The Evolution and Development of Police Technology

A Technical Report
prepared for
The National Committee on Criminal Justice Technology
National Institute of Justice

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EXECUTIVE SUMMARY

THIS REPORT provides a detailed look at police technology. It is meant to help readers as they consider the evolution and future development of police technology and the role of the National Institute of Justice (NIJ) in fostering that development. It was prepared with a diverse audience in mind, all of whom have a stake in ensuring that the police are equipped to do their job safely and efficiently:

- police officers on the street and policymakers responsible for their efforts;
- citizens concerned about crime;
- the news media, and opinion leaders interested in making the police more effective;
- the private sector, the manufacturing and marketing source of current and new technologies.

The job is exacting. The police are asked to control crime, maintain order, and provide an intricate array of services, from responding to emergency 911 calls to regulating the flow of traffic. On occasion, they must perform remarkable feats of criminal investigation, quell rowdy crowds and violent offenders, and put their lives on the line. Much of the time, police resources are limited. It is estimated that the workload crime imposes on the police has increased fivefold since 1960. Their resources have not kept pace with their workload.

THE POLICE AND TECHNOLOGY

To do their job, police frequently have looked to technology for enhancing their effectiveness. The advent of fingerprinting in the 1900s and of crime laboratories in the 1920s greatly augmented the police capacity to solve crimes. The introduction of the two-way radio and the widespread use of the automobile in the 1930s multiplied police productivity in responding to incidents.

But, as noted in this report, progress in technology for the police has often been slow and uneven. A quotation from the President's Crime Commission in 1967 illustrates how the police at times have lagged behind other sectors in reaping the benefits of technology:

> *The police, with crime laboratories and radio networks, made early use of technology, but most police departments could have been equipped 30 or 40 years ago as well as they are today.*

The Crime Commission was established in the 1960s in response to rapidly rising crime rates and urban disorders. The Commission advocated federal government funding for state and local criminal justice agencies to support their efforts. It called for what soon became the 911 system for fielding emergency calls and recommended that agencies acquire computers to automate their functions. But even with the start-up help of hundreds of millions of dollars in early federal assistance, computerization came slowly. Only in recent years have many agencies found the use of information technologies significantly helpful. Examples include fingerprinting databases, computerized crime mapping, and records management systems doing everything from inventorying property and cataloging evidence to calculating solvability factors.

POLICE TECHNOLOGY AND THE NATIONAL INSTITUTE OF JUSTICE

Many police technologies are drawn and adapted from the commercial marketplace. Cars, radios, computers, and firearms are examples. But this report notes that the police have vital needs for special technologies for which there is no easily available source. Examples are devices to use less-than-lethal force in controlling unruly persons, to stop fleeing vehicles, and to detect concealed weapons and contraband in nonintrusive ways.

Private sector technology developers and manufacturers are reluctant to meet many special technology needs of the police. The fragmentation of the American police market, which numbers more than 17,000 agencies, makes selling to the police a time-consuming and expensive proposition. Liability issues are also a concern: Will the manufacturer be protected if its product is used in a way that injures officers or citizens?

The job of fulfilling special technology needs for state and local law enforcement belongs to the National Institute of Justice (NIJ), the criminal justice research arm of the U. S. Department of Justice. NIJ's Office of Science and Technology fosters technology research and development when it otherwise will not occur.

To determine technology requirements, the Office of Science and Technology regularly surveys the police through its Law Enforcement and Corrections Technology Advisory Council (LECTAC), which is comprised of top law enforcement officials from throughout the country. It also develops voluntary product standards, compliance and testing processes, and it disseminates a wide range of information on police technology. The vehicle for much of this activity is the NIJ-sponsored National Law Enforcement and Corrections Technology Center (NLECTC), a network of national, regional, and special purpose offices.

For the first 20 years after the federal government began supporting local criminal justice agencies, NIJ's role in technology was limited. Its most notable accomplishments were the development of soft body armor for the police and establishment and dissemination of performance standards for police equipment. Beginning in the 1990s, however, the Administration and Congress recognized increased needs for technology and began funding NIJ to meet them. A current example is a five-year project to improve the quality and availability of DNA technology to local and state law enforcement. A second example is funding to detect concealed weapons and contraband. Often in cooperation with other federal agencies such as the Departments of Defense and Energy, NIJ sponsors scores of efforts to develop new technologies.

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OBSERVATIONS FOR POLICYMAKERS

The purpose of this report is to inform. However, in preparing it, observations were formed that may be useful to federal policymakers. One set of observations suggests ways to coordinate federal technology development efforts for avoiding fragmentation and duplication of effort and ensuring certain systems are compatible. On the basis of its mission and partnerships with other federal agencies, NIJ seems well suited to play a coordinating role in these efforts.

A second observation is that the coordination of technology development, as well as the emphasis on its importance, would be better served by the appointment of a science and technology adviser to the Attorney General and a senior law enforcement official to the Technology Policy Board of the White House Office of Science and Technology. Here, again, it would appear that NIJ could provide excellent support in this endeavor.

