

Global Positioning Systems / Global Information Systems

Usage for Law Enforcement

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Global Positioning Systems / Global Information Systems Usage for Law Enforcement

GPS/GIS technology isn't new; it was first intended for military applications and has been around for several years. Many of the same benefits offered to the military can be extremely valuable to the law enforcement community as well. Navigation in remote areas or on large bodies of water, unit coordination, and enhanced command and control capabilities are currently being used. In addition to these same benefits, law enforcement has begun to utilize GPS in several new and exciting ways. Every law enforcement agency in the United States should be striving to learn more about GPS capabilities, as well as how to best utilize this technology for their agency. For agencies that have very large and/or remote jurisdictions, the navigational capabilities of GPS technology could greatly enhance the efficiency and safety of Officers. Some agencies utilize GPS and GIS technology for crime scene mapping and different types of special operations, while others are beginning to use GPS for monitoring probationers. GPS is just now beginning to be utilized by law enforcement agencies, partly because declining costs have made this technology more accessible. Some of the most important uses of GPS technology are probably yet to be discovered.

The purpose of this paper is to educate the reader about what GPS is, the history of the GPS satellite system, how it works, accuracy and factors affecting it, sources of error, automatic vehicle location and navigation, crime mapping, special operations, and other uses.

GPS/GIS

What is GPS?

Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. The first of these satellites was launched in 1978 and all 24 satellites were in place by 1994. Each satellite is built to last about 10 years, but new ones are constantly being built and launched to replace older satellites. The satellites orbit the earth at a height of about 12,000 miles and travel at speeds of about 7,000 miles per hour. A GPS satellite weighs approximately 2,000 pounds and is roughly 17 feet across with the solar panels extended. GPS satellites are powered by solar energy. They have backup batteries onboard to keep them running during a solar eclipse, when there is no solar power. Small rocket boosters on each satellite keep them flying in the correct path. The GPS was originally intended for military applications, but in the 1980's the United States Government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day (Garmin 2005).

How does GPS work?

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to the earth. The satellites transmit two low- power radio signals designated L1 and L2. Civilian GPS uses the L1 frequency of 1575.42 MHz. The signals travel by line of sight and can pass through clouds, glass, and plastic, but cannot

go through most solid objects, such as buildings and mountains (Garmin 2005). GPS receivers take this signal information, transmitted by the satellite, and use triangulation (see figure 1.1) to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. If the GPS unit has information from other satellites, it can determine the user's position and display it (GPS Basics AGF).

