More frequently, however, a patrol vehicle is "commandeered" by a *supposedly* incapacitated suspect who has managed to crawl through the divider separating the officer from the suspect. In either situation, no valid location data is available to the dispatcher except via the automatic vehicle locating system, if one is in use. Because no driver interaction is necessary to sustain the operation of an automatic vehicle locating system, the dispatcher will have available a continuous record of the stolen vehicle's movement upon which he/she may base an interpretation of the events and plan a sequence of counteractions.

OVERCOMING OFFICER RESISTANCE

Tien and Colton (1979) found that officers distrust any system that graphically displays their physical location for observation by management or their dispatcher.[40] Clearly, officers' greatest objections are to the continuously displayed map showing their location for all to see. Among reasons commonly cited for this resistance include, subordination of individual responsibility for one's assigned area, the "Big Brother" complex, and another way for management to "get" the officer. A few police agencies have implemented AVL systems only to have them subverted by cunning manipulation of the system by

40 U. S. Department of Justice, A National Assessment of Police Command, Control and Communications Systems, National Institute of Justice, Grant 78-NI-AX-0144, U. S. Government Printing Office, Washington, D. C., Pub., 1978 pp. 49-57.

their personnel, or, in more severe cases, outright sabotage of the system occurred.

However, Weaver (1987) proposed an alternate solution to this distrust of an AVL system, while preserving the integrity and value of the system to officer safety and dispatcher effectiveness.[41] Weaver proposed that the AVL system map, the primary focus of the officer's objections, be suppressed and "hot-keyed" when needed. Rather, the system would provide the key longitude and latitude geographic information to a computer aided dispatching (CAD) system which would use the vehicle's location coordinates in suggesting which unit(s) to assign to a particular incident. The area map would be called up as needed, much like one would do in a multiple session *WINDOWS* application. The map, with the units' location displayed, runs continuously beneath the surface until called upon by the radio dispatcher or communications supervisor.

FINANCING AVL SYSTEMS

To be sure, AVL systems can be expensive to implement and equally expensive to maintain. Maintenance costs increase with land-based sensors, as we discussed previously in describing direct or indirect proximity AVL system. However, if planned and sized properly, and using state-of-the-art technology, they can be paid for by "other" system users, users whose polling rates are less critical than those commonly found in public safety. The following is an example of such a system:

41 Executive Briefing Document: Futures Planning Report on state-of-the-art Communications, Command and Control Capabilities of the Houston Police Department, Houston (TX) Police Department, dated January 20, 1987.

The author is aware of an AVL system which can support a coverage area of 1600 kilometers by 1600 kilometers (or 25,600 square kilometers). Standard accuracy for this system is thirty meters (slightly more than ten yards). This means that, without modification or enhancement, the system can identify the location of a transmitting unit within 30 feet of its actual location. Such a system involves the erection of four ground based antenna towers and the installation of vehicle transmitting units operating in the 150 Mhz range in every vehicle to be polled by the system. As for capacity of the system, 4,092 units can be tracker with varying polling rates.[42]

Assuming that the host public safety agency must constantly monitor the location of 1,500 vehicles in the field. The highest polling priority would be given to uniformed patrol officer and patrol supervisor vehicles, emergency medical ambulance units (and only when outside of their station quarters), and other mobile units where location geographic information is considered a high priority. Consequently, these vehicles have installed in them the required transmitter communications equipment to broadcast their unique identification code on the transmitting beacon designated for AVL use.

Given that the capacity of our "shared system" is 4,092 units during a specific polling period, and 1,500 units have been assigned the highest polling priority available (let's say the poll rate is every 10 seconds), the remaining monitoring spectrum could be "outsourced" to:

1) other agencies within the government's structure and include such operations as the Traffic and Transportation Department, Emergency Management Services, Ground Transportation Services (bus, handicap lifts, etc), and

42 Houston Police Department, Product feasibility review and discussion group of Applied Micro-Systems' AVL product offering. Unpublished Internal Report, dated February 1992.

2) local utilities management and fleet dispatching systems (gas, electric, water, etc) and high profile private sector operations (e.g., armored car transport).

The system described above has a projected infrastructure cost of $850,000.00, which does not include the per unit expense of the in-vehicle transmitting units. Total costs would depend on the number of units produced and the accuracy required to support the target operation. (A portion of the covered area can be modified to pin-point a unit's position to within one meter of its actual location, for more money - of course!)

If 1,500 units are given the highest priority, and an additional 500 units are placed in strategic reserves, the position of the remaining 2,000 units (approximate) can be monitored at significantly less critical polling rates. At an average cost of $25.00 per unit per month, in addition to costs associated with leasing and installation of the in-vehicle polling units, the financial package could be structured so that a portion (10-15%) of the fees collected per unit is dedicated to maintenance and enhancement to the system. It's not hard to see that $50,000.00 per month could be collected monthly to offset the cost of maintaining the host agency's AVL system.

CONCLUSION

AVL technology is relatively new. As the technology becomes more advanced, and system costs decrease, increased use of the applications may occur. However, in order for these systems to succeed, management must be conscious of the reservations their line personnel have about these systems and re-think their implementation plans. For instance, rather than implementing an AVL system that CONTINUOUSLY displays the location of personnel, consideration should be given to 1) utilize the system's field unit location data (X-Y coordinates) to augment unit recommendations on calls for service without the aid of the area map, and 2) use the area display features of the system during (normally) short term tactical command and control situations (narcotics operations, vehicle pursuits, in-progress incidents, high-speed intercepts, etc). For unless and until the line officer sees these system as his/her ally, the promise of AVL technology for public safety will not be fulfilled.

NINE-ONE-ONE

An emergency single-number access system is defined as a *"telephone system that has a unique single telephone number dedicated to receiving emergency calls from the general public for one or more emergency services, such as fire, police, or ambulance."* This definition excludes the use of "0" for operator. This section of the report will address the most widely used (and most famous) three telephone number used to report emergencies: **9-1-1.**

Nine-one-one is the three digit telephone number by which a majority of the citizens of living in major population centers in America have direct access to an emergency answering center.[43] It is the number that has been designated for reporting an emergency and requesting assistance in any community in the United States that modifies its existing emergency reporting system to accommodate the number. By legislation, 9-1-1 is the standard nationwide emergency telephone number. Eventually, nearly every American citizen and visitor to the country who has access to a telephone could summon aid by dialing the numbers 9-1-1, regardless of the location, familiarity of the area, time of day or type of emergency.

NOTES: An excellent source for background information on 9-1-1 is *Nine-One-One/The Emergency Telephone Number: A Handbook for Community Planning.* Executive Office of the President, Office of Telecommunications Policy (Washington, DC, 1973).

Also, see a *Checklist for Communities Considering Emergency Single Number Access Systems* in 9-1-1 and Other Emergency Single Number Access Systems in Texas: An Informational Report, 1979, Appendix E.

43 Telephone Engineer & Management, 9-1-1 Industry Report: "Why and How '911' Can, Will and Must Work." June 15, 1970.

The philosophy of the 9-1-1 system straightforward and simple: *To make the number available to any community which elects to install 9-1-1, and facilitate communications with any emergency service(s) that the user community wishes to include in its response system.*[44] Clearly, the value and benefits of a single emergency telephone number have received such recognition through the various media (print, television shows, etc) that, soon, this *emergency single number access* system will be in-service in communities, large and small, throughout the United States (and its properties).

Countless number of lives have been saved through the use of the 9-1-1 system. Almost daily, one can read reports of the "miracles" facilitated through the use of 9-1-1 as choking babies are brought back to life, citizens are instructed over the telephone in CPR, and police officers, firefighters or paramedics give testimonials referencing the worth that 9-1-1 contributed to their successful operation.

