ATTACHMENT TWO
"PSAP CHALLENGES IN USING GPS TO LOCATE 911 CALLS FROM CELLPHONES."

Ovum Consulting (June 2010)

PSAP challenges in using GPS to locate 9-1-1 calls from cell phones

Executive Summary

In the United States, the number of 9-1-1 calls from cell phones is rapidly increasing. Processing 9-1-1 phone calls from cell phones is complex because wireless callers are not automatically linked to their current location the way callers using landline phone service are linked to their address. Currently, the two most widely used methods of locating wireless 9-1-1 calls are Global Positioning System (GPS) and Uplink Time Difference of Arrival (U-TDOA). Ovum interviewed managers of Public Safety Answering Points (PSAPs) in 10 of the largest metropolitan areas in the United States. Our survey results concluded that GPS is not adequate for locating 9-1-1 phone calls in some environments because of its inability to locate callers in many indoor environments and in cities with tall buildings. The following paper analyzes the results from our in depth interviews with PSAP managers and provides additional insight into why GPS delivers limited performance under certain real-world conditions.

A brief history of E9-1-1

Fixed-line 9-1-1 was introduced in 1968, but the system received a significant boost in 1999 when President Bill Clinton signed legislation designating 9-1-1 as the nationwide emergency number. As wireless usage grew, the system was extended to cell phones with Enhanced 9-1-1 (E9-1-1). The Federal Communications Commission (FCC) mandated a rollout of E9-1-1 in two phases. Phase I, announced in 1998, required network operators to identify the phone number of the caller. Phase II, which was announced in 2001, required network operators to calculate the geographic location of the cell phone within a certain accuracy.

FCC Phase II performance requirements vary depending on the type of location technology used. Handset-based technologies must locate callers within 50 meters for 67 percent of cases and within 150 meters for 95 percent of cases. Also, mobile network operators that selected handset-based solutions were required to have 95 percent of their subscribers equipped with GPS-enabled phones by December 31, 2005. Network-based solutions must locate callers within 100 meters for 67 percent of cases and within 300 meters for 95 percent of cases. Verizon and Sprint deployed a handset-based technology called Assisted Global Positioning System (A-GPS), which is a form of GPS, while AT&T Mobility and T-Mobile currently use a network-based location solution called Uplink Time Difference of Arrival (U-TDOA). For both types of location solutions, operators currently achieve regulatory compliance by averaging accuracy statistics statewide, or in some cases, network-wide.

Descriptions of location technologies for wireless 9-1-1

Global Positioning System (GPS) utilizes a chip installed inside the cell phone in conjunction with orbiting satellites, which identify and communicate the cell phone location coordinates to the operator's 9-1-1 location system. A-GPS (Assisted Global Positioning System) is a form of GPS, which uses some additional assistance data from the cellular network. The information from within the cellular network tells the cell phone which satellites to look for, improving the time to obtain the first location fix.

In order for GPS to work, the cell phone must be equipped with a GPS chip. It is important to note that while the majority of new cell phones in the United States have an embedded GPS chip, not all active cell phones in the United States are GPS-equipped. Wireless carriers that rely on GPS-based location systems have no way of locating cell phones that do not have a GPS chip. Carriers that use GPS have attempted to minimize this problem by encouraging customers with older, non-GPS phones to voluntarily upgrade to newer GPS-enabled models. But with the responsibility fully in users' hands, non-GPS phones continue to be used by the public, many of whom may be unaware of the limitations of their cell phone's 9-1-1 location capabilities.

For wireless carriers using the network-based Uplink Time Difference of Arrival (U-TDOA) location system, the lack of a GPS chip in a cell phone is of no consequence, since U-TDOA can locate any type of cell phone. U-TDOA calculates the location of a cell phone based on the difference in measurements of time it takes the cell signal to reach multiple cell towers, using highly sensitive receivers that are installed in the carriers' cell towers.

Survey methodology

Ovum conducted in-depth interviews with representatives from large, high-volume PSAPs around the United States. Ovum interviewed 10 PSAP managers in 10 of the largest metropolitan areas in the United States in January and February 2010. The study includes feedback from PSAPs located in New York, Los Angeles, Houston, Detroit, Phoenix, Dallas, Philadelphia, Chicago, San Antonio, and San Jose.

Qualified respondents were operations and dispatch managers from Phase II-compliant PSAPs who receive and process wireless 9-1-1 calls. Ovum specifically targeted PSAPs in the largest cities because they have the most experience dealing with wireless emergency calls from dense urban areas and indoor environments. Respondents were pre-screened to confirm that their centers were Phase II-compliant and that they were able to evaluate GPS performance based on first-hand experience using location technology in their center.