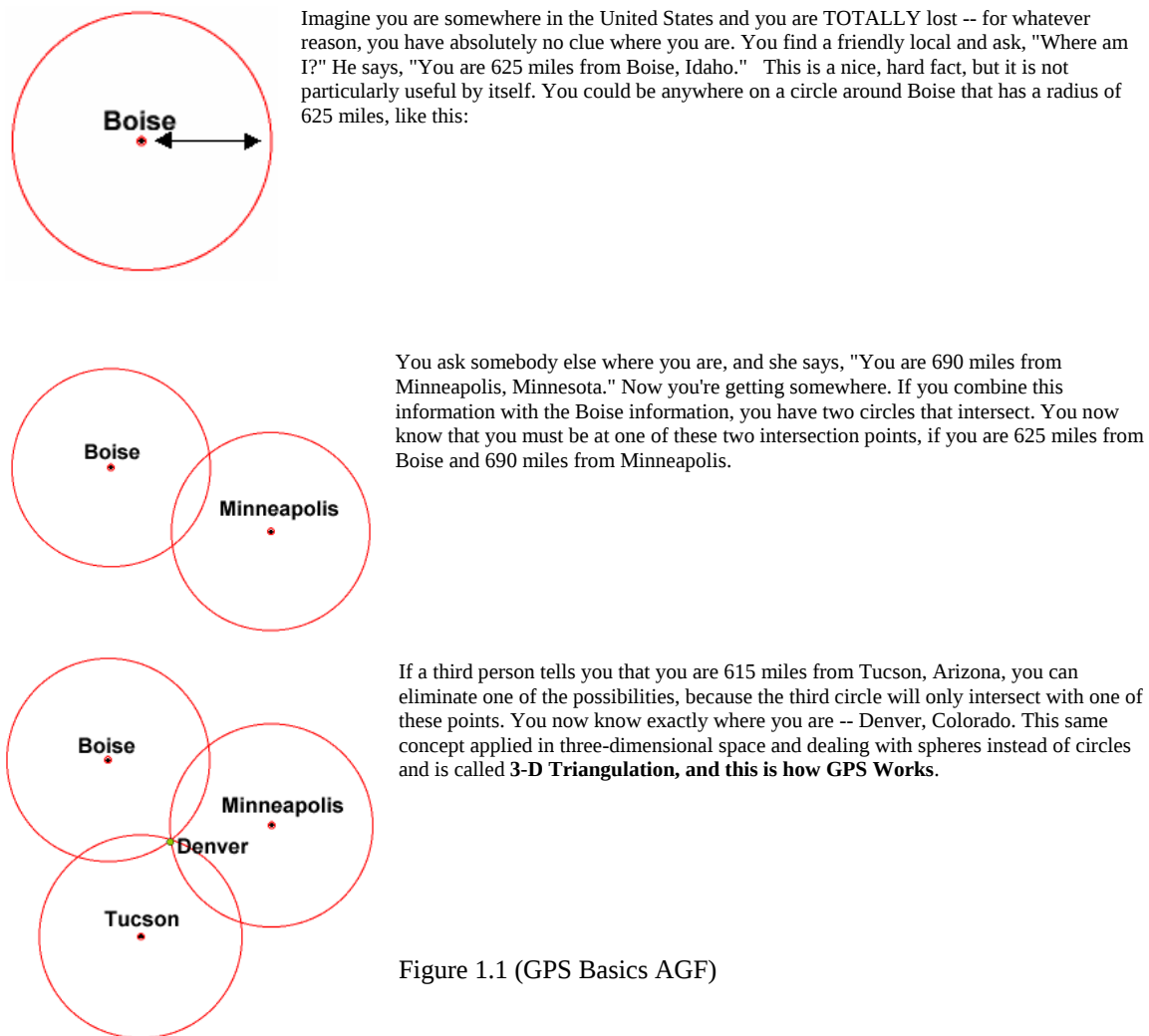


Figure 1.1 (GPS Basics AGF)

How Accurate is GPS?

GPS receivers today are extremely accurate, thanks to their parallel, multi-channel design. They work well in dense foliage or urban settings with tall buildings. Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. Most GPS receivers are accurate to within 15 meters on average.

Receivers equipped with WAAS (Wide Area Augmentation System) can improve accuracy to less than three meters on average. Wide Area Augmentation System was developed by the Federal Aviation Administration and involves two extra satellites placed over the equator. These satellites constantly broadcast correction signals.

Receivers equipped with Differential GPS correct accuracy to 3 to 5 meters. DGPS equipped receivers use third party, fixed ground stations to correct the coordinates received from GPS satellites and re-transmit them to the GPS receiving device (Garmin 2005).

Sources of Error

GPS signals can sometimes be degraded by certain factors, thus affecting the accuracy of the system (Garmin 2005).

- Receiver clock errors – A receiver's built-in clock is not as accurate as the atomic clock.
- Ionosphere/troposphere delays – Satellite signal slows as it passes through the atmosphere. GPS uses built-in models to calculate this and help correct error.
- Signal multi-path – This occurs when the signal reflects off of objects such as tall buildings or large rock surfaces, thus increasing the signal travel time.

- Clocks onboard the satellites - This may cause very slight timing errors.
- Orbital errors – These are inaccuracies of the satellite’s reported location.
- Number of satellites visible – The more satellites a GPS receiver can see the better the accuracy. Buildings, terrain, electronic interference, or dense foliage can sometimes block signal reception.
- Satellite geometry or shading – This refers to satellites that are located at wide angles relative to each other or when they are located in a line or tight grouping.
- Intentional degradation of the satellite signal – Selective Availability (SA) is an intentional degradation of the signal once imposed by the U.S. Department of Defense. SA was intended to prevent military adversaries from using the highly accurate GPS signals. The government turned off SA in May 2000, which significantly improved the accuracy of civilian GPS receivers (Garmin 2005).