Other observations address ways of encouraging industry to manufacture and market technologies developed under NIJ's aegis; of strengthening compliance with product standards; and of encouraging the federal government to help police agencies acquire new technologies through such means as buying consortiums, low-interest loans, and distribution of surplus equipment. A final observation addresses the issue of inadequate funding to support technology development for state and local police and of the necessity to provide a stable budget as a matter of highest national priority.

Through this report and these observations, we hope to accelerate the process by which the police finally become full beneficiaries of our era's continuing technological revolution, thereby enhancing their vital work in the nation's fight against crime. Our citizens deserve nothing less.

Vice Admiral E. A. Burkhalter, Jr., USN (Ret.)
Chairman, National Committee on Criminal Justice Technology
President, Seaskate, Inc., Washington, D. C.

COMMUNICATIONS

Communications is easily the lifeblood of any organization, but in policing, it can mean the difference between confusion and order, efficiency and chaos, life and death.

Today's modern communications are light-years away from those employed by the *rattel wacht*, or rattle watch of the 1600s. These Dutch officers made up the "burgher guard," a force of eight men who patrolled the newly formed city of New Amsterdam. Equipped with little more than their wits and a rattle to summon aid, they stood the night watch over the city that was soon to become New York.

Communications, as a function in and of itself, literally stood still for the next 200 years. New York City in the 1800s wrestled with problems brought on by its burgeoning population. It struggled with vice, corruption and greed among its city officials, its police officers, its citizens. It faced rioters, thieves, and the complaints of citizens served by a meager force of 52 men. Although the Industrial Age was beginning, technologies that could be useful to law enforcement were hardly a consideration in those tumultuous times.

Then, in the mid 1800s, the first call boxes, or street telephones, were installed so citizens could report crimes and patrol officers could communicate with each other. It was not until the 1930s that the first radios were installed in patrol cars. Even then, most of communications abilities were strictly one way. In the Dallas Police Department, officers could receive messages but could not answer the dispatcher or communicate with other patrol cars. In Houston, police calls were broadcast by a local radio station, which interrupted regular programming for police emergencies. In New York, automobiles were introduced in 1919, but these early patrol cars were not equipped with radios until 1932 (Bailey, 1995.)

IT WAS NOT UNTIL THE 1930S THAT RADIOS WERE INSTALLED IN PATROL CARS. EVEN THEN, MOST COMMUNICATIONS WERE STRICTLY ONE WAY. IN THE DALLAS POLICE DEPARTMENT, OFFICERS COULD RECEIVE MESSAGES BUT COULD NOT ANSWER THE DISPATCHER OR COMMUNICATE WITH OTHER PATROL CARS. IN HOUSTON, POLICE CALLS WERE BROADCAST BY A LOCAL RADIO STATION, WHICH INTERRUPTED REGULAR PROGRAMMING FOR POLICE EMERGENCIES. IN NEW YORK, AUTOMOBILES WERE INTRODUCED IN 1919, BUT WERE NOT EQUIPPED WITH RADIOS UNTIL 1932.

Radios have undergone dramatic changes since then, from the bulky Dynamotor that was mounted in the trunk, that dimmed the headlights and emitted a loud growl when the microphone was keyed, to today's light portable radios. Tubes changed to crystals, which were replaced by microprocessors. An eight-channel system that was once considered state-of-the-art is today's dinosaur when compared to those that boast as many as 300 channels.

One of the biggest changes in communications has been the move, noted in Part One, to 911 dispatching. As it was originally envisioned, 911 was to be the nationwide emergency number, a system in which telephones were hooked to computers. When the phone rang, the computer checked its database to find the number and display it on the computer screen. The system became "enhanced" (E911) when the computer got smarter, showing the telephone number, address, and in some cases, the name of the person who owned the number. Some systems also showed the fire department or ambulance service responsible for handling emergencies in the caller's area. If the call did not go directly to a law enforcement agency but came into a public safety answering point, or PSAP, the call-taker simply pushed a button on the console to transfer the call to the appropriate agency. The additional information on the screen transferred with the call.

The idea of a nationwide emergency number was popular with citizens and lawmakers, but it became the local political football even after its implementation was mandated by legislation. Some agencies had to fight the telephone company for access to numbers and addresses, a tug-of-war that brought privacy issues into play. Others could not afford to maintain the required database and were happy to let the telephone company handle it. Decisions had to be made about whether to use a PSAP to route calls, or whether each call should go directly to the appropriate agency. That was only the beginning. Each telephone number in the system had to be assigned to a particular law enforcement agency, ambulance service and fire department. Funding had to be secured, hardware purchased, consultants consulted. It was a process that took anywhere from two to five years.

As useful as 911 now is to citizens, in some ways it has become the tail that wags the dog. There are those who criticize the 911 system because it drives the way the department does business, not the other way around. Officers, particularly those in large metropolitan agencies, complain that they are so busy responding to calls for service, they cannot spend time with the people of the community, which means community policing

programs may take a back seat to handling emergencies. Proponents of 911 tell a different story, saying that with enhanced 911 and the addition of computer-aided dispatching (CAD) the opportunities to implement community policing programs are improved.