To understand their personal experiences using GPS-based location information, we asked respondents a mixture of rating and open response questions to get their input on the performance of GPS-based location information in emergency response to cellular E9-1-1 calls.

The volume of calls from the PSAPs we interviewed ranged from 4,000 calls per month to more than 200,000 calls per month. Across our PSAP survey sample, an average of 64 percent of the emergency calls that PSAPs receive each month involve serious or life-threatening emergency situations.

While our survey sample size was small, the survey was designed to target PSAPs in the largest metropolitan areas of the country (by population). The one-on-one interviews provided a setting in which responses to our questions could be discussed, analyzed, and corroborated with anecdotal information from PSAP managers to inform and support our conclusions. While statistical conclusions cannot be drawn about all PSAPs from this limited sample of the PSAP community, the strong and consistent agreement from the majority of PSAP managers that we interviewed demonstrate a clear trend in experiences and perceptions of using GPS-based location information to locate emergency calls from cell phones.

PSAPs confirm that location information saves lives

The PSAPs Ovum interviewed confirmed that one of the most important uses of location information is to help maximize the valuable, and yet limited, first responder resources in search and rescue missions. We asked survey respondents to tell us about other essential characteristics of location information. Respondents unanimously agreed that accuracy, response time, and reliability were essential characteristics of location for emergency response.

In many instances, 9-1-1 operators must rely exclusively on the information provided by the location system to dispatch first responders to an emergency call. Survey respondents recounted numerous examples of emergency calls involving life-threatening situations such as medical emergencies, injuries, kidnappings, carjackings, and crimes in progress where callers were unable to provide verbal clues or guidance on their whereabouts because of the circumstances of their emergency. PSAPs also revealed that it is a common occurrence that callers are lost or unfamiliar with their surroundings or that the emergency call gets dropped before the caller can relay their location to the 9-1-1 operator. Knowing the location of the caller is crucial in providing assistance in emergency situations.

Everyone should be located in a time of need

PSAP managers told Ovum that it is imperative that location information works with every type of cell phone. Not all cellular subscribers have GPS-enabled phones, therefore, not all cellular subscribers can be located by the carriers that use GPS as their location technique. In fact, sixty percent of our survey participants disagreed that GPS-based location information works with every type of cell phone, while only one respondent claimed it did. One primary advantages of U-TDOA is that it does not require a chip inside the cell phone to locate the phone. Because U-TDOA it is a completely network-based location technique, it can locate any type of cell phone – regardless of the make or model.

Emergency responders demand high accuracy location

The accuracy of the location information is of utmost importance for PSAPs and first responders. The better the accuracy, the faster first responders can arrive at the emergency. Eight out of 10 of the PSAPs we surveyed agreed that the location information provided to the PSAP must be within 50 meters of the caller to be actionable and useful. The remaining twenty percent of respondents claimed that a minimum accuracy of 100 meters was acceptable. To underscore how critical accuracy is to PSAPs, a number of those that we interviewed recalled situations in which the lack of high-accuracy location information delayed—or negatively impacted—emergency response. Fortunately, GPS and U-TDOA can both achieve location accuracy within 50 meters—under the proper conditions. For GPS, however, the two environments where proper conditions do not exist are indoors and in dense urban environments.

Issues locating cell phones indoors using GPS

GPS requires a line of sight between orbiting GPS satellites and the GPS chip in a wireless phone to locate callers. When that cell phone is indoors, however, the phone does not have a clear line of sight to the satellites, since the signal is frequently blocked by the steel and concrete of the building.

Steel and concrete act as impenetrable barriers for GPS signals, rendering the technology useless for emergency response to wireless 9-1-1 calls originating from many indoor environments. The architecture of a house or other building, along with the placement of windows, can cause issues with line of sight between the GPS chip in a wireless phone and the GPS satellites.

Additionally, PSAP survey participants reported that some calls made from inside vehicles have the same line of sight issues because the signal has difficulty penetrating the metal in some vehicles. Since most people spend the majority of their time indoors and in their vehicles, the issues that the PSAPs revealed about the specific challenges in acquiring actionable GPS location information from these environments have a significant public safety impact.

None of the PSAPs that we interviewed indicated that GPS delivered accurate location data from indoor settings. When asked if GPS-based location information from indoor callers was reliable, only twenty percent of our respondents agreed that it was. A rebid occurs when a PSAP does not receive any location information, and they must "relocate" the cell phone in an effort to get a position, delaying emergency response. On average sixty percent of PSAP rebids come from GPS-based calls.