LAW ENFORCEMENT USES

GPS and Law Enforcement

GPS technology offers many benefits for all types of law enforcement agencies. There are numerous benefits to Conservation Law Enforcement in particular. This is due to the large jurisdictions (usually an entire state) as well as the diverse, remote, patrol areas encountered.

The navigational capabilities offered by GPS enhance efficiency and safety as well as support a variety of law enforcement and criminal justice functions. GPS technology can also be used to carry out special operations and help educate new personnel about a newly assigned work area.

GPS is just beginning to be used by law enforcement agencies. Although it offers many new, exciting tools to help law enforcement, it may offer a multitude of now unforeseen applications in the future. The technology has declined in cost during the last few years, making it much more affordable and therefore accessible to agencies. Many agencies issue hand held GPS units, helping integrate officers into a law enforcement plan utilizing airborne assets or other ground units working as a team. The Riverside (California) Police and Ventura County (California) Sheriff's Department use GPS to enhance the efficiency of their aviation units (Role of Global Positioning Systems in Policing Oct. 2001). They do this by utilizing computerized maps of their jurisdictions in conjunction with GPS. Thus, aviation personnel can determine their exact location, speed, and arrival time when responding to calls. The GPS unit provides a computer with constant updates of the helicopter's location and plots it on a map. This allows them to know their exact location during the day, night, or during adverse weather conditions (Role of Global Positioning Systems in Policing Oct. 2001). Air units utilizing GPS can also relay the location of any activity on the ground simply by relaying the coordinates to responding ground units. By utilizing computer maps, the air units can even relay the fastest and easiest route into a location to ground units. The air unit personnel do not have to fumble with maps, or provide vague locations in reference to other landmarks.

This technology is also being applied to ground personnel. The advantages of GPS are the most valuable to law enforcement working in very large jurisdictions with very diverse and remote patrol locations. Most counties in Arkansas are approximately 600 square miles, with most having dense, remote forest and some having large waterways such as major rivers and lakes. These areas are extremely difficult for a newly assigned officer to learn and patrol. This transition can be made easier by a database of problem enforcement areas, and other areas of interest being made available to him. Taking data collected by the former officer who worked the area and providing it to the new officer, using computer programs such as Arc View, can accomplish this. The new officer can then begin his/her patrol in the newly assigned area armed with many of the lessons already learned from a veteran officer who has worked the area for many years. If his/her vehicle is equipped with a GPS unit, the officer will never be lost in the new jurisdiction, (although there is no substitute for first hand knowledge of the officer's jurisdiction). The Officer will also never be completely isolated from backup if the dispatch cannot determine his/her location using his GPS unit, even with no idea how to direct backup officers to his location (Role of Global positioning Systems in Policing 2001).

If an officer is involved in a pursuit, he can always determine his precise location. Officers can always find the location of an incident, plan their travel route, and estimate their arrival time. Officers acting as first responders can always find it easy to summon medical help, even in unfamiliar territory by using GPS to provide their location to a responding ambulance or med flight.

GPS can be used in some unorthodox ways, such as having a bait vehicle in an area that has a high automobile theft rate. The vehicle can be equipped with a GPS unit, which will relay information about the vehicle's location to a remote unit. This will allow investigators to easily track the vehicle and make an arrest once it has been stolen. Utilizing GPS will allow teams to track these vehicles over an unlimited area while allowing them to keep a greater distance from the vehicle than if they were using another type of tracking system. This could allow investigators to track a vehicle until it has been taken to a "chop shop" in another location, perhaps even another city or state (Role of Global Positioning Systems in Policing).

GPS also allows police to provide enhanced recovery of stolen items expensive enough to be equipped with GPS units. Items such as cars, heavy equipment, boats, airplanes, and almost anything else may be equipped with a GPS unit to locate it if it were stolen.