CAD systems give officers a wealth of information about a call for service. Police departments can be inventive in determining the type of information they need and how they will use it. For example, a CAD system can match an incoming call with files that show ownership of a building where a call originates. It can report any associated hazards, such as previous reports of drug involvement, or of allegations of stockpiled weapons or explosives. It can give a complete history of calls made from a location and tell officers whether the residents have chronic problems with domestic violence, if a homeowner has a history of mental instability or makes numerous calls to the police, or if the house was previously used by drug dealers.

A CAD system that is equipped with Global Positioning Satellite/Automatic Vehicle Location technology can track every patrol car on the street, pinpoint each one on a dispatcher's map, and suggest which unit to send to a call for service. It can display a unit's location with relation to an incident, as well as jurisdictional boundaries, landmarks, road networks and routing information. It can provide access to other databases that store information on building floor plans, sprinkler systems, electrical control panels, emergency exits, and gas lines. It can track property watches, false alarms and response times. (For a description on how the police can use a Global Positioning System, see Appendix Sixteen.)

A CAD system can provide a direct interface with state and national computers for warrant checks and license plate and driver's license queries. It can plot water pipes, power lines, rivers, creeks, fire hydrants, and hazardous materials locations. Some CAD software programs even plot wind direction and predict where fire plumage will spread.

A CAD system is essentially a data-gathering tool, an electronic file box that can keep track of every person who has contact with the police agency in any context. It shows the context of that contact, links it with data, and tracks the disposition of a call. Because it acts as a computer-based paper trail for every incident or call for service, it ideally can replace the manual file card system. What a CAD system does not do is give meaning to the information it gathers. That is management's task, to draw the data from the CAD system for reports, such as the number of calls for service on each shift, a breakdown of types of emergencies per beat, the number of calls per service each officer answered. The type of report that can be generated from CAD-gathered data is limited only by the imagination of management. For example, it can be used for crime analysis of specific areas of the city, or geographic mapping to pinpoint high crime areas or find patterns of criminal activity, both of which allow the department to allocate manpower more effectively.

One of the biggest benefits of a CAD system has been its ability to reduce radio traffic. The city of Detroit, for example, integrated its E911 system with CAD, in-car mobile data terminals, and an automatic vehicle locating and mapping system. Dispatchers see a map on their screen, and zoom in for a close-up of the area. By clicking on the closest vehicle, the call is automatically dispatched to the computer terminal in the patrol car. It does not go out over the air. Systems such as this also let officers bypass the dispatcher to access the department's databases, as well as those at the state and national level.

Direct access to critical information, such as that needed for traffic stops, has the benefit of increasing officer safety. With the correct information, an officer is less likely to be surprised or overwhelmed by a situation. CAD systems help to avoid bottlenecks that occur when officers have to wait for voice access to the dispatcher. They increase communications security by reducing the possibility of casual monitoring of unencrypted conversations and decrease the number of errors typically associated with human conversations. Finally, CAD systems' capacity to reduce radio traffic is important owing to the proliferation of cellular phones and paging systems that take up valuable airwaves.

The problem of congested airwaves has existed for years. The diminishing radio spectrum was recognized in the 1967 report of the President's Commission on Law Enforcement and Administration of Justice. The commission's Science and Technology Task Force recognized that the nation's police agencies were basically mobile forces. Its authors

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studied what was then considered an overloaded spectrum and the cities it affected: In New York City, communication for 2,000 mobile units was provided by eight radio channels. At one point, the city put 500 officers on patrol without radios because of a shortage in radio frequencies. In Cook County, Illinois, 35 base stations and 200 mobile units operated on one frequency. Six cities in Los Angeles County with a combined population of 250,000 shared one radio frequency, as did 15 municipalities on the north side of Chicago. The report concluded that law enforcement agencies needed to make more efficient use of the available radio spectrum, and made recommendations to help relieve some of the congestion.

IN NEW YORK CITY, COMMUNICATION FOR 2,000 MOBILE UNITS WAS PROVIDED BY EIGHT RADIO CHANNELS. AT ONE POINT, THE CITY PUT 500 OFFICERS ON PATROL WITHOUT RADIOS BECAUSE OF A SHORTAGE IN RADIO FREQUENCIES. IN COOK COUNTY, ILLINOIS, 35 BASE STATIONS AND 200 MOBILE UNITS OPERATED ON ONE FREQUENCY. SIX CITIES IN LOS ANGELES COUNTY WITH A COMBINED POPULATION OF 250,000 SHAREDONE RADIO FREQUENCY, AS DID 15 MUNICIPALITIES ON THE NORTH SIDE OF CHICAGO.