Meanwhile, survey respondents unanimously agreed that GPS-based location information does not work in every indoor environment. This is a strong indication of the frequency of emergency wireless calls made from indoor or in-vehicle environments. Additionally, it corroborates that the line of sight issues surrounding GPS-based location calculation negatively impact emergency response.

Issues locating cell phones in cities using GPS

GPS relies on a direct line of sight to orbiting satellites in order to calculate the location of a wireless caller. In dense urban areas this is problematic for a number of reasons. Because of skyscrapers, the topography of a city can severely obscure open sky views. Buildings in cities tend to be constructed largely of concrete and steel, and GPS signals are too weak to pass through these materials. This is widely known as the "urban canyon" effect.

So, even when an emergency call is made from outdoors, the buildings surrounding an emergency caller in a metro city location often obscure the line of sight to the satellites, making location of the caller using GPS impossible. Survey responses from PSAPs corroborate this limitation. Only one in 10 PSAPs agreed that GPS-based location information from dense urban areas meets performance expectations. Likewise, only one in 10 of our survey respondents agreed that the GPS location information from wireless emergency calls from dense urban areas is reliable, seldom requiring rebids in order to acquire an accurate location for the caller.

We asked the PSAPs if they agree that location information from GPS-based phones worked in every dense urban area environment. Sixty percent of respondents disagreed or strongly disagreed with this statement. Furthermore, only one in 10 survey respondents claimed that GPS-based location information works in all dense urban area environments.

The United States Census Bureau estimates that approximately 80 percent of the U.S. population resides in metropolitan areas throughout the country. With the majority of the United States population of more than 307 million people living, working, and spending time in cities throughout the United States, the problems with acquiring adequate location information in these areas are especially pressing to public safety, since they affect such a large number of U.S. citizens.

Conclusion

Ovum asked respondents to evaluate statements about using GPS-based location information to locate wireless 9-1-1 emergency calls made indoors and in dense urban environments. As Table 1 summarizes, only a small percentage of PSAPs agreed with statements that commend the accuracy, reliability and consistency of GPS-based location information from indoor and urban environments.

Figure 1: Highlights of PSAP GPS Location Survey Results

Statement	PSAPs who agreed
"GPS-based location information from cellular calls made from indoors is accurate"	0 in 10
"GPS based location information from indoors is reliable"	2 in 10
"GPS-based location information works in every indoor environment"	0 in 10
"GPS-based location information is accurate from cellular E9-1-1 calls received from dense urban areas"	1 in 10
"GPS-based location information is reliable and seldom requires rebids"	1 in 10
"GPS-based location information from cellular calls works with every type of cell phone"	1 in 10
"GPS-based location information works in every environment in dense urban areas"	1 in 10

Source: Ovum N=10

The results of our survey suggest PSAPs lack confidence in the GPS location information provided for 9-1-1 calls made in these settings. The majority of PSAPs did not agree that GPS met their reliability or accuracy standards, nor did they agree that GPS works in all emergency situations or with all mobile phones.

As stated throughout this report, GPS relies on a clear line of sight to orbiting GPS satellites in order to calculate an accurate and reliable location. There are definite conditions and environments where the direct line of sight can be obscured. As a result, the PSAPs' ability to respond efficiently in emergency situations is negatively affected and presents additional challenges to first responders.

While the purpose of this report is to highlight the limitations of GPS in mission-critical situations, like locating 9-1-1 phone calls, the location technology called U-TDOA, which is used by AT&T Mobility and T-Mobile and was mentioned earlier in this paper, can locate any type of cell phone accurately and reliably in city and indoor environments.

Wireless subscribers in the United States are charged a monthly fee on their cell phone bills with the expectation that they can—and will—be located when they dial 9-1-1. It is evident that the PSAPs in the United States are faced with an ever-growing dilemma when trying to help those people who dial 9-1-1 using a carrier that relies on GPS for 9-1-1 call location. The challenges faced by PSAPs that are trying to locate 9-1-1 calls from GPS cell phones is a growing public safety issue.

For full details of Ovum's citation policy, see
www.ovum.com/media/citation.asp.

Whilst every care is taken to ensure the accuracy of the information contained in this material, the facts, estimates and opinions stated are based on information and sources which, while we believe them to be reliable, are not guaranteed. In particular, it should not be relied on as the sole source of reference in relation to the subject matter. No liability can be accepted by Ovum Europe Limited, its directors or employees, for any loss occasioned to any person or entity acting or failing to act as a result of anything contained in or omitted from the content of this material, or our conclusions as stated. Ovum has no obligation to update or amend the research or to let anyone know if our opinions change materially.