Emergency single number access systems are not "new" systems in the sense that have been in use since the late 1930s. Great Britain was the first country to establish a universal emergency telephone number for its citizens in 1937. Since then, any person (citizen, tourist, etc) in the United Kingdom has been able to dial *9-9-9*, receive prompt response from an single emergency answering point, and have his request for assistance quickly and efficiently directed to the appropriate agency. Not long after that, Belgium introduced its emergency

44 Federal Communications Commission, Proceedings, Conference on Universal Emergency Number 911, U. S. Government Printing Office, Washington, D. C., dated, June 5, 1972.

single number access system (9-0-0). Denmark (0-0-0) and Sweden (9-0-0-0) soon followed. Although the selection of the particular agency to act as the answering point may differ from country to country or within a country, the concept of a single number, received at a central reporting agency, has been well accepted and has proven a quite effective component of the total emergency response mechanism.

The actual designation and use of the numbers 9-1-1 came as a result of the 1967 President's Commission on Law Enforcement and Administration of Justice report that recommended a single telephone number should be established nationwide for reporting (police) emergencies.[45] This report, plus recommendations by several other agencies, stimulated significant interest in emergency single-number access so that rapid movement was taken on several fronts in 1968:

- AT&T announced 9-1-1 as the designated single emergency number;[46]
- the first National Conference on 9-1-1 was held;[47]
- the first 9-1-1 system was installed in Haleyville, Alabama (population 4,000) by an independent telephone company;[48] and
- the largest city in the United States, New York City, provided 9-1-1 service to its citizens the same year.

45 Specific wording of the recommendation is as follows: *"Wherever practical a single [police emergency] number should be established, at least within a metropolitan area and preferably over the entire United States...."*

46 The Franklin Institute Research Laboratories, Proceedings, Consultation on the Single Emergency Telephone Number, March 18, 1968, FIRL Project C2217, Contract LEA 68-43, Philadelphia, Pennsylvania, June 1968, pp 14.

47 9-1-1 and Other Emergency Single Number Access Systems in Texas, Texas Advisory Commission on Intergovernmental Relations, December 1979, pp. 2.

48 American Telephone & Telegraph, AT&T and Its Involvement in 9-1-1 Emergency Telephone Systems: An Historical and Informational Report, American Telephone & Telegraph, undated publication, pp. 4.

As noted above, 9-1-1 is the three digit number that was designated by American Telephone & Telegraph (AT&T) as the universal emergency number for the United States. Among the reasons for selecting 9-1-1 as the universal emergency number was that a single three-digit number would be easy to recall and easy to dial (the *9* and the *1* are located in key positions on the telephone such that one could dial 9-1-1 without looking at or seeing the dial) and that, if the number was used throughout the United States as the one common number to a community's emergency response system, it would aid travellers and new residents alike.

Advantages to Public Safety and Other Emergency Agencies

Clearly, a number of advantages accrue to public safety agencies through the provision - and use - of 9-1-1:

- Because the time from detection of an incident to the time an agency is notified is *POTENTIALLY* reduced through the use of 9-1-1, total response time can be reduced. This reduction can lead to the saving of lives and property (Most reporting delays are attributed to decision/action conflicts and reporting delays by the viewing or involved citizen).[49]
- A higher degree of public confidence in the ability of its safety and emergency resources to serve its needs.
- Because calls are received at a central answering point, better coordination between emergency agencies is possible. It is not difficult to imagine the value of such a capability to both the public and emergency resources when multiple services are required to handle a single incident.
- Priority calls are immediately identified when a 9-1-1 call comes to the attention of the answering center. Whether or not all such calls are true emergencies depends on the continued education of the system users

49 Houston Police Department, *Executive Session - Policing Style, Overview of Session #5,* Houston (TX) Police Department, dated *November 24, 1986*, and Kansas City Police Department, *Response Time Analysis: Executive Summary,* U. S. Government Printing Office, Washington, D. C., Pub., 1978, p. 11

(public, children, etc) and the policies and procedures of the operating agencies.

- o Better record-keeping procedures are possible (and nearly inherent) in the initiation and operation of a 9-1-1 system. The actual worth of the data collected depends, of course, on the extent to which the data are used by the agency (enforcement actions, abuse/misuse of system, etc).

- o 9-1-1 is linked to a community's emergency communications system. Improvements to increase the efficiency and effectiveness of that system may be suggested (or required) as planning for 9-1-- proceeds. Obviously, the more efficient a community's communications network, the effective is response to the public it serves. Costly capital improvements are not, however, a requirement of 9-1-1.

Types of 9-1-1 Systems

There are two types of 9-1-1 systems in operation today: Basic and Enhanced. The differences between the two are distinct, though fundamentally they both perform the same primary function: Connect the caller with a central answering point where their emergency call can be processed and response to the scene initiated.

BASIC 9-1-1 (or B/9-1-1)

Basic 9-1-1 service involves the routing of a call from a calling location (business, residence, coin or mobile phone) to the local central office serving that telephone service area. The local central office routes the call and the caller's telephone number to the designated **PSAP**: the **P**rimary/**P**ublic **S**afety Answering **P**oint (depends on who you talk to in the telephone and public safety industries). Depending on its functional role, the PSAP will **1)** initiate response to the scene of the emergency or **2)** transfer the call and caller and the caller's telephone number to the required response agency.

The primary characteristic of the basic systems is that provides a quick, reliable and dedicated communications path into a community's emergency response and emergency communications systems. However, basic systems have one fundamental shortcoming: They require that the caller verbalize to the PSAP operator or the agency call taker his/her physical address so that emergency response could be initiated. If the caller is unable to talk (unconscious, small child, etc), the receiving operator or call taker must research the caller's address using their displayed telephone number in various criss-cross directories produced for this purpose. Two key problems arise when using these directories: *First*, unlisted or private telephone numbers are not listed. *Second*, Americans are a very mobile population. It is not uncommon for an incorrect address to be listed for a specific telephone number, especially in large metropolitan areas.[50] Because of these issues (and others technical and operational suggestions), the 9-1-1 system was improved to the state known as ENHANCED.

Without question, the states are fast moving to standardize E/9-1-1 systems as **THE** emergency communications system for communities and emergency response agencies (particularly fire, police and EMS services) within their borders. Since California, which was the first state to legislate E/9-1-1 systems as the state standard, many have followed suit.[51]

50 Weaver, Jr., William C., in Houston Police Department Call Taker Operations and Training Manual, May 1993, pp. 6-9.

51 The trend is for states to enact legislation that mandates E/9-1-1 as the standard emergency communications architecture for communities within their boundaries. Source: Mr. Dave Pickett, Operations Manager, Greater Harris County 9-1-1 Emergency Network, August 1993.

The fundamental characteristics of an Enhanced 9-1-1 system are selective routing, automatic number identification, and automatic location identification. Each is explained below:[52]

- Selective Routing: Enables the system administrator to designate a specific agency responsible for providing a particular service(s) to a specific address. Selective routing eliminates the boundary mismatch problem between local law enforcement agencies. However, a potential mismatch exists where fire protection and emergency medical service, within a law enforcement area, is provided by different agencies (especially in unincorporated areas of a county or parish).

- Automatic Number Identification: Enables display of the seven-digit telephone number used to place the 9-1-1 call at the PSAP answering position (and sometimes at the locations that have 9-1-1 calls transferred to them). ANI eliminates the need for the called party hold, ring back and switch-hook status indication features common on basic 9-1-1 systems. Direct trunked 9-1-1 lines are required to provide the ANI information stream.