Although cellular telephones did not exist at the time the report was published, their appearance on the communications network has had the effect of reducing some radio traffic. One of the first departments to explore the use of cellular phones was the St. Petersburg, Florida, Police Department in 1985. Officers used them to send incident reports via modem from their laptop computers. They were able to have conversations over the telephone that would have been impossible over police channels, which require brief, cryptic messages. They communicated with other officers, supervisors, detectives, or other agencies, and often talked directly to the citizens. Patrol officers talked to 911 callers while responding to crimes in progress to get clarifying information as they approached the scene. Citizens used them at accident scenes to call family members, and officers used them at crime scenes to coordinate the activities of backup officers. The biggest benefit reported by the officers was that cellular phones saved time. They were more efficient with less assistance from other officers and dispatchers; there was less need for dispatchers to relay information or for other officers to come by, go by or stand by. (Pilant, 1989).

Still, in today's modern world of communications, complaints about diminishing frequencies for law enforcement are not uncommon. Experts warn that the problem may get worse. Until the last several years, transmitting text constituted the extent of an officer's computer query. Departments are currently implementing the kind of technology that will allow them to transmit graphic images, like fingerprints and mug shots. Graphics take an enormous amount of radio spectrum because they take so much time to send; one uncompressed fingerprint would take about 26 minutes. Reducing the amount of transmission time requires that images be compressed with computer algorithms. As part of its NCIC 2000 project, the FBI is developing algorithms to reduce the transmission time of one fingerprint to about seven seconds.

Departments still have to successfully integrate voice and data transmission. There are typically four approaches:

Dedicated data systems are independent of their voice counterparts. A typical installation in a patrol vehicle requires a radio for voice transmission and one for data transmission. This kind of redundant system provides its own backup, but can be costly to build and maintain. Expanding the system also can be quite difficult.

Shared voice/data systems use the same mobile radio for voice and data. This approach may initially appear to be cost effective, but the associated technical problems that occur when humans and computers contend for the same radio channel may make it more expensive in the long run. Officers may not have immediate access to the channel, and data may be queued for an overly long period while awaiting a break in voice transmission.

Trunked systems operate on the same principle as telephone trunk lines, with the system locating an empty line and assigning it to the caller for the duration of the transmission. The advantage here is that a large number of users can access the system. Voice and data transmission can be integrated because short data packets, delivered in bursts, are sandwiched between voice traffic. The disadvantages to this type of system are that it lacks redundancy, since voice and data share the same mobile radio and system infrastructure, and there is little possibility that data services can be extended beyond the range of the voice system.

Public networks are the latest attempt at voice/data integration and are a radical departure from the traditional way of conducting police business. Private networks are those owned by a governmental body, while public networks serve many customers and typically charge a fee based on the amount of activity. Public networks, which can be

thought of as a telephone company for data, give officers access to information and message-switching services well beyond the normal voice range, and in some cases, even hundreds of miles away. A minimal capital outlay is required because the department does not set up the system. Also, if the infrastructure in the area has been built-out, start-up time is minimal. Public networks are highly reliable, redundant, and generally adaptable to new technology (Pilant, 1994).

With all of this impressive technology, one of the biggest communications problems still remains to be solved — that of law enforcement's inability to communicate across jurisdictions. It is a problem that has existed since the early days of radios in policing. In the 1960s and 70s, when radios were underpowered and cumbersome, one officer described his inability to communicate with his fellow officers: "Mission Control could talk to astronauts on the moon, but we couldn't talk to our partner around the corner less than a block away."

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Although today's lightweight, programmable, portable radios have plenty of power to communicate within the department, modern technology has yet to find a way for neighboring agencies to talk to one another unless they use the same radio channels. Illustrative of the problem is a pursuit in Southern California that involved numerous agencies, none of which could communicate with each other. The incident started when an officer from one city tried to pull over a vehicle for a traffic violation. When the driver refused to stop, the pursuit spilled over into the neighboring jurisdiction, and another officer joined the chase. Because the officers could not communicate with one another, they had to give information to their dispatchers, who relayed it to the other jurisdiction's communications supervisor, who relayed it to a dispatcher, who then gave it to the officer. During the chase, units from two state and federal agencies joined in, as did several more from neighboring jurisdictions. A local security guard even switched on his lights and followed along. The second officer to join the chase described the scene:

"Here we were, most of us not able to talk to one another, no one really knowing where we were going, where we were or why. ... Because we could not communicate with one another, no one really had any idea who was involved in the chase or what their function was. We also had units from all over trying to join in the chase, which meant folks cutting one another off and forcing us to lose ground on the crook. And the crook was driving with that old 'reckless abandon,' which meant he was close to having a wreck." (Zeljeznjak, 1995).

The police pursuit was confusing, chaotic, and dangerous. Had the units involved been able to communicate, they might have devised a plan for roadblocks, paralleled the chase to create a show of force and discourage the suspect, or moved ahead of the pursuit and set up a perimeter in case the driver abandoned the car and fled on foot.

Pursuits aren't the only multi-agency activity hampered by the lack of interoperability between jurisdictions. When a fire broke out in Northern California, response times were slowed because there was no common radio channel. The agencies that responded had to trade radios so they could communicate with one another. Another problem is the information that falls through the holes in the communications net. Investigations have been hampered for years because files stored in the database of one department are inaccessible to investigators from a department only a few miles away.

