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Mapping the Right Direction—What GIS advancements mean to public safety

Geographic Information Systems and Public Safety

By Bill Weaver

This article will look at public safety operations from the perspective of a new paradigm. This new paradigm is driven, primarily, as the result of the ubiquitous cellular telephone (over 100 million users) and cellular users contacting public safety answering points (PSAPs) to report emergencies using the U.S. universal emergency number, 9-1-1.

The Primary Driver

In 1994, the Federal Communications Commission (FCC) issued its landmark report and order directive to the wireless carriers relative to delivery of the cellular caller's true telephone number, and the technology required to locate these very mobile callers in the emergency public switched telephone network (PSTN). The FCC's order, titled FCC 94-102, has been amended three times—to date. These iterations were due in large part to petitions by the wireless carriers, advancements in location technology, and the continued maturation of cellular location technology. These iterations—and assuming additional iterations will come in the future—have a common denominator: Provide a technology-based solution to enable PSAPs to receive and locate cellular 9-1-1 callers by way of a desktop map.

Location Enabling Technology

Two schools of thought exist when discussing solutions to locate cellular 9-1-1 callers: network-based and handset-based. In their simplest form, they are:

> **Network-based**: Also called a "smart network" approach, this methodology entails installing special hardware and software in (or on) the cellular carrier's network which uses some form of network intelligence to determine where a cellular 9-1-1 phone call is originated.
>
> **Handset-based**: Commonly called a "smart phone" approach, this solution uses a global positioning satellite (GPS) chip embedded in the cellular telephone which communicates with orbiting GPS satellites to determine where it is in the serving area. This location information is relayed to the receiving PSAP when 9-1-1 is dialed.

Regardless of the location solution employed by the wireless carriers, the objective is the same: Establish a voice connection with the emergency dispatcher using the 9-1-1 public switched telephone networks and transmit calculated location information to the PSAP for response.

More on 94-102

FCC 94-102 places the responsibility to locate wireless 9-1-1 callers entering the PSTN on licensed cellular carriers and their selected location determination solution. The PSAP must, however, be able to use the derived cellular caller's location information. Such use will involve employing a new, but familiar, technology in the PSAP to a greater degree than is currently the case. This is the new paradigm: geographic information systems (GIS) and its increasing relationship to public safety in general, and public safety communications in particular.

GIS Defined

A GIS system is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information on a computer monitor for enhanced decision making and analysis. The operative word here is information.

Through visualization, a GIS system can be used to produce images—not just maps, but drawings, animations, and other cartographic (map-linked) products. These new images allow public safety personnel (i.e., dispatchers, responders, specialist personnel) to support their responsibilities in ways that were literally never before available.

More Than Just Wireless 9-1-1

It is presumed that FCC 94-102 will result in a large number of PSAPs acquiring mapping systems and GIS technology for the purpose of locating wireless 9-1-1 callers. It would, however, be improvident to use this new visual information tool solely for the purpose of locating wireless 9-1-1 callers. Once a base map is developed, public safety agencies have the cornerstone foundation for a number of applications to improve dispatcher decision making, agency response to calls for service, and implement better agency planning and management initiatives, to name a few. Clearly, the opportunities for influencing decision making by and management of a public safety agency are significant with the use of a robust GIS system. What follows is a short list of emerging and available applications using GIS-derived information as a decision support tool.

In a public safety sense, typical GIS-based applications include, but are not limited to, the following (in alphabetical order):

Automatic Crash Notification (ACN). ACN is an emerging application that employs a range of technologies related to notifying the appropriate PSAP (or third-party resource) of an emergency incident, when a specially equipped vehicle has been involved in a traffic accident. Transmitted information elements from the vehicle to the PSAP may include location, direction of travel, extent of crash, number of occupants, and key information related to the event and "assumed" required resources (i.e., roll-over, vehicle fire, injury status).

Automatic Vehicle Location (AVL). AVL systems have been in use for a number of years. In general, a typical AVL system involves the monitoring and display of vehicular fleet information in a specific geographic area (district, zone, beat, etc.) generally for command and control purposes as well as status and asset management purposes.

Electronic Pin Map. A form of location identification display, this application can include both real time and post-incident location information. In the former, this might include displaying the location of the physical (estimated) location of inbound callers requesting public safety services from an area PSAP or service provider, including emergency and non-emergency callers. In the latter, this might include geo-spatial analysis capability of specific incidents, crimes or calls for service within a specified physical area or a particular time period. Common uses include incident analysis, crime/incident analysis, pattern recognition, incident linkage, etc. (Geo-spatial analysis is defined as analyzing events based on time distribution and location—or what happened where.)