- Automatic Location Identification: Enables display at the PSAP call answering position of some or all of the following information:

    - the seven-digit telephone number used to place the 9-1-1 call;
    - the physical street address or other indication of the geographical location of the calling telephone (i.e., southwest corner, second floor hallway);
    - codes identifying the law enforcement, fire suppression and emergency medical response agencies serving that telephone's location (called emergency service numbers or ESN);
    - a code indicating the class of service used to place the 9-1-1 call (i.e., coin, residence, business, mobile, off-premise private branch exchange or PBX), and

52 Houston Police Department Emergency Communications Division Supervisors Handbook, published by the Greater Harris County 9-1-1 Emergency Network, January 1993.

- the billing party's telephone number (i.e., a second or alternate telephone line where another party - other than the user - is responsible for paying the telephone bill, as in a teenager's personal telephone number paid for by the parents).[53]

Together these standard features, and other optional ones, make up the system known as Enhanced 9-1-1.[54]

53 See the attached **9-1-1 GLOSSARY** for a complete listing of various telephone jargon, phrases and abbreviations common to 9-1-1 systems.

54 See Attachment B for a flow-diagram of a typical E/9-1-1 call.

GEOGRAPHIC INFORMATION SYSTEMS

Today, local governments and their public safety agencies face challenges more complex and demanding than at any time in the past several decades. These challenges arise from several factors. City and county governments have experienced unparalleled growth in the demand for services from their communities. Shifts in populations bases and density have made it increasingly difficult to design and manage transportation systems, identify utility needs, and a whole host of services. In addition to the demands for such traditional services as planning, transportation, public safety, economic development, and urban renewal local governments are also expected to bear an increasing burden from providing health, welfare and social services. These demands come not only from local communities themselves, but also from state and federal agencies that expect cities and counties to implement programs mandated through legislative action.

Local governments operate in a complex legal and administrative environment. They must comply with and enforce a variety of federal and state mandates and regulations, while maintaining the services required by their community.

With the decreasing cost and increasing acceptance of computers, many local governments are meeting demands for greater service provision partly by using new technology solutions to improve productivity, solutions that, until recently, were viewed as private sector applications. Improved productivity is defined as when service to the public improves when *"additional products and* *information can be produced without a commensurate increase in investment, or when the same level of service can be maintained for a lesser investment.[55]"*

A geographic information system (GIS) has, increasingly, become an essential technology for local governments, especially public safety and emergency management, in making these types of improvements because most of the decisions their key managers (council, department heads, etc) make are related to a geographic or territorial area(s). Geographic information is one of the most important and valuable components of the infrastructure that local governments build, support and plan for.

A GIS system is composed of a computer (or several computers on a network) that uses special software with a powerful set of tools for creating and editing geographic databases and performing spatial and spatiotemporal analysis (i.e., location and time and location), data query and display, and data management. These tools can be used to support a variety of local government functions, such a permit processing, emergency response, tax assessment, infrastructure management, planning, developing policy, budgeting, decision making, and much more.

Clearly, GIS technology offers solutions to problems that go beyond increases in the speed and quality of conventional mapping. GIS software can help local governments on limited budgets get the most out of their existing resources by

[55] Baltz, Karl, Regional Manager, InterGraph Corporation, GIS Issues Discussions Direct and Indirect Benefits to a local governing body with/through the implementation of a GIS system, Meeting Notes, dated January 1992.

providing state-of-the-art technology to help various departments work more closely together (as in shared or co-opted systems). Clearly, GIS has been implemented and used successfully by numerous cities and towns as an effective tool to help solve the types of problems that local governments face. These include, but are not limited to, the following:

- o Automated mapping, including parcel mapping, creation of base maps, and thematic mapping, as well as extensive annotation (text files appended to an area) and symbolization functionality (icon relationships).
- o Engineering functions, including coordinate geometry functionality and work order processing.
- o Spatial analysis and query, including locational and logical query, dynamic segmentation capabilities, and address matching, geocoding and routing.
- o Public and commercial data access, including U. S. Census Bureau, and well as many other common, public domain digital files.
- o Raster image support and image integration capability, providing a means to display and manage photographs, building and site plans and scanned documents.
- o Powerful and flexible data modelling, including vector and raster topology, multimedia integration, extensive relational database functionality, and database security.[56]

Clearly, system capabilities - and price - vary. Equipment costs have dropped significantly while the heart of the GIS system - the software - has become increasingly easier to use. At the low end, PC-based products are available off-the-shelf. Users of PC-based GIS work with it as a productivity tool, much as one would a spreadsheet program. The relative low cost and ease of use of these GIS programs have helped to push mainstream GIS vendors to develop simpler, user-oriented systems. For instance:

56 Environmental Systems Research Institute, Inc. ARC/INFO, An Integrated Answer for Local Government, 3 page Undated Publication.

- o Just a few years ago, the hardware needed to run GIS programs from major software vendors meant an investment of $25,000.00 to $50,000.00 for a single workstation. Today, however, workstations that are 2-3 times more powerful that the <u>fastest</u> PC can be purchased for around $8,000.00.[57]

Not surprisingly, leaders in the GIS marketplace have developed new generation GIS programs with graphical user interfaces (GIU) that allow casual users to perform complex tasks and conduct spatial queries with minimal training.

Putting a GIS to Use at the Local Level

By combining computerized data with automated mapmaking, local governments and public safety agencies, in particular, can take advantage of a versatile new tool to help manage calls for service, identify crime and order maintenance problems, and respond to emerging problems and concerns within a specific district, beat, neighborhood, or other geo-political subdivision (voting precinct, council district, etc).[58] The GIS software provides the ability to select any area, without being limited to the above reporting areas using box, polygon, or circle to specify query boundaries. The area chosen can be as small as an apartment complex, a particular block and street, or larger areas which cross police operational boundaries (for example).

GIS software also provides the ability to perform three dimensional (3-D) modelling using a variety of selections from crime analysts from incident

57 Newcombe, Tod, GIS on the Comeback Trail, Government Technology, (V6, N7), Government Technology, Sacramento, California, July 1993, pp. 56-57.

58 <u>Houston Police Crime Analysis GIS Software, Request for Proposal,</u> Houston (TX) Police Department, July 1993, pp. 2-4.

(crime) profiling in selected areas. Crime patterns can be easily recognized by crime analysts geocoding (entering geographic data) crimes to street files. Medical science tells us that the human mind is geared to visual input as eighty percent of the input pathways in the nervous system are devoted to bringing visual stimuli to the brain.[59] The more information that can be absorbed visually, the quicker one can come to a decision (and the faster a response can be implemented or an action plan formulated).

In summary, more and more public safety agencies are discovering the advantages and benefits to be gained from GIS technology. Along with software that runs on a variety of personal computers (MacIntosh, IBM, etc), the emergence of faster, less expensive workstations equipped with better graphics and more memory is speeding the spread - and effectiveness - of the technology. Clearly, *as with any technology*, the applications of GIS technology to the challenges presented to today's law enforcement manager are limited by one's imagination and desire to use technology to discover solutions to problems.

59 Bylinsky, Gene, Managing with Electronic Maps, Fortune Magazine, Time/Warner Publishing Company, New York, New York, Pub., April 1989, pp. 35.

IN-FIELD DATA ENTRY

Highly portable LapTop and PalmTop computers and in-vehicle Mobile Digital Terminals are the dominant forms of technology capable of supporting most police agencies in addressing in-field data entry applications. These technologies bring significant benefits to the agency and include:

- A means of dedicating an "intelligent" workstation to the in-field officer. This work station would assist him/her in developing and enhancing the criminal offense report and building related crime analysis information.

- A means of providing the officer with a more efficient environment through which the officer's productivity could be increased. It is seen as a mechanism to more efficiently capture information regarding field officer work products and will support and assist the officer in a number of administrative and operational areas.

- Finally, many information systems professionals view this technology as a proven and effective solution to problems related to in-field submission of offense reports and other field related issues (i.e., work card, tow slips, pawn tickets, witness statements and confessions, property and evidence documentation).

