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4. Anticipating Rescue 9-1-1 in a Mobile Wireless Society

by Tim Obermier

Wireless telephones provide us with security, mobility, and peace of mind in unexpected situations. Those who have wireless telephones, commonly referred to as cellular telephones, probably could not imagine a personal or professional life without such conveniences. These seemingly simple devices have helped rescue stranded motorists and alerted emergency personnel to countless accidents, in effect, saving numerous lives. They have also become the personal convenience and efficiency devices of this decade.

While the benefits are obvious, the cellular telephone is contributing to a societal evolution—the evolution towards a mobile wireless society. Satellite television, paging, data, and voice are all wireless services many of us depend upon. With the correct complement of wireless devices, one can roam the world in the most remote regions and still maintain contact. Several research expeditions have included thousands of individuals, all thanks to wireless technologies. One of the many implications of this newfound mobility is a societal demand for additional security and safety. As people use their cellular telephones to report accidents, spot hazardous weather, and ensure personal safety, the device takes on more importance than simply the novelty it once was. Cellular telephones are becoming so prevalent in our society that they are currently reshaping the way emergency personnel receive notification and respond to accidents and emergencies.

Evidence of the increasing importance of the cellular telephone, and the evolution in process, exists with the large numbers of people purchasing them. According to the Cellular Telecommunications Industry Association (CTIA), there are currently 68 million wireless subscribers in the United States (Wheeler, 1999). Subscriptions for cellular telephones have increased at an average annual rate of 52% since the CTIA began keeping industry statistics in 1985 (CTIA, n.d.). According to a recent study conducted by the Consumer Electronics Manufacturers Association (CEMA), cellular telephones are in 39% of American households. Of those surveyed, 44% indicated that they purchased their cellular telephone to be able to communicate in an emergency (CEMA, 1998).

The Problem

With the growth of wireless subscribers and an increasingly mobile society, emergency calls placed by cellular telephones are increasing. Dr. Bob Cobb, director of education for the National Emergency Number Association, places the total number of 9-1-1 wireless and wireline calls at approximately 260,000 per day (personal communication, September 22, 1998). According to testimony before the U.S. House of Representatives speaking in favor of the Communications and Public Safety Act of 1999, Wheeler (1999) indicated that emergency 9-1-1 calls from cellular telephones total over 98,000 calls daily. In further testimony, it was noted that at least 35% of cellular telephone owners have used their telephones in an emergency or life-saving situation.

Wireline or landline telephones are those found in homes or businesses that are connected to the telephone network via copper wires to the local telephone office. Although the ever-popular portable telephones are wireless between the handset and base unit, the base unit must be connected to the wireline network. Portable telephones contribute to mobility, but only within the relatively short radius allowed by its base unit. The term *cellphone* or *cellular telephone* is used to refer to both forms of wireless telephones, analog cellular and digital personal communication system (PCS). The term *cellphone* has evolved from the theoretical engineering design of a cellular system that appears like a honeycomb or *cell* when drawn as a schematic.

Wireline telephone systems are static, and the geographic location of the telephone instrument is always known. Therefore, when an emergency call is placed to an enhanced 9-1-1 system through a wireline telephone, the Public Safety Answering Point (PSAP) can identify the name and street address of the caller. PSAPs are command centers from where 9-1-1 telephone operators dispatch appropriate emergency personnel in response to a need for emergency assistance. PSAPs are funded through monthly fees paid by everyone served by wireline 9-1-1 service. With the street address, PSAP operators can more efficiently dispatch assistance without first attempting to discern from the caller, who may have difficulty speaking, the street address where the assistance needs to be delivered.