Law enforcement agencies typically operate on UHF and VHF frequencies. However, if radios do not have cross-band capability, they cannot communicate with one another. One manufacturer tried solving the problem by building a vehicle repeater and cross-band capability into its mobile radio. This allowed the officer with a low-powered radio to extend his communication range while transmitting to other agencies. Another solution, and one that addresses the crowded radio spectrum, has been to move to an 800 megahertz system, which operates at a higher frequency than that typically used by law enforcement agencies. In emergencies, multiple agencies can be grouped on one channel if they are all using the 800 MHz frequency. An 800 MHz system also allows for a more creative and efficient use of the airwaves. The disadvantages are that such systems are expensive, and may not let the department integrate existing equipment. They also may not have the range necessary for patrol officers unless the department installs a series of repeaters to pick up the signal and broadcast it to another receiver.

The National Institute of Justice's Rocky Mountain NLECTC center, located at the University of Denver, is investigating solutions to interoperability problems. Important also is its work with experts at Motorola, Ericsson, and the Association of Public Safety Communications Officials International (APCO) to set technical equipment standards.

In the early days of communications, Motorola led the way by developing and manufacturing the first two-way radios. It wasn't long before Motorola was policing's biggest, and, in many cases, its only supplier. When agencies wanted to expand their communications systems or buy new equipment, they found that only Motorola systems integrated with Motorola. New companies had sprung up, but police could not use them because their equipment was incompatible with what the department already owned. It was an equipment dilemma that was also a financial problem. It ruled out competitive bidding entirely and forced law enforcement agencies to "sole source" equipment purchases.

Today's field of communications equipment suppliers has broadened considerably, but many of the interoperability issues still exist. Creating technical standards that set specific criteria for communications equipment will enable these companies to develop radios that work together so departments can seamlessly integrate the equipment of more than one supplier.

The Rocky Mountain Center has also been tasked with finding ways to incorporate the needs of public safety agencies into the development of new technologies. To include the requirements of law enforcement in current technologies generally means retrofitting, redesigning, or rebuilding. By getting in on the ground floor and working with researchers, scientists, engineers and equipment manufacturers, public safety requirements can be incorporated at the development stages.

A significant improvement in communications will be the implementation of NCIC 2000, the FBI's project that is expected to increase the speed and processing of the current NCIC system.

When the National Crime Information Center was established in 1967, only 15 agencies used it. It processed 6,580 transactions per day, which added up to about 2.5 million transactions every year. NCIC currently transmits information to about 79,000 users and processes 574 million requests every year, about 1.5 million a day. It is the largest and most sophisticated system of its kind in the world.

When the NCIC 2000 project first began in 1990, it was intended to update the old NCIC system. It had not been fully modernized since its inception, and was handling millions more transactions than were originally intended. NCIC 2000 will still process requests for wants, warrants and criminal history information, but will have the added ability to transmit graphics such as fingerprints and mugshots by way of a scanning device in the patrol car. Prints and photos will be transmitted by radio to police headquarters and then by wireline to the FBI database.

Departments will access NCIC 2000 in much the same way they do now, but there will be different levels at which to participate, depending on the technical sophistication of the agency. At the highest level, an agency workstation might have a document scanner, live-scan equipment, and a digital video camera. In the patrol vehicle would be a single-finger live-scan machine, a printer and a video camera, along with a mobile computer. Those that do not have or cannot yet afford such sophisticated equipment, can still access the system. Even at the most basic level, data transmission services will be improved as the system's capacity and speed increases.

As noted earlier, the eventual goal is to tie together NCIC 2000 — which, along with wants and warrants information, will have a database of single prints of wanted persons — with the Integrated Automated Fingerprint Identification System (IAFIS), which is slated to be a huge tenprint database.

Street officers need this kind of advanced technology and sophisticated communications systems primarily for reasons of safety. But state-of-the-art communication has many more benefits, like its ability to turn a patrol car into a rolling substation. It also reduces radio traffic and, by acting as a force multiplier, boosts officer productivity. From management's perspective, it encourages efficient resource allocation so a department can effectively respond to the community's needs.

STREET OFFICERS NEED ADVANCED TECHNOLOGY AND SOPHISTICATED COMMUNICATIONS SYSTEMS PRIMARILY FOR REASONS OF SAFETY. BUT STATE-OF-THE-ART COMMUNICATION HAS MANY MORE BENEFITS, LIKE ITS ABILITY TO TURN A PATROL CAR INTO A ROLLING SUBSTATION. IT ALSO REDUCES RADIO TRAFFIC AND, BY ACTING AS A FORCE MULTIPLIER, BOOSTS OFFICER PRODUCTIVITY.

Appendix Sixteen

Car 54 Where Are You?

The Global Positioning System, quite possibly the greatest revolution in navigation since the sextant, is helping police departments use their resources more efficiently.