INTRODUCTION

The most frequent method used by an officer to record the facts of an given investigation is to manually write the report on a **Field Notes** form (or some other paper instrument) and submit this copy at the end of the officer's shift. The report is brought to the agency's data entry location where it is sorted, copied and reviewed for accuracy. Once accepted, the reports are distributed to clerical personnel for entry into the Department's records management system (RMS). The amount of time required from initial investigation to entry of the report into the RMS system can range from several days to several weeks (depending on the number of administrative levels and review points the report must pass). Clearly, there are several challenges in the manual process. Consider the following:

a. Since most officers complete their Field Notes as they interview their complainant and turn these notes in at the end of their shift, there is opportunity for Field Notes to "get lost" prior to being entered into the RMS system.

   Unless a complainant specifically inquires about a case, it will never become known that the case is missing. The patrol officer has no way of *proving* that he did, in fact, turn his report into his station.

b. The entry time for hand-written reports by Officers is an average of 4.6 days from the initial contact date.[60] Considerably longer times have been known in times of severe backlog.

c. Officer Field Notes generally consists of a multi-part form and a second page of continued information. Often a two or more page report will become separated. When the data clerk attempts to enter the report, she will find that the report cannot be completed due to "missing" pages.

Another common method for report entry is for officers to take notes on their

60 Based on a twenty agency telephone sample conducted by the author as part of this subject's initial research in 1989/1990.

notepads and go to the area police station and enter their own reports into the agency's RMS system (if decentralized entry is supported).

The deficiency with this method is that officers who enter their own report are not in the field where their services are needed. Most agencies who support decentralized entry of report information find that a significant number of their officers prefer to enter their own reports.[61] Reasons cited include better investigations, more professional looking results, and clarity of information presented.[62]

Lastly, low priority reports (minor thefts, criminal mischiefs, and harassment by telephone) and most other minor property offenses can be processed by other means than dispatching an officer to the scene (i.e, TeleServe, Expediter Unit). Agencies that do support telephone reporting state that demands for these "convenience" services are increasing as field resources become more scarce.

While TeleServe is an efficient means of entering a police report, in the opinion of some professionals, it severely lacks the probing, investigative function that should be present at all crime scenes, and could possibly invite fraudulent reporting (i.e., insurance scams, property disputes).

This section of the report addresses the role computer technology and technological advances can play in reducing the steps involved in moving an

61 Ibid.

62 Ibid.

offense report from its field-written form to a more technologically usable format and into an agency's records management system. For until it is entered in the RMS, it is not available for investigative division review and assignment/follow-up, crime analysis consideration, and a host of other issues related to public safety operations. With this aim, the remainder of this report discusses several different devices that were researched and reviewed to determine if they would (or could) be suitable for direct entry from the field into an existing law enforcement records management system. They are as follows:

The ScriptWriter

The **ScriptWriter** is the trade name for a portable computerized "clipboard" which recognizes printing and maintains this handwritten copy in its memory. At the end of a work session or shift, the user brings the unit to the station and plugs it into a personal computer which transmits the information to the RMS host computer. The ScriptWriter does not use a keyboard but is written on a hard copy form using a ball point pen by the user.

The unit can handle different forms and comes with a small amount of memory. It has an 80 character display of the last line the user has written so that he/she can tell if the memory has properly recorded what was intended.

For public safety operations, the ScriptWriter has several operational and technical deficiencies. Specifically, upon viewing a demonstration of the unit, it was observed that the ScriptWriter requires *careful and painstaking* hard strokes with the ballpoint pen to write a character the recognition system will/can identify. The user must continuously check the display to make sure that he has "created" the proper character. Clearly, the ScriptWriter would make writing the average report *excessively* time consuming for an officer.

Another major deficiency is that the ScriptWriter requires a significant amount of space between each letter to allow the pressure sensitive pad to recognize the previous character. As a result, most police offense reports would have to be modified.

The ScriptWriter is clearly designed more for inventory or order forms, rather than the comprehensive narrative characteristic of a police offense report and detailed criminal investigations.

Optical Character Recognition System

The **Optical Character Recognition System** is a scanner which reads typewriting or *constrained* printing directly from a piece of paper and transmits it to a personal computer. The OCRS reads at 70 characters per second and faster, and is monitored by a clerk who corrects any "misreads."

The manufacturer claims the OCRS can enter data at four (4) times the rate of an average clerk. The unit reads the data and places a question mark (?) in the space of any character it does not recognize. The clerk-monitor follows behind the scanner and makes necessary corrections. Once this information is entered into the unit's personal computer, the reports are uploaded to the RMS host in batches during slow computer times.

The OCRS' **main deficiency** is that it is designed to read *one page of information* and cannot accommodate a second page without a complex program change. Most systems are designed to read only one side of the same form over and over and could not easily interpret the hand-written narrative of a report. However, a double sided scanning system is available at considerable cost (approximately $30,000.00 per unit). Although the OCRS may be able to successfully read the information placed on the front page of the offense report (where there are a lot of check-off blocks and bi-polar responses), the narrative portion would still have to be keystroked into the RMS system by a data clerk.

Only one agency is known to actively use an OCRS system; Baltimore Co., Maryland (1990). This agency, however, does not enter the narrative portion of their report into their computerized records system. Instead, the agency uses the computer to index cases and maintains the rest of the report (the narrative) on hard copy.

LapTop Computers

A LapTop computer is a similar to the common desktop office personal computer seen in many office environments with one notable exception: It is easily portable.

Many software programs currently used by various agencies could be also used in a LapTop computer. These include, but are not limited to, Professional Write, Letter Perfect, Lotus 123, Windows, Harvard Graphics, etc.

Common applications for LapTop computers include writing correspondence and reports, developing statistical databases, and using financial planning software packages.

Mobile Digital Terminals

Many agencies that have **Mobile Digital Terminals** (MDTs) would prefer to capitalize on their capital investment and use their existing RF network for transmitting offense report data from the field. However, most MDT systems do not currently support extended text capability due to the small screen size of the MDT. Limited "writing" is afforded to users and is usually restricted to notations and comments regarding calls for service and/or personal notations on the officer's daily activity file (commonly called the unit history file). Articles, property, persons, vehicles, and locations are the primary inquiry only files accessed by field personnel.

The Ideal Solution

The generation of offense and investigative reports by field officers requires the cooperation of several different technologies. The immediate requirement calls for a method of generating the actual report. This requires a display screen, keyboard and specialized software to process the officers input.

After generation, a method must be found to transfer the report quickly and efficiently to the agency's RMS host computer. This requires the use of a data communications link and specialized communications software. Other considerations include room in the police vehicle, power consumption and portability of the unit, ease of use, reliability, environmental requirements, and ergonomics.

The modern patrol vehicle has severe constraints with respect to utilization of available dimensions. The concepts employed in todays MDTs meets environmental needs. Technologically, however, the current state-of-the-art MDT is not capable of supporting data entry. Clearly, the next generation MDT should marry the qualities of current MDT capabilities with that of the personal computer (i.e., the LapTop or personal computer). The resulting device from this marriage *should* provide the best opportunity at a workable system for full implementation of field entry of offense reports.

The MDT solves most of the logistical problems and represents an ideal solution and medium for the data communications issue. Nonetheless, current MDT technology falls short on the report entry requirement. The next generation MDT may rectify these problems.