GIS-based Computer Aided Dispatch (CAD). As GIS mapping systems mature and become more widely deployed public safety tools, so, too, will their integration with CAD systems. Other anticipated improvements will involve CAD systems' acceptance of multiple forms of location information (aside from the standard GEO file format) and the ability to support a wide range of dispatch management capabilities. For instance:

Many of today's contemporary CAD systems require a considerable amount of "key-stroking" by the dispatcher to complete an assignment, change status information, manage units, etc. As CAD systems become more integrated with GIS and map-based systems, the dispatcher will have the option of using icon manipulation to, for example, assign calls for service to area field units, as well as transmit dispatch incident information to in-vehicle communication units (i.e., MDTs, MDCS).

In addition, most of today's CAD systems use "relational" logic in their recommendation of a particular unit to a call for service. Relational logic assumes that all available units in Zone 1, for example, are eligible for assignment to calls in Zone 1, regardless of their actual location relative to the pending assignment. This, too, will change considerably as mapping integration trends continue to mature.

Instead of using general relationship logic, mapping systems will use the actual location of an in-field unit as the primary assignment recommendation criteria. Thus, the unit closest to the call would be assigned as opposed to the "next-up" unit logic in conventional recommendation algorithms. Finally, as CAD systems become more visual and unit recommendation logic becomes based more on the unit's location in relation to the call, public safety agencies will be faced with new challenges to managing field units using location as a key dispatch decision factor as opposed to existing relationship logic.

In Vehicle and Mobile Mapping. This involves installing equipment capable of displaying and manipulating a digitized map for a wide range of public safety and public safety management objectives. These include, but are not limited to, field supervision, deployment management, and route identification support. Further, as personal digital assistants (PDAs) become more mainstream public safety tools, the use of, for instance, Palm Pilots (TM) equipped with hand-held mobile mapping solutions will become more commonplace.

Location Identification Display. This application involves the display of crimes and pending and/or in-progress call-for-service locations and displaying their locations on a (overhead) map display. (A recent episode of the new CBS crime drama, The District, highlighted the impact and contributions

GIS systems can have on data collection, police management, and an agency's response to crime.) Common inputs include, for example, wireline ALI information, wireless X/Y information, and in-field field unit monitoring. In addition, the ability to locate a specific "free form" address location is usually built into the application (i.e., officer on-view or self-initiated call).

Tactical Response Planning. This effort is closely linked to high profile/high impact incidents at specific locations, such as hazardous material sites, major incident responses, and other events involving multiple response and support dimensions. Pre-incident planning and response is at its root. If event A occurs at location X, then a predefined response plan, linked directly to the physical location of the incident, is invoked for action. In some cases, this may also involve automated notification of specific response and/or management entities, without any action required by the dispatcher (i.e., HazMat, ARFF).

Displaying and Manipulating The Map

No one mapping system will provide all the "bells and whistles" each person using the map will want. From a public safety communications perspective, one of the most common—and most debated—features is the actual display of the map to the dispatcher, and ability of the map display to be manipulated to best support exigent needs. Consider the following sample concerns:

1. Can the displayed map image be split into multiple views?
2. How many views are provided for the same reported event?
3. What level of detail is available in each view?
4. Can each view's focus be manipulated?
5. Can data and data structures in each view be manipulated independently?

Another configuration issue commonly discussed is the amount of data layering possible (or available) from the GIS system. At a fundamental level, the map lines representing the streets and freeways and the naming conventions or titles of the surface streets represent the basic map. Additional levels of data can be added to meet specific issues. For instance, what follows is a sample list of commonly used data structures discussed in GIS systems:

- Area police stations, substations and community storefronts
- Area fire stations and equipment compliment
- Area hospitals, clinics and emergency rooms
- Local utilities infrastructure (gas, water, electric)
- Aviation networks (terminals, concourses, runways, etc.)
- Railway infrastructure (i.e., networks, crossing ownership)
- Fire hydrant network
- Area bridge locations and capacities
- ESN and i-nap grid information
- MSAG data management
- Key city/county government buildings
- Chemical processing and storage facilities

- Geo-political boundaries (voting districts, council districts, etc)
- Police and Fire district/beat boundaries
- Jurisdictional boundary lines
- Facility templates (i.e., floor diagrams)
- Offender-based information (i.e., name, crime specialty)
- Routing support (i.e., evacuation routes, point-to-point routing)
- And so many more!

Maintenance and Support

Perhaps the most overlooked aspects of mapping are the resources (personnel and money) needed to properly support the total GIS system after initial start-up. To be sure, mapping systems require a clear commitment on the part of agency upper management to keep map data relevant and to maintain the viability of the mapping solution(s) as a meaningful tool for all users. Regardless of the application, a map-based system is only as good as the amount of data available from it, and the accuracy—and relevance—of the information it provides.

Finally, public safety and public safety communications will become more visual due, in large part, to increased emphasis and implementation of aligned and location-based technologies to meet the FCC's intent outlined in FCC 94-102 (as amended). It would, however, be shortsighted for PSAPs to use the this new and powerful visual medium solely for the purpose of displaying the location of wireless 9-1-1 callers. As mapping systems mature and become more commonplace in public safety, opportunities to improve response, management and oversight of valuable public safety resources will abound.

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