GPS was initially designed for the military. Foot soldiers in Desert Storm used hand-held GPS units to find their way around the desert sands and to seek out, locate and destroy the enemy. The technology has since made its way into the civilian sector and into applications as diverse as yachting, hiking, fishing and civil aviation.

The GPS receiver locks in on the Defense Department's NAVSTAR network of satellites and provides a reading of the user's exact position to within an accuracy of a few feet. The system consists of 24 satellites in high earth orbit transmitting a constant stream of radio signals. Each satellite has an extremely accurate, miniature atomic clock. The exact time the signal is sent, along with the position of the satellite, is encoded in the broadcast. The GPS receiver has a similar clock and compares the time the signal arrives with the time it was sent. This tells the device the precise distance to the satellite. The device homes in on three satellites, determines their distances, and through triangulation, provides the latitude, longitude and elevation anywhere on the face of the globe. For military uses, the GPS is accurate to within 10 meters. In peacetime this accuracy is available to all users with special equipment. But to keep a potential enemy on a par lower than the United States, an "error" is encrypted in the signal giving an ordinary GPS user coordinates accurate to only about 100 meters.

The public safety arena is one of the most important applications of GPS. City bus services, fire departments, and ambulance services — all organizations that maintain large fleets of vehicles — use a system based on GPS called Automated Vehicle Location (AVL). The system keeps dispatchers constantly informed of vehicle locations.

The principle behind AVL is simple. Each vehicle in the fleet has a GPS receiver which gives latitude, longitude and time. This information is translated into speed, heading and estimated time of arrival, which is then relayed via modem to the central dispatch location. But GPS is only one facet of an AVL system. An AVL system can also determine the vehicle's location, translate the coordinates into a street location, and communicate that location to the dispatch center. This information is broadcast quickly and frequently, about every 15 seconds for critical units, and every minute for other units. The system translates the latitude/longitude coordinates into an icon on a digital map of the city, or a text statement giving the street address, intersection or mile marker.

Location information is transmitted without any help from the driver. The dispatcher can even tell if the officer's lights and sirens are in use. Not only does this give the dispatcher and supervisor an accurate idea of where the department's vehicles are located, it keeps the officer from diverting his attention to relay information in what may be an emotional or adrenaline-charged situation.

AVL can support operations involving multiple vehicles, as in the case of pursuits. It can reduce radio time. It can be used to document a series of events, which can supplement the legal testimony of police officers. It can also provide the statistical information needed to redraw beat boundaries and allocate resources more effectively.

The police department of Schaumburg, Illinois, was one of the first to implement a GPS/AVL system. Schaumburg is a 70,000-population residential suburb of Chicago in which 19 dispatchers take 50,000 calls per year and send out 130 officers to cover 24 square miles. In the past, dispatchers assigned a call to the nearest beat car. They kept the information in their heads, continuously juggling locations, headings, speeds and assignments of all cars. Each of Schaumburg's critical response units now has a GPS receiver/antenna mounted on the trunk. The GPS provides the car's computer with the local coordinates, which it converts and sends along a frequency separate from voice transmissions to the CAD system at headquarters. Dispatchers see vehicle locations either on their individual screens or on a large terminal that displays a map of the entire city.

Although no quantitative study has been done to show how Schaumburg's GPS/AVL system has benefited the officers or the community, department officials believe it has helped immensely, said Lt. Tom Osterman, the system's architect. In one instance, an officer called for backup but neglected to inform dispatchers of his location. AVL enabled the dispatchers to pinpoint the officer and send assistance. In another incident, an officer pressed his emergency button before he was incapacitated, which enabled the department to send backup.

Since the system was implemented in 1992, the department has added some new features: vehicle polling, which has the computer selectively tracking certain vehicles; unit analysis to optimize the department's coverage and place vehicles in high-activity areas; real-time and archival use of a fast-reporting chase mode to "see" vehicles in pursuit.

The Schaumburg Police Department had two primary objectives when implementing AVL: improved response times and increased officer safety. According to Osterman, both goals have been met. Officers feel safer because they know the dispatcher is constantly monitoring their location and status. They know backup units can be dispatched many times faster than before. The system has also been surprisingly durable. Schaumburg's GPS receivers logged more than 600,000 vehicle hours with no functional problems. Schaumburg also saved money by purchasing a system that was not the most sophisticated but is still extremely accurate, Osterman said. "If you were to walk to the vehicle location that was reported by the GPS receiver, you would see the patrol car. We've always found the car right where the system said it would be."

Source: *Police Chief* magazine, International Association of Chiefs of Police, September 1994, by Lois Pilant.

Appendix Eighteen

Innovations in Policing:
Charlotte-Mecklenburg Police Department, North Carolina

The Charlotte-Mecklenburg Police Department is building a Police Master Information System for this North Carolina department that has 1,386 sworn and 424 civilian employees, and a commitment to community policing. The project is funded by COPS MORE 95 and 96 grants, as well as local matching funds and additional local funding.