While the mobility of a cellular tele-

phone is the primary benefit, mobility becomes the most negative attribute of a cellular phone when seeking emergency assistance. Unlike wireline telephones, the location of cellular telephones can only be determined through interaction with the caller. With rapid subscriber growth of cellphones and a subsequent increase in the number of wireless 9-1-1 calls, PSAP operators are finding it extremely difficult to determine the location of mobile wireless callers. Individuals have died attempting to describe their location. In one specific incident in Nebraska, an individual was routed through three separate PSAPs until an operator who used to live in the area finally recognized the surroundings a heart attack victim was describing. Unfortunately, emergency services arrived too late and the individual did not survive. Cellular telephones are mobile, and identifying their location is difficult at best. Compounding the location problem, not all of the geographic United States is served with the most basic 9-1-1 service; therefore, cellular telephones do not always reach emergency services by dialing 9-1-1.

As society becomes more mobile, demand is increasing for wireless cellular telephones to have the same technological features as wireline telephones. A call to an enhanced 9-1-1 system from a wireline telephone will result in the arrival of emergency personnel even if the caller cannot speak to the operator. A call to 9-1-1 on a cellular telephone will result in a time-consuming explanation of the caller's location because callers are not always aware of their whereabouts and must describe local landmarks or roadways to identify their location. Should the wireless caller be unable to speak, emergency services are unlikely to arrive. To be functionally equivalent to a wireline telephone, the cellphone requires the technological ability to automatically be located. The location information must then be transmitted to a PSAP for emergency dispatch.

In some instances, wireless carriers, the equivalent of your local telephone company for cellular telephones, block wireless 9-1-1 calls, leaving callers at a complete loss for emergency services. Blocking is a process of rejecting any 9-1-1 call placed on the wireless system. Blocking occurs because either the PSAP will not accept the wireless call load due to lack of funding or the wireless carrier lacks the technology to pass the call to the PSAP. Unfortunately, wireless carriers also block 9-1-1 calls due to concerns of liability. Several wireless carriers have been sued for incidents where wireless emergency calls did not reach 9-1-1 PSAPs. Because the wireless system is considered to be a competitive industry, ancillary to the wireline industry, wireless companies do not receive protection from liability like wireline carriers. In the case of 9-1-1 wireless call blocking, mobile individuals who need emergency services have to be aware of special dialing codes or local emergency numbers to receive assistance.

Travelers unaware of 9-1-1 blocking and lacking local seven-digit emergency telephone numbers are essentially stranded. Representative Pat Danner found that travelers had to dial *55 in Missouri, *999 in Illinois, *DUI in Ohio, and *77 in Maryland to access emergency services (Wheeler, 1999). Further analysis reveals that at least 15 different numbers exist across the United States to access emergency services from cellular telephones.

If the cellular telephone is to be a truly effective tool for a mobile society, all wireless carriers must contend with the challenge of creating a wireless enhanced 9-1-1 system that ensures consumers will experience the same benefits and quality as wireline telephones. The wireline 9-1-1 system has evolved into a high quality, life-saving technology that society now relies upon daily for safety and security.

History of Basic 9-1-1 Service

Before the technological development of dial tone and direct dial technology, a person initiating a telephone call had to use a central exchange operator who immediately connected the customer's call to the appropriate emergency service. Because of the technological design limitations of the telephone system, operators were typically local individuals familiar with most local residents. In time of emergency, they could locate doctors, firefighters, or police, whether on duty or not.

The development of dial tone and direct dialing technology allowed users to dial their own connections, resulting in a consolidation of operator services. No longer was the extensive number of local operators required. Dialing "0" could result in contact with an operator quite unfamiliar with the caller's town or area. Operators might even be several hundred miles away. To reach local emergency personnel, one had to know the specific telephone number for fire, police, or doctors, or know where to look for the directory listing. This could be a difficult and untimely task should a house be burning or a medical emergency be affecting a person's presence of mind.

President Lyndon Johnson's Commission on Law Enforcement and Administration of Justice Report (The President's Commission, 1967) first recommended the creation of a single emergency phone number. A year later, AT&T announced its decision to make 9-1-1 a universal emergency number for all their local telephone exchanges. AT&T's announcement in 1968 created a universal emergency number that telephone companies began to adopt.