During the last decade, law enforcement professionals have begun to map crimes and other incidents in their respective jurisdictions. The delay was probably due to the difficulty of use with early GIS software applications as well as the relatively high cost. It has now become relatively inexpensive and certainly much more user friendly. The availability of data sources has also mushroomed in the last ten years, to the point where digital street map data is available virtually everywhere in the United States. Therefore, crime mapping is becoming very popular (Incident Mapping and Analysis Program with Arc View handbook).

The future prospects and applications of GPS technology are virtually limitless. GPS already helps law enforcement operate in unfamiliar territory, track stolen

merchandise, stay safe, summon help, and do many other things. GPS technology is a great, powerful asset to support law enforcement agencies in a broad and continually expanding variety of operations.

Automatic Vehicle Location (AVL)

Automatic Vehicle Location or AVL is one of the most popular and widely used applications for GPS/GIS technology. It is a computer-based vehicle tracking system. These systems are used extensively both in military and civilian purposes, including transit and trucking fleets, ambulances, and police vehicles. The benefits to Automatic Vehicle Location systems are:

- Increased overall dispatching and operating efficiency
- Quicker response to calls
- Increased officer and passenger safety
- Input to traffic signal preferential treatment actuators
- Silent emergency alarm

The system operates by measuring actual real time position of each vehicle and relaying the information to a central location. Actual measurement and relay techniques vary, depending on the needs of the agency and the technology purchased by the agency. Receivers placed on the roof of each patrol vehicle (picture 2.1) read the signals from satellites and transmit the location back to dispatch. Some potential problems with this system are that foliage, mountains, tall buildings, and tunnels affect the system and may interfere with satellite reception, as well as transmission of data to dispatch (Internet).



Picture 2.1 GPS Roof Receiver

AVLN (navigation) is when AVL is used in conjunction with navigation information, such as roads and maps. AVLN provides the officer with accurate information concerning the best response route to an incident. It also gives dispatch location information on patrol units, thus enabling the closest patrol officers to be dispatched to a particular incident. Should an officer need immediate assistance, AVLN is a safety net. It gives backup officers or rescue personnel precise information about the location of an officer in need of assistance. This approach is also being applied to commercially available navigation systems, such as On Star, so that motorists will no longer have to guess at their location when requesting assistance from emergency response personnel (Role of Global positioning Systems in Policing).

The Arkansas Game and Fish Commission Enforcement Division recently equipped its fleet of Law Enforcement vehicles with a Merlin AVL (picture 2.2). The Merlin AVL is an 8 channel, Internal GPS with backup power supply. It has 6 general-purpose lines for vehicle monitoring. It is PC programmable to tailor to your needs, and

can store 1,024 position fixes for replay. The system was implemented more for officer safety than for fleet management. The system allows dispatch to see the location of each enforcement unit in the state (figure 2.1).



Picture 2.2 Merlin AVL system on AGF patrol vehicle

The information available to the dispatch is: date and time of the update, vehicle location (both in coordinates and road number), direction of travel, and vehicle speed. Each individual Merlin unit is programmed to send information at a designated time interval. The system also notifies dispatch when the emergency lights are activated on the patrol vehicle. Each unit is equipped with [Edited out due to sensitive material] in case of an emergency (picture 2.3).



Picture 2.3 [Edited due to sensitive material]