Laptop computers will serve as an effective intermediary, while technological development can produce a device which can be effective in the demanding environment found in a patrol vehicle. Further, the LapTop has been in use for quite some time, which allows for review of the unit's performance and reliability in real world conditions. For instance, the first agency to use the LapTop computer for offense report entry was the St. Petersburg (Florida) Police Department. At the time (1989), St. Petersburg issued a Tandy 100 LapTop computer to each officer while in the Academy, and instructs them on how to enter their reports. There is a high level of satisfaction among line officers with the use of these computers. But, the St. Petersburg system has one substantial flaw in their report entry program:

> *When an officer finishes his tour of duty, he brings his Laptop into the station and transmits the information he has entered into a personal computer. This personal computer then directs the report to a printer, which prints out the report. This hard copy is then hand carried to the Records Division for keystroke entry by a clerk into their mainframe. Although the St. Petersburg system appears on the surface to be an advanced system, the only tangible gain received is a more legible offense report for entry by a data clerk.*

Clearly, to make an informed decision on the use of laptops, as many different models as possible should be investigated. Nonetheless, after careful consideration, the following requirements should be considered as minimal operating standards in any LapTop used for in-field police data entry:

1) at least 640k memory, 2) an external battery pack with "toaster" rechargers, 3) under 8 hour battery recharge time, 4) battery life at least 4 working hours, with power down feature, 5) a full 80 character by 24 line screen, 6) a backlit screen, 7) a minimum 48 hour repair turnaround, with exchange program, 8) lightweight - around 5 lbs., 9) a sufficiently protective carrying case, 10) resume feature (allows indefinite pauses between data entry and data collection), 11) MS-DOS operating system, 12) built in modem, and 13) low cost.

ANTICIPATED BENEFITS VIA LAPTOP

Clearly, the use of the laptops for report entry will create the following advantages for the user agency:[63]

More timely report entry: Using a Laptop reporting system, all reports would be transferred from the Laptop at the end of an officers shift to the RMS host computer. This effectively reduces the maximum report entry lag time to the length of an officers shift (commonly less than 8 hours). At worst, the intermediate transfer device (usually a dedicated PC) would hold reports from the time they are received and then "batch" transmit the reports to the RMS host computer in bursts.

More effective the RMS system: Shared systems commonly become overburdened with information requests by the large number of users attempting to access the system (particularly from 8:00 am until 4:00 pm, Monday thru Friday). It is not unusual for the user to wait what appears to be an "eternity" when a report screen is transmitted until the next screen is generated and presented to the user.

63 Weaver, Jr., William C., Assessment of Field Data Entry Applications for the Houston Police Department's Field Operations Command, Houston (TX) Police Department, Internal Report, dated June 1989, pp. 3-7.

The mini-computer to be used as the intermediate or decentralized staging device should be an intelligent unit that can be programmed to batch load reports to the host RMS computer during those times that the RMS system has the least users working on it (i.e., probably the Night Shift).

More complete, more accurate reports: A Laptop computer report program has the capability of "channeling" an officer in the proper direction for the report the officer is making by prompting the officer with questions about the incident being investigated. For example, if an officer begins his report as a burglary, the Laptop program, if properly structured, can channel the officer in the proper investigative "direction" to secure all of the elements of the burglary, i.e.: the Entry, the Exit, tool marks, evidence. These elements would not normally exist in other types of crime reports. Although there is clearly no substitute for officer thoroughness and accuracy, the computer prompt has proven to be an effective method of insuring all the necessary information is included in a particular transaction (in this case, an offense report).

Offense Report Choice Fields: Many agencies are moving to check off boxes on the proposed offense report forms in order to standardize and improve data collection. Laptop offense report programs can be designed to provide a pop-up window list of choices for any field on the screen. This technique accomplishes the check off box data collection approach and saves considerable space. For example, the incident report offense field could provide a list of approved offense descriptions such as assault, burglary of a business, and auto theft. Unlike the form, the list of choices for a particular field on the laptop could be modified easier when needed than would be the case with a paper form.

Additional Enhancements to Laptops Can Be Added Later: The laptop concept is not limited to offense reports nor is it limited to field operations. Any form currently being used by an agency to collect data could be replaced by the laptop. For example, officer workcards, accident reports, arrest blotters, tow slips, gas cards/tickets, vehicle and property inventories, confessions, Miranda warnings, standard operating procedures, city ordinances, witness statements, personal field notes and city correspondence are examples of many functions that could be supported by the LapTop. The laptop could also be used to disseminate information such as administrative and training information and documentation.

Automated Coding Features: A Laptop program can be designed to do a substantial amount of Uniform Crime Report and interdepartmental coding. Any automated coding will reduce present and future personnel costs. This may be even more significant in the future as the UCR changes from its current summary based report to the National Incident Based Reporting System (NIBRS) in which each report must be coded to describe different parameters rather than the simple counting of each reported crime.

Long range personnel cost savings: Many agencies employ legions of personnel to support data entry and coding at significant costs. The conservative estimate of the re-direction or attrition of 1/3 of the agency's data entry positions would equate to considerable savings to the host agency's city.

Further, work efforts of personnel could be re-directed to more fruitful investigative/police oriented endeavors (i.e., pawn slip data entry).

More effective report taking: Many departments experience problems with lost or misplaced investigative reports. Lost reports have, in the past, created embarrassment on the part of officers who write the reports and supervisors who are questioned about reports for which their officers were responsible for making. Often times, the reports were just mixed up with other paperwork during mail runs and transfers. Laptop computers can significantly reduce the "lost report" syndrome, to the point of providing the officer with a receipt verifying he/she had successfully transferred the report. If implemented, this system feature would establish an unquestionable link to the RMS host computer and prevent lost reports.

Effective Training Aid: The LapTop offers the advantage of being a highly portable and extremely versatile training aid. New officers can be trained more quickly and easily in using the LapTop system as each new officer would have a single dedicated processor independent from other system users and current system operations. The officer is easily directed through the myriad of essential elements of an offense report (and other work products) via the various prompts and windows available in the LapTop's report program.

Crime Analysis enhancement: Without question, the collection of crime analysis and investigative data by the agency will be enhanced significantly. Investigating officers will be led by different screens which must be filled in requiring the officer to input relevant characteristics of the reported incident (i.e., increased solvability factors associated with specific offenses). It is a well established fact in investigative circles that different incidents have equally different information requirements and solvability factors. With the LapTop solution, each major crime (i.e., Burglary, Robbery, Sexual Assault) can have a tailored investigative "fact-finding path" down which the officer would be lead. This gathering of critical facts will assist Crime Analysis personnel immensely with determining crime patterns, multiple offenders, method of operation (M.O.), and case enhancement research. With more information being captured via the Laptop's offense directed strategy, investigative and patrol functions will be more efficient to the end user of the Department's services: the citizen.

To be sure, there are disadvantages to using a LapTop for report entry. They are:

Logistical problems with issuing laptops: The laptop will be another item of equipment that an officer will have to check out from the radio room officer and carry. Space for storage and electrical wiring for the chargers may be lacking at some stations. Another administrative procedure will have to be instituted to keep up with the laptops.

Battery distribution and maintenance: Nickel Cadmium (Ni-cad) battery technology has not kept up with computer chip technology. The result is that there will be a substantial problem with the maintenance and distribution of batteries for the laptop. The ni-cads just do not hold as long a charge as would be preferable for long usage. Experience with the portable radios has shown this to be a substantial problem (but one that is being addressed by the industry). It would, needlesstosay, be extremely frustrating for an officer to have a battery failure and lose the data he has collected.

Laptop repair and maintenance: Most of the laptops come with the ability to purchase a second year's warranty. Even in the first year, however, there will be some expense with the logging of broken laptops, carrying them to a repair center, and returning them to their proper end-user location. This function would most likely fall upon the division responsible for technical services support, which is probably working at capacity.

NOTES: The decision to implement an in-field data entry program should not be made without the valued assistance of end-user personnel. Officers, programmers and managers should be assembled and given broad discretion in designing a cost-effective data collection solution for the agency. Clearly, immediate and long term benefits available from the system far outweigh the initial costs that might be incurred during this key design phase component.