Burton (1996) therorized that AT&T spent large amounts of money to support emergency services through their operators. The concept of 9-1-1 may have been created by AT&T to shift the burden of providing operator services for emergency connections from AT&T to public safety agencies, thus allowing for cost savings and creating future equipment sales. While basic 9-1-1 service greatly enhanced emergency services, it was soon to be replaced due to severe limitations.

Wireline Enhanced 9-1-1

Basic wireline 9-1-1 allows for emergency calls to be routed to PSAPs by the local telephone company, rather than first going through an operator or dialing a seven-digit phone number. The PSAP then dispatches the appropriate emergency personnel. In systems with basic 9-1-1 service, the PSAP operator does not receive two critical pieces of information: the seven-digit telephone number of the calling party and the location of that party.

Wireline enhanced 9-1-1 (E 9-1-1) service provides to the PSAP operator the caller's telephone number and location. The caller's telephone number is displayed on the PSAP operator's computer monitor through automatic number identification (ANI), and the street address is displayed through automatic location information (ALI). The ALI allows PSAP operators to coordinate the caller's location with the geographically closest emergency services. ALI ensures that callers who cannot speak, or who may lose consciousness after dialing, can still receive emergency services. ANI enables PSAP operators to call a person back should they hang up prematurely or in case of a disconnected call.

Nearly 85% of the population and 50% of the geographical area of the United States have access to some form of 9-1-1. Of that coverage 95% are served by E 9-1-1 (National Emergency Number Association, 1998). Wireline telephones that benefit from E 9-1-1 allow PSAPs to become much more effective at serving the emergency needs of their constituency. Wireline telephone customers currently rely on a stan-

dard of excellent service that remains to be duplicated in the world of cellular telephones.

The Federal Communication Commission (FCC) has recognized the importance and quality of wireline E 9-1-1, the tremendous growth of wireless subscribers, and the need for ubiquitous E 9-1-1 coverage, for both wireline and wireless. On July 26, 1996, the FCC set forth in CC Docket 94-102 initial rules and regulations for the implementation of Wireless Enhanced 9-1-1 (WE 9-1-1) service.

Societal demand helped to begin the transition to WE 9-1-1; however, regulatory pressure was required to begin implementation of what the public both needs and wants. As with any societal transition, several regulatory, technological, and societal obstacles must yet be surmounted before cellular telephones become the personal security and safety device of an evolving mobile society.

Regulatory, Technological, and Societal Obstacles

Wireless enhanced 9-1-1. Because of the FCC ruling, WE 9-1-1 should eventually become a reality; however, the FCC ruling contains several provisional mandates. First, the PSAP must be capable of receiving and using the ALI and ANI information transmitted to them by the wireless service provider. Second, the PSAP must formally request the service provider to send the ALI and ANI to the PSAP. Third, there must be a system in place to reimburse the wireless service providers and the PSAP for the cost to deploy and maintain the technology to make the service possible.

According to the FCC ruling, deployment of WE 9-1-1 will occur in two phases. Phase I requires the wireless caller's phone number and the specific cell site or sector identification number to be transmitted to a PSAP. Therefore, when a caller makes an emergency call from his or her cellular telephone, the 9-1-1 operator will receive a display on his or her computer monitor of the cellular 10-digit telephone number and the cell site location from which the call originated. If the emergency call is disconnected, this information will allow the operator to reconnect the caller. It will also allow the operator to have initial broad-based location information to assist in identifying the caller's location. In larger metropolitan areas, the ANI combined with the ALI will allow selective routing (SR) to take place. SR ensures that the PSAP and subsequent emergency services nearest the caller's location will receive the call. The April 1, 1998, deadline for Phase I was subject, however, to provisional FCC mandates. Wireless service providers are not subject to the federal mandates if the PSAP cannot use the data and if the PSAP failed to file a formal request to the wireless service provider. In addition, wireless service providers are not obligated to provide WE 9-1-1 services should a funding mechanism not be in place.