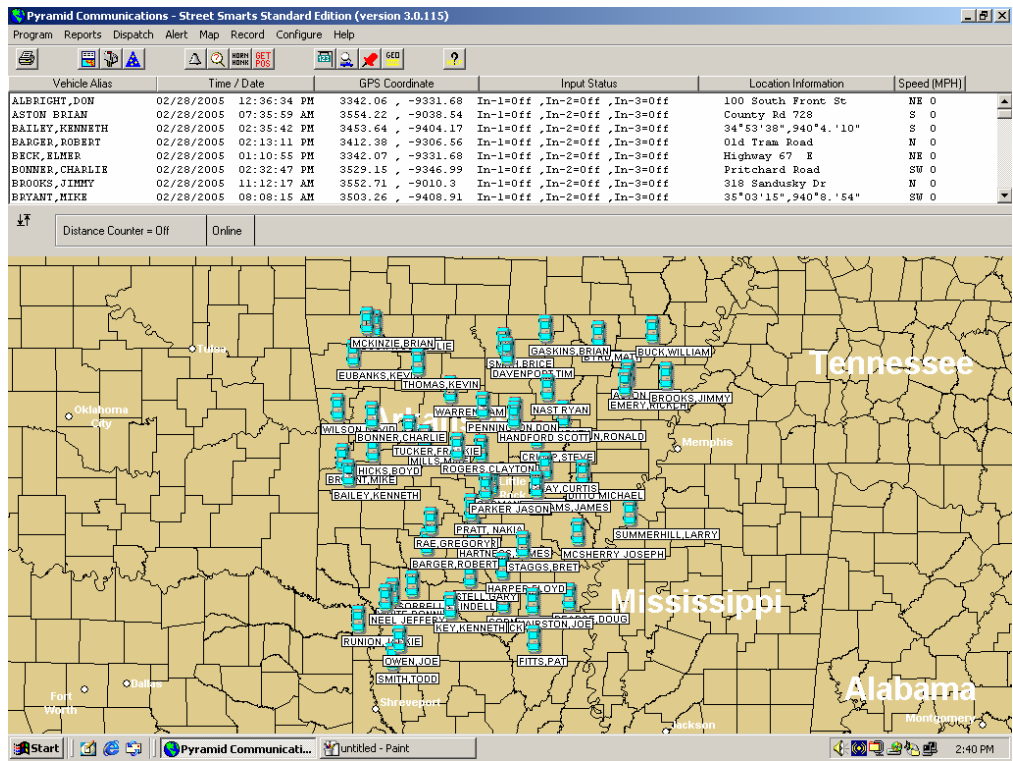


Figure 2.1 AVL System display as seen by Arkansas Game and Fish Dispatch

Crime Mapping

In recent years, many law enforcement agencies have begun to use GPS/GIS for crime mapping (figure 2.2). A crime is a spatial event. It happens at a place and can usually be described by its type of offense and the date and time when the offense was committed. Why a crime occurs at a particular place may be influenced by the attraction of potential targets at a specific location or the simple geographic convenience for an offender to commit an offense at a particular location. For example, night hunting deer may naturally occur in an area where the poacher has a good chance of encountering deer, but may not occur as frequently in an area where road access is not available. To help understand where and why crimes occur, maps of crime events can often help in the targeting, deployment and allocation of crime prevention resources to areas of vulnerability. Maps showing patterns or hotspots of crime can present effective visual images that help people understand their distribution and explore possible reasons behind certain types of criminal activity (What is Crime Mapping? OJP USDOJ).

Mapping crime of any type can help law enforcement to enforce laws and regulations more effectively and even prevent crime in the areas they work. An understanding of the locations where crimes or concentrations of crimes have occurred can be used to better utilize manpower resources. Administrators may use maps of larger geographical areas to identify trends, possibly identifying future problems for other areas in their jurisdiction (What is Crime Mapping? OJP USDOJ).

I believe that crime mapping can be used very effectively when a patrol area is being taken over by a new officer. If crime mapping has been completed for the patrol

area, a new officer has a better idea of where and when most kinds of crimes occur. This will give a new officer a head start on effectively policing his/her patrol area.

Departments frequently use computer mapped crime locations to delineate hot spots or concentrations of crime. Highlighting such areas helps police direct patrols where they are most needed (figure 2.2).