Finally, *increased officer productivity, higher criminal conviction rates, more thorough investigations, and an increased capacity to identify and interdict crime and community problems* are just a few of the anticipated outputs expected from a properly designed and managed in-field data entry system.

CONCLUSION

A variety of new computer techniques have been proposed to improve the speed and accuracy of decision making in the public safety communications, command and control environment. Two perspectives are offered that may provide a glimpse into the future of command and control applications. They are development of highly sophisticated intelligent workstations and advanced communications networks and "interpersonal" communication between computers and their users. First, we are a long way from achieving the level of interaction between the computer and the user as seen in the Star Trek television series and the more recent Star Trek movies. Nevertheless, researchers envision that future decision makers may be able to deal with computers much as they now deal with human associates. Primarily, this implies ease of communication with computers which "understand" the context of human requests and can reply in kind. Much work still needs to be done in developing the speech recognition/translation/action/response interface.[64] In the interim, one will still have to use the keyboard (*press*), the mouse (*point and click*) or the screen (*touch*) as the primary user interface.

However, while we wait for computers which will sense human concerns, researchers continue to explore new ways of making available computers and computer technology to better support public safety objectives. One such example is the use of highly sophisticated intelligent workstations which, when connected to a high speed data highway, serves as the single point of contact

64 Beam, Walter, R., Command, Control and Communications Systems Engineering, McGraw-Hill Publishing Company, New York, New York, Pub., 1989, pp. 140-141.

with any information stored on the network. For instance, within the dispatching arena, conventional systems implementation requires the use of independent monitors to display different aspects of command and control data and communications support:

- o Called for service (CAD) information, including pending and active service requests, available and active field units, and access to other information and communications components.

- o Unit location information derived from an automated vehicle location system. Depending on the level of sophistication, some systems may have a stand-alone proprietary geographic data display.

- o Geographic information system displaying topographical street and freeway information and, depending on the levels of data accessible to the user, may display secondary and tertiary layers of geographic data (i.e., residential/commercial plot information, two- or three-dimensional floor plans, buildings and codes inspection information, etc).

- o User interface to other internal information systems such as the agency's host records management system, any other archived data (personnel, etc), and terminal-to-terminal communications support.

- o User interface to external information systems such as Texas Crime Information Center and Texas Law Enforcement Telecommunications System, and associated information networks available from these systems (NCIC, NLETS, InterPol, etc).

Assuming our example public safety agency had access to each of the systems listed with no systems integration capability, a total of five (perhaps 6) CRT monitors would be arrayed around the dispatcher's work area, each controlled by its own keyboard or mouse interface. Such a system design is 1) grossly inefficient for obvious reasons, 2) stressful to the worker and counter-productive to the work environment, 3) makes inefficient use of spatial and ergonomics requirements of today's communications centers, 4) contributes poorly to worker productivity, and 5) training timelines would be extended far beyond what would *reasonably* be expected for the public safety dispatcher position (six months of pre-production training would not be uncommon in such a "clustered" environment).[65]

Current trends in systems development have centered around the development of a common user interface capable of accessing data from, and communicating with, multiple operating systems, regardless of the type. Instead of our fictitious agency dispatcher having 5 or 6 terminals at their position, the state-of-the-art will be to have a single terminal running multiple sessions that the operator would pre-define (or would already be configured for the user). The operator would use his/her mouse (or other pointer) to move from operating system to operating system, accessing information, performing inquiries, and posting status changes. Each of the various systems would be updated as changes are made to them or as circumstances and field conditions warrant. Instead of multiple keyboard templates and function keys, a single keyboard interface would be used to perform inquiries on all systems. Or, with the help of a mouse or similar pointer, pull down menus would perform routine functions. Training on such as system would be simpler and less time consuming.

Conventional data manipulation systems will become more useful for decision support when they provide more rapid and flexible ways for a public safety dispatcher to examine the dispatch-decision environment and associated external constraints (staffing, traffic information, ETA projections, resource specialty, etc). Since vision is a human's most important information-input mechanism, continued attention will be placed on human-machine visual interfaces.

65 Ergomonics for Computer Users (VIDEO), Ergonomiks, Inc., Tempe, Arizona, Pub., 1992

Having conquered the display and manipulation of data, the next challenge for the future will be to reduce operator induced delays on performance. Inasmuch as automation can handle routine procedures more rapidly than humans, routine human control-loop activity has become less representative of human tasking in systems. The tasks remaining are generally more subtle: the system presents information, the operator must use personal training, experience, and judgement to 1) analyze the available information, 2) determine if action is necessary, 3) determine what alternative actions might be appropriate, 4) select from the alternatives, 5) determine what needs to be done to execute that course of action, and 6) execute it. Task complexity may increase if the operator must query the system (or network) for additional information before completing the action. It is this problem recognition-analysis-decision-action loop that the author believes will be the focus of the next generation of system enhancements.

Finally, much discussion is being addressed toward reducing the number of "routine" decision-problems the public safety communications operator should process and only present those that require human interpretation or where further analysis is necessary before action is taken. As a guide, the following simple rules can be applied in the total system's design to reduce information and task overload in operations and supervisory personnel:

- Avoid cognitive (mental) overload from a combination of too many concurrent cognitive and/or manual tasks.
- Eliminate avoidable stresses, such as eyestrain, that are produced by displays which are difficult to see or by requirements to maintain continuous but nonessential alertness.
- Remove nonessential distractions which might disturb operator thought or performance (i.e., monitors, printers, telephones).

- Do not rely on complex action triggers which require maintained alertness and/or continuous mental activity on the part of the operator.

- Employ a scheme of distinct alertness and response levels, to reduce stress and fatigue when a high state of readiness is not mission-essential.

- Use mnemonic aids (symbols, colors, icons, etc) to quicken and simplify recognition of items of importance, such as status changes, call priorities, activity timers, etc.

- Make stimuli which call for different trained responses as distinct from one another as possible in order to reduce the incidence of incorrect/inappropriate response.

Finally, many important public safety objectives require intelligent combination, or fusion of data from a combination of sources. These sources can include independent internal systems, such as computer aided dispatch and automated vehicle location systems, to external information and communications systems, such as traffic pattern and volume data and traffic signal control systems. The fundamental problem in information fusion is determining which data (and which systems) from other sources is credible and pertinent. Clearly, the perspectives from which different systems view some object or event greatly complicate the fusion process, as do ambiguity and incompleteness of data.

POLICE COMMUNICATIONS SYSTEMS

Applications and Trends

ATTACHMENT A

9-1-1 GLOSSARY

ACD:
See **AUTOMATIC CALL DISTRIBUTOR**

ALI:
See **AUTOMATIC LOCATION IDENTIFICATION**

ALTERNATE ROUTING:
A selective routing feature which allows 9-1-1 calls to be routed to a designated alternative answering location if all incoming 9-1-1 lines to the primary PSAP are busy or if the primary PSAP closes down for a period.

ANI:
See **AUTOMATIC NUMBER IDENTIFICATION**

AUTOMATIC LOCATION IDENTIFICATION (ALI):
A system capability that enables the automatic display of the calling party s name, address, and other information.

AUTOMATIC CALL DISTRIBUTOR (ACD):
Equipment used to distribute large volumes of incoming calls in approximate order of arrival to call attendants not already working on calls. or to store" calls until call attendants become available.

AUTOMATIC NUMBER IDENTIFICATION (ANI):
A system capability that enables the automatic display of the seven-digit number of the telephone used to place the 9-1-1 call.