Each officer is issued a laptop computer configured to have the same capability as a desktop computer. The system will support the CMPD's philosophy of Community Problem Oriented Policing (CPOP), and be comprised of several key components, all of which are viewed as critical to the overall success of the information system and to the actualization of CPOP within this police department.

The first component is the Police Local Area Network (LAN), which was implemented in early June, 1998. The LAN is structured in a way that links all workstations within the headquarters building and workstations at 18 remote police facilities (district offices, training academy, service area centers). The LAN servers are centrally located within the headquarters facility and connected with workstations in the headquarters and remote sites. The LAN operates on a Windows NT 4.0 server/workstation platform and utilizes Microsoft Exchange/Outlook 97 as its E-Mail server/workstation application.

A second component of the system is the Mobile Data Communications System (MDCS). This component, scheduled for implementation in August-September 1998, will enable officers to receive their dispatches, perform queries of local, state and federal databases, perform the wireless transfer and query of police offense reports, field interview records and other local records, and allow officers to utilize E-Mail (with attachments) in a wireless setting, thereby eliminating many of the traditional communication barriers which exist between members of the patrol force and investigators and administrators. The MDCS will enable officers to have field access to mugshot photographs. In addition, the MDCS will provide field officers with access to the legacy IBM mainframe computers. In essence, the MDCS has been designed to truly promote and actualize the "mobile office."

The KB-COPS records management system (Knowledge-Based Community Oriented Policing System) is a custom developed database which provides the department with advanced reporting detail and querying capabilities, based upon the elements of the North Carolina criminal statutes. The implementation of KB-COPS started in June 1998.

The department has conducted a thorough needs analysis and design concept, including templates for the police offense report and supplemental individual offense categories (e.g., robbery, burglary, larceny).

The Computer Aided Dispatch (CAD) system will provide the traditional functions a CAD system provides, with several enhancements. The CAD will aid the department in becoming less "call-for-service" driven and enable officers to manage time for problem-solving efforts through making appointments and call selection features. The CAD will provide address histories to officers in the field to enhance safety and provide the necessary background to identify and begin resolving problems. Also, the CAD will enable enhanced query capabilities as well as interfacing directly with the KB-COPS records management system. The CAD is scheduled for implementation in Summer 1999.

The Field Interview system will enable officers to directly input field interviews from laptop computers in the police vehicles and to query the field interview database when they contact a suspicious person. The effect of this system is that officers will be able to more easily and readily identify patterns among suspects in offenses and take appropriate measures to investigate them further or to refer information to investigators for proper follow up. The result is that fewer suspects in crimes will be able to slip through the net woven by incomplete, ill-conceived, or inadequate paper-to-computer collection systems.

The Future Alert Contact Network (FALCON) is a triggering/alerting software application being developed through a joint venture between the CMPD and the University of North Carolina at Charlotte. Its purpose is to use technology, more so than officers, to sort through reports and records to establish patterns, trends, particular offenses or incidents, contacts with individuals or suspects. The application is based on officers setting database queries for any of the databases mentioned in this narrative. Incoming reports are filtered through FALCON and, upon a query threshold being met, FALCON sends an E-Mail, a page, or both to the inquiring officer. The officer can then respond accordingly to address an issue to which he or she is alerted.

The Internal Affairs Case Management component, which will automate all internal investigation forms and data, is designed to enable the department to conduct trend and other analyses of complaints in general or against individual officers, case dispositions, problem behaviors, and training and policy issues.

Important Technology Lessons Learned

The Charlotte-Mecklenburg Police Department has undergone an exhaustive process of identifying and analyzing its information system and data needs. The needs analysis was conducted involving a majority of the department's patrol, investigative and civilian staff. It was conceived in the spirit of providing the data and system needs of those who make community policing a reality. While the system enables the management and direction of resources and data, and will provide the department with information necessary to fulfill its mission and obligations to the community, it is not a "management" system.

Off the shelf software products were incapable of fulfilling the needs identified by the department. As a result, the department has had to look to software vendors for custom development of applications to meet its information system needs.

The results of the needs analysis are likely to be very applicable to police organizations both large and small throughout the country. The development of system components such as Field Interview, FALCON, and possibly Internal Affairs are also likely to be transferrable in such a manner. However, the KB-COPS records management system and CAD are likely to have more limited transferability, such as throughout the state of North Carolina. Particularly with KBCOPS, the system is based upon the criminal statutes (and thus the elements of offenses) of North Carolina. Such an application can be modified to incorporate the elements of offenses of another state, however, these changes would require additional coding and programming costs.

The department has developed a very comprehensive information system plan and is proceeding in a fashion which places it at the forefront of technology initiatives and applications within police agencies. Department personnel welcome anyone interested in learning more about these initiatives, believing that the lessons learned and the analyses it has completed can and should be available to other agencies both large and small.

Source: CMPD Web page (www.charmeck.nc.us/cipolice/cmpdhome.htm), and the Web page of the International Association of Chiefs of Police committee on Law Enforcement Information Management (www.iacptechnology.org).