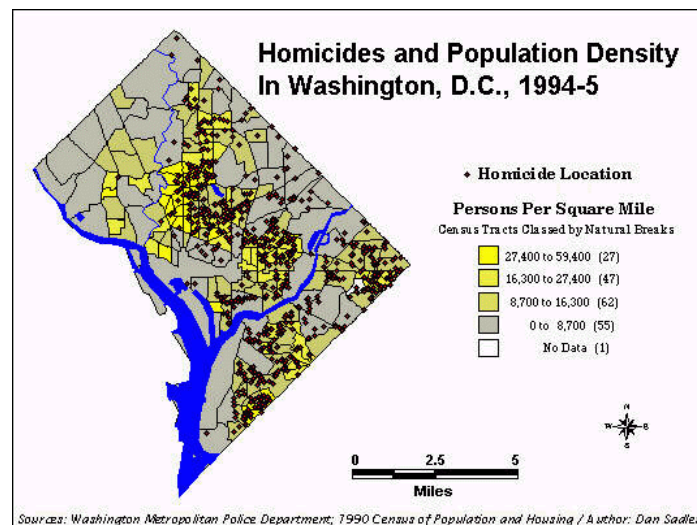


Figure 2.2 Example of Crime mapping (What is Crime Mapping? OJP USDJ)

Special Operations

Special Operations is an area in which GPS has proven to be very useful in law enforcement. Special Operations can range from SWAT team operations, anti-terrorism units, or operations utilizing extra manpower to target an area high in a certain type of crime. The Arkansas Game and Fish Commission has found handheld GPS to be quite useful during many types of special operations. They use GPS to position officers at key locations in a county while conducting counter- night hunting operations, which utilize airborne observation platforms. Most officers assigned to these operations are unfamiliar

with the patrol area, as are the pilots in the aircraft. By using GPS, the aircraft unit will know the area where officers on the ground are located and can direct them to a violation using GPS coordinates. The officers can then enter the coordinates in a GPS receiver and find the violations without being familiar with the area.

In one particular situation, an officer discovered seven illegal turkey bait sites on the evening prior to Spring Turkey Season. Because these sites were several miles apart, the officer could not be at each bait site the next morning. He had a handheld GPS with him and saved the coordinates of each site. Since not enough time existed to take other officers to each site, officers from neighboring areas were given the coordinates and entered them into their handheld GPS. On opening morning, these officers made their way to the illegal bait sites, even though they had never been to them before. They successfully apprehended illegal hunters on several of these sites. The success of this operation would not have been possible without the help of GPS.

Monitoring Probationers and Parolees

Another very exciting use for GPS is the monitoring of probationers and parolees. Probation and Parole Officers tend to have a very high number of probationers or parolees under their care. Probationers tend to change addresses frequently and sometimes tend to be hard to locate. Maps displaying Probation Officer workloads by showing the locations of each probation Officer's clients, color-coded by the required level of supervision, can be an effective management tool for administrators (Role of Global Positioning Systems in Policing 2001).

Continuous monitoring of the location of the probationers can also be accomplished through GPS. Although cost is a factor, electronic ankle bracelets can be used to monitor probationers. Florida-based Pro Tech Monitoring has developed a GPS-based tracking system, called SMART system, that combines Trimble's miniature Lassen SK8 GPS board and cellular technology into a unit worn by the criminal offender. In addition to the 3.5 ounce, tamper proof ankle bracelet, the system includes a portable tracking device that is electronically leashed to the ankle unit.

Unlike conventional systems that are only able to monitor offenders at home, Pro Tech's Monitoring system, and other systems like it, can keep track of offenders anywhere at all times. The system is smart and can be programmed with "rules of release" which stipulate where the offender should be at any given time. If an offender breaks the rules of release, the system automatically warns the offender and then sends a message to a control center if the problem is not immediately corrected (Role of Global Positioning Systems in Policing 2001).

CONCLUSION

In summary, the use of a Global Positioning System can be an effective and powerful tool for any law enforcement agency. The history of GPS, what GPS is, how it works, its accuracy, sources of error, GPS and law enforcement, automatic vehicle location, crime mapping, and monitoring probationers and parolees are just a few of the many important aspects of this amazing technology.

Also significant are the ways in which the Arkansas Game and Fish Commission Enforcement Division and other law enforcement agencies currently utilize GPS. The potential uses for GPS yet to be discovered will more than likely be useful in law enforcement as well.

Hopefully, this information will motivate law enforcement managers to learn as much as possible about GPS and its applications in law enforcement, as well as to strive to find new, innovative applications for this important technology.

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