BASIC 9-1-1 SYSTEM:
A telephone system which automatically connects a person dialing the digits "9-1-1" to an established PSAP through normal telephone service facilities. Generally, Basic 9-1-1 connects all calls from a given central office to the same PSAP, regardless of jurisdictional boundaries.
ANI and ALI are not provided.

CALLED PARTY CONTROL:
A set of telephone features which allows control of the call to reside with the party being called. These features usually include: **CALLED PARTY HOLD, FORCED DISCONNECT, RINGBACK,** and **IDLE CIRCUIT TONE APPLICATION.**

CALLED PARTY HOLD:
A telephone system feature that enables the 9-1-1 attendant to maintain a connection through the telephone system s switching facilities, even when the caller has hung up the telephone.

CALL REFERRAL METHOD:
The 9-1-1 call attendant provides the calling party with the telephone number of the appropriate agency or organization which is responsible for providing the requested service.

CALL RELAY METHOD:
The 9-1-1 attendant takes all the information from the caller and relays the information to the appropriate agency for further action.

CALL TRANSFER METHOD:
The 9-1-1 attendant determines the appropriate response agency or agencies and transfers the call accordingly.

CENTRALIZED SYSTEM:
A system in which all facilities for a given 9-1-1 system or systems are centralized at a single location and all voice and data traffic is routed through that location. See **DISTRIBUTED SYSTEM and STAND-ALONE SYSTEM.**

CENTRAL OFFICE (CO):
Also called a wire center a switching unit in a telephone system.

CENTRAL OFFICE ISOLATION:
A situation in which the serving central office cannot communicate with any other central office. Dial tone is present but only prefixes assigned to the central office can be dialed.

CENTRAL OFFICE IDENTIFICATION:
When a PSAP serves more than one central office and direct trunking is used it is possible for a PSAP to identify the central office which originates the call.

CLASS MARKING:
Also called **CLASS SCREENING.** It is a method of providing selective routing in a Central Office without having to first direct the call to a control office. It is usually used in a distributed system.

CO:
See **CENTRAL OFFICE**

COG:
Council of Governments. In Texas, twenty-four (24) COG's serve as the 9-1-1 administering agencies for much of the state's non-urban areas. Separate from 9-1-1 districts. (See 9-1-1 Districts).

COIN-FREE DIALING:
A telephone system feature which enables a caller to dial from a pay phone without depositing money. Sometimes called Dial Tone First.

CONTRACT SERVICES:
Any services which one agency agrees to provide another agency under written contract.

CONTROL OFFICE:
Also called a Tandem Office it provides selective routing capability in a centralized 9-1-1 system. All calls are routed from the central office to the control office and re-routed back to the proper PSAP. Control offices do not exist in all 9-1-1 routing systems.

CUSTOMER RECORDS INFORMATION SYSTEM (CRIS):
A computer listing of the names addresses and other information of telephone subscribers. Different telephone companies each have their own term for this.

DATA CIRCUITS:
Telephone circuits designed to carry computer-type digital telephone information. Used in 9-1-1 systems to carry ALI data.

DATA MANAGEMENT SYSTEMS (DMS):
DMS is used in centralized systems lo provide ALI data to the PSAPs. ANI information is forwarded from the PSAP to the DMS location (Dallas or Houston for Texas); the DMS matches the ANI number to a computer file and forwards the resulting ALI information back to the PSAP through a series of data circuits and subsidiary computers called node- processors.

DEFAULT PSAP:
See **DEFAULT ROUTING**

DEFAULT ROUTING:
A selective routing feature which allows 9-1-1 calls to be routed to a designated alternate location (default PSAP) if the incoming 9-1-1 call cannot be selectively routed.

DIAGNOSTICS:
Programs and procedures used to check and isolate equipment failures and/or malfunctions.

DISPATCH CENTER/RADIO DISPATCH CENTER:
The location from which a public safety agency's mobile units are dispatched, monitored and controlled.

DIRECT DISPATCH METHOD:
9-1-1 call-answering and radio-dispatching functions for a particular agency are both performed at the PSAP.

DIRECT TRUNKING:
A telephone system design which will assure that a telephone line connection has no intermediate switching points between the originating central office and the PSAP. In other words, no tandem or control office is used to route the call to its end point. Generally, this is used in distributed systems.

DISTRIBUTED SYSTEM:
A 9-1-1 system in which "intelligence" or capabilities are distributed throughout the network rather than being centralized at one location. This usually involves class marking at the central office to provide selective routing and the use of computers at the PSAP to provide ALI information. See **CENTRALIZED SYSTEM.**

DMS:
See **DATA MANAGEMENT SYSTEM**

EAA:
See **EXCHANGE ACCESS ARRANGEMENT MAIN TELEPHONE**

EAX:
Electronic Automatic Exchange. A central office with programmable telephone switching logic.

EMS:
Emergency Medical Services (Ambulance or Paramedic Response).

END OFFICE:
The telephone company central office(s) where the 9-1-1 calls originate.

EMERGENCY SERVICE NUMBER (ESN):
A number used to designate the unique combination of police fire and EMS service associated with a given geographical area. Used for selective routing of the E/9-1-1 call.

E/9-1-1:
Enhanced 9-1-1.

E/9-1-1 (ENHANCED 9-1-1):
A Bell System term referring to one or a combination of selectively routed 911 service ANI and ALI and certain other advanced features.

ESN:
See **EMERGENCY SERVICE NUMBER**

ESS:
Electronic Switching System. A central office with programmable telephone switching logic. See **EAX.**

EXCHANGE:
A defined geographical area. served by one or more central offices in which a telephone company provides service.

EXCHANGE ACCESS ARRANGEMENT:
A telephone that is connected directly to a central office and has a unique telephone number. It is not an extension station.

FIXED TRANSFER:
A feature which allows the attendant to transfer a 9-1-1 call to a secondary PSAP by use of a single button. Each button corresponds to a designated secondary PSAP.

FORCED DISCONNECT:
A telephone system feature which allows the attendant to disconnect a telephone call and thereby avoid caller jamming of 9-1-1 lines.

FOREIGN EXCHANGE (FX):
A trunk line provided by a common carrier from an exchange other than the local exchange.

GRADE OF SERVICE:
The probability (usually expressed as a decimal fraction) of a telephone call being blocked by busy lines.

IDLE CIRCUIT TONE APPLICATION:
A telephone system feature which applies a distinctive tone to the 9-1-1 call to indicate that the calling party has hung up.

INDIRECT TRUNKING:
A telephone system design in which all calls are routed through a central location from which they are re-routed to the desired end destination. Generally used in centralized 9-1-1 systems with control or tandem offices. Usually involves trunk concentration.

LOCAL ACCESS AND TRANSPORT AREA (LATA):
Calls between points within a LATA are handled entirely by the local telephone company. 9-1-1 calls crossing LATA boundaries require special trunks.

MAIN STATION:
A telephone that is connected directly to a central office and has a unique telephone number. It is not an extension station.

MANUAL TRANSFER:
A feature which allows the attendant to transfer an incoming call by dialing either a seven digit number or a two digit speed calling number.

MASTER STREET ADDRESSING GUIDE (MSAG):
A computer "map" of the 9-1-1 calling area which lists street names and block ranges associated with a given city ESN district or other answering area.

MULTIBUTTON TELEPHONE SET:
An instrument with the capability of multiple line terminations. Each line is accessed by pressing an associated button.

MULTIJURISDICTIONAL SYSTEM:
A network providing 9-1-1 service to more than one political entity.

9-1-1 CALL ANSWERER:
The initial answerer of a 9-1-1 call. This individual may also be a dispatcher.

9-1-1 CENTER:
Sometimes called a PSAP. This is the initial answering location for 9-1-1 calls.

9-1-1 DISTRICTS:
9-1-1 administering agency. Twenty-four (24) 9-1-1 Districts serve as the administering agencies for the majority of urbanized areas in Texas. Separate from COG's.