Innovations in Policing:
Oxnard Police Department, California

In 1995 the Oxnard Police Department received federal funding under COPS MORE to institute a laptop computer field reporting program. The grant allowed for the purchase of 30 mobile computers, a Windows NT 4.0 network, and software for use in field report writing. Upon deployment, the project was to allow the completion of report face pages in the field and a subsequent download of appropriate information directly into the records management system (RMS), thereby eliminating data input downstream. Officers would dictate the narrative portion of their police reports, as they have done in Oxnard for some 15 years.

Initial field deployment was to be in briefcases followed by docking station mounting in field units. The laptops were to be loaded not only with the field reporting program, but also with reference materials, such as the *California Peace Officers' Legal Sourcebook* and electronic editions of the Penal and Vehicle Codes. The department also considered adding instructional programs in Spanish and tutorials in typing.

In 1996 Oxnard signed a contract with the developer of a report writing package. The package printed out the department-specific forms on blank paper and downloaded report data back to the records management system. In June 1997, seven months into the pilot phase of the report writing project, the department recalled all machines loaded with the report writing software, and reexamined the priority of field reporting versus replacing its existing CAD/RMS system. The recalled laptops were redeployed to field officers with software that supports the Microsoft Office suite of applications.

The Ventura County Consortium

The Ventura County Sheriff's Department, the Simi Valley Police Department and Oxnard Police Department formed a consortium of agencies in pursuit of a shared mobile data information system. The group visited 15 public safety sites that used various solutions to capture and process mobile data. The group discovered:

- Few officers make use of laptop features. It is rare for them to actually take computers out of their units.
- Some agencies experienced, and many more feared, damage to laptops by removing/replacing them throughout an officer's shift.
- It was difficult to obtain both officer acceptance and airbag compliance with most mounting solutions for laptops.
- Seeing screens in oblique or direct sunlight is nearly impossible, with the exception of the MobileVU screen.
- Modular installations are less likely than laptops to be stolen.
- Although more expensive than its laptop counterpart, it is hoped that a modular installation's durability will outlast two to three generations of laptops.

Oxnard Innovations

Exchange

Probably the biggest boost in productivity was the June 1997 roll-out of Exchange 4.0 on the department's NT 4.0 network. Gone forever is the need to photocopy memos to every commander, sergeant and officer. Exchange works equally well on laptops or desktop PCs. Exchange was a big hit internally, and plans are to fold it into a wireless system for use by field units.

Red Light Enforcement

After a successful testing period where motorists were only warned about red light violations, in July 1997 the city of Oxnard began issuing citations for red light violations caught on camera. The U.S. Public Technologies company installed photo red light enforcement cameras at key intersections. Such systems have been used in the U.S. since 1968, and there are more than 8,000 such systems in 45 countries today. The camera system takes photographs of the vehicle's front license plate and the driver's face as the vehicle crosses the limit line on a red light.

In addition to the cameras, the company installed poles and cabinets to mount the cameras; installed roadway detection loops; installed warning signs at major entrances of the city; distributed pre-enforcement notices; provided all supplies; maintains all equipment; provides training to department staff; performs processing of all phases of the program, up to and including notices to appear; handles media and community relations, including public service announcements and presentations to local groups and schools; participates in community activities; provides expert witness testimony; maintains a toll-free, bilingual service for violators to call; manages reports and provides statistical studies.

It is important to note that this system is not intended to generate revenue. The cost is 90 percent of the city's normal revenue from like tickets issued by officers.

TeleMinder

The TeleMinder system makes it easy to quickly identify and telephone thousands of people with emergency instructions. It can be used for neighborhood-specific crime alerts, staff recalls, neighborhood watch notifications and senior citizen check-ups. It includes faxing capabilities with features that allow for automatically faxed reports, fax broadcasting, and fax-back service.

GO/TRAK

The Gang Offender Tracking Program grew out of the Oxnard Police Department's role as a national demonstration site for the Department of Justice's Serious Habitual Offender program. GO/TRAK catalogs information on gangs and gang members, allowing officers to pull up photographs of the offender at computer terminals.

InfoCOP

The Information Management for Community Oriented Policing program is administered and funded by the Department of Justice's Office of Community Oriented Policing Services. InfoCOP is the next generation of crime analysis software designed for the collection and analysis of crime, operations, and calls for service data. The program was written by John Simmons and Dennis Jay Kenney of the Police Executive Research Forum.

AutoCAD R13

This program provides to-scale representations of major crime and critical traffic collision scenes. AutoCAD graphically represents the circumstances of major incidents for both investigators and juries.

LCD Projector

The Oxnard Police Department said goodbye forever to overhead slides when it started using the Sharp XGE1000UB LCD Projector. It provides color images with enough lumens to operate in a fully lit room. It operates off a variety of input sources, including external laptop monitor parts, TV cable, VCF and even laser discs.

Source: OPD Web page, and the Web page of the International Association of Chiefs of Police committee on Law Enforcement Information Management (www.iacptechnology.org).