NEUTRAL PSAP:
A PSAP not associated with a response agency. The function of the neutral PSAP is to determine the proper response agency and transfer the call.

PBX:
PRIVATE BRANCH EXCHANGE. Also called PABX, a private telephone switchboard with many stations not individually identifiable to the telephone company's switching network.

PREFIX:
The first three digits of a seven-digit telephone number.

PRIVATE LINE:
A telephone line used only for communication between two points and which does not connect with the public telephone system.

PRIMARY PSAP:
The initial answering location of a 9-1-1 call.

PUBLIC SAFETY ANSWERING POINT (PSAP):
A location which answers 9-1-1 calls. See PRIMARY (PSAP) and SECONDARY (SSAP).

PUBLIC SAFETY AGENCY:
A functional division of a public agency which provides police, firefighting, medical or other emergency services.

RINGBACK:
A telephone system feature usually available on circuits equipped with called party control which enables the attendant to ring the telephone used to place a 9-1-1 call immediately after the caller has hung up by pressing single button.

RINGDOWN CIRCUITS:
A non-switched telephone connection between two points sometimes called a "hotline." Going "off hook" at either end (raising the telephone receiver from its base) will cause the other end to ring without having to dial the number.

RURAL ADDRESSING:
The process of assigning street and house numbers to locations that have a post office route number and box number.

SECONDARY PSAP:
See **SSAP**

SSAP (SECONDARY SERVICE ANSWERING POINT):
A location to which 9-1-1 calls are transferred from a PSAP. Normally the response agency responsible for servicing the call.

SELECTIVE ROUTING (SR):
A telephone system feature that enables all 9-1-1 calls from a defined geographical area to be answered at a predesignated PSAP.

SELECTED TRANSFER:
A feature which allows the attendant to transfer an incoming call by pressing a single button.

SERVING CENTRAL OFFICE:
The telephone company central office area in which a PSAP is located.

SR:
Selective Routing.

STANDALONE SYSTEM:
A 9-1-1 system in which the computer is dedicated to a single PSAP. See **DISTRIBUTED SYSTEM.**

SWITCHHOOK STATUS INDICATION:
Allows the PSAP to monitor by means of supervisory lamps the status of a calling party being held. Indicates whether the calling party still is connected is on hold or has disconnected.

STEP-BY-STEP OFFICE (SXS):
A central office which uses electro-mechanical switching and usually has little or no programming capability.

TANDEM TRUNKING:
An arrangement where a telephone line connection has one or more intermediate switching points which are required (usually on a controlled dial pulse basis) before reaching the final destination. See **CENTRALIZED SYSTEM.**

TARIFF:
A document filed by a telephone company and approved by the state Public Utilities Commission which lists the communication services offered by the company and may give a schedule of rates and charges.

TERMINAL EQUIPMENT:
Telephone call answering and transfer equipment.

TTY:
Teletypewriter a device used to transmit typed messages interactively over phone lines. TTY is used in emergency communications to "talk" to the deaf. Also called a TTD.

TWO-STAGE SYSTEM:
The 911 services call-answering and the radio-dispatching functions are performed by separate individuals.

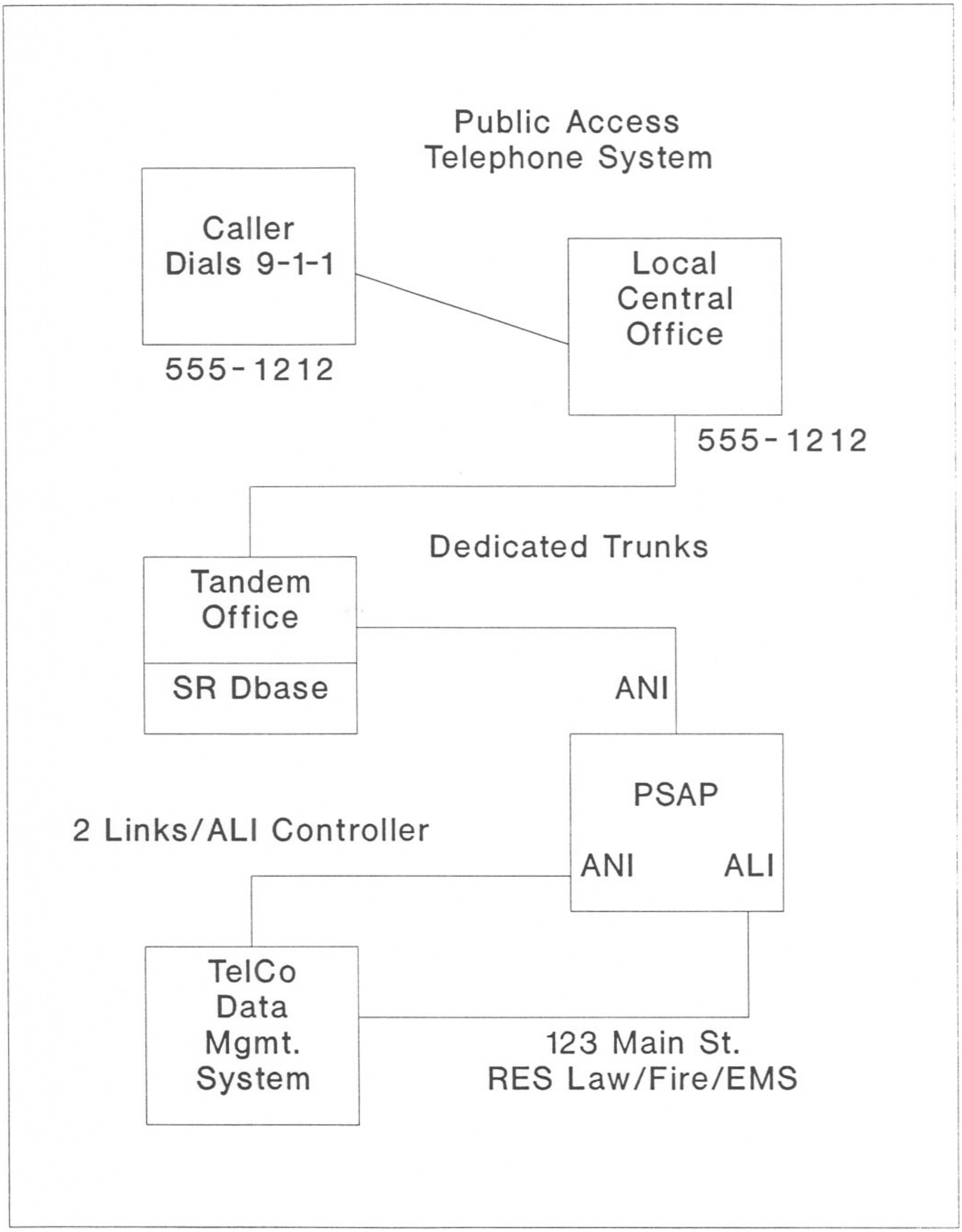
UNINTERRUPTABLE POWER SUPPLY (UPS):
An auxiliary power unit using stored energy to provide continuous power within specified voltage and frequency tolerances. Usually consists of a power supply that charges a

battery and an inverter that provides AC power from the battery. During power failures the batteries and inverter will provide power for a period of time.

WIRE CENTER:
See **CENTRAL OFFICE**

POLICE COMMUNICATIONS SYSTEMS
Applications and Trends

ATTACHMENT B


Public Access
Telephone System
Caller
Dials 9-1-1
555-1212
Local
Central
Office
555-1212
Dedicated Trunks
Tandem
Office
SR Dbase
ANI
PSAP
2 Links/ALI Controller
ANI
ALI
TelCo
Data
Mgmt.
System
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RES Law/Fire/EMS

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