Phase II of the FCC ruling requires all wireless service providers to transmit to the PSAP the longitude and latitude of all wireless 9-1-1 callers within 125 meters by October 1, 2001. The location accuracy must be completed successfully at least 67% of the time. During an emergency call, the ANI and ALI must be transmitted to the PSAP within a fraction of a second. Therefore, when callers cannot speak or are completely unaware of their location, they can dial 9-1-1 with their cellular telephone and the PSAP will locate them, directing emergency personnel to the site. Advancing to the next technological step, rescuers could utilize global positioning with longitude and latitude data to locate individuals with pinpoint accuracy. This would eliminate all the guesswork in the location of persons needing emergency assistance. It is important to note that currently altitude is not a consideration for location. Therefore, if a person was in a multiple-story building, location identification could be more complicated. The FCC has sought comments on the issue of altitude, but it has not ruled on the topic as of yet (FCC, 1996).

Another recent decision by the FCC may have a tremendous impact upon the wireless consumer who only wants a cellular telephone for emergency purposes. In a Memorandum Opinion and Order adopted by the FCC on December 1, 1997, the FCC announced that wireless carriers must route all wireless 9-1-1 calls to a PSAP without validation of a subscriber's account (FCC, 1997). This decision allows any working cellular telephone, regardless of subscriber account status, to transmit a 9-1-1 call. This ruling is significant because as consumers upgraded to models with more features and benefits, older cellular telephones were discarded. Previously unusable and without value, they now can be used for emergency purposes.

Technological strategies are primarily in the testing phase to meet the FCC WE 9-1-1 mandates. However, regardless of technological deployment, consumers will not receive the benefit of WE 9-1-1 unless three major issues are resolved: Each state must have state funding, liability protection for wireless carriers, and an organized process for antenna tower location.

State funding, liablility, and antenna tower siting. Monthly wireline telephone bills include a fee for 9-1-1 service. Legislative or regulatory statutes establish the authority to collect fees to support the 9-1-1 system. The fee supports technology deployment and maintenance by the local telephone company to route emergency calls to the PSAP. Support also includes PSAP technology deployment and maintenance. Currently, in states where WE 9-1-1 funding statutes do not exist, wireless subscribers do not pay a monthly levy and therefore do not contribute funds to keep the wireline E 9-1-1 system operational. In states without funding legislation, the call load placed upon PSAPs by wireless subscribers lacks financial support.

The problem with funding rests with the mobility of a cellular telephone. Since a wireline telephone is not mobile, it is very easy to determine which PSAP should receive the monthly payment to the 9-1-1 system. However, a cellular telephone could quite literally be anywhere in the country when placing an emergency call. Which PSAP then is to receive reimbursement for processing the wireless 9-1-1 call and how does the PSAP receive reimbursement? The answer presumably lies with establishing a WE 9-1-1 fund administered by each state's public service commission (PSC) or public utility commission (PUC). The PSC or PUC would then reimburse PSAPs for the volume of calls they receive from wireless callers. Currently, according to XYPoint (1998), 34 states have funding mechanisms in place. Of the 16 that do not, only one has legislation pending at this time.

Once states pass funding statutes, one would assume that WE 9-1-1 service could begin. For wireless carriers there yet remains an issue that has caused WE 9-1-1 deployment delays for several states. Wireline telephone companies receive governmental immunity from liability as determined by statute or regulatory authority. Currently, many states do not grant this same immunity from liability to wireless carriers. With no immunity from lawsuit, a wireless carrier has the potential of liability for any mishandled WE 9-1-1 call. Wireless carriers are concerned about liability due to the possibility of dropped calls and gaps in coverage. As mentioned previously, only 50% of the geographic area of the United States has 9-1-1 coverage. Should an emergency caller not be able to complete a call, the carrier is potentially liable for the failed

connection. Currently, only 30 states have legislation protecting wireless carriers from liability for providing WE 9-1-1 service (XYPoint, 1998). In those states without protection from liability for wireless carriers, WE 9-1-1 service will be delayed, or possibly not implemented at all.

When funding and liability issues are resolved, there yet remains the issue of tower siting. The Telecommunications Act of 1996 mandates that any state or local government: "(I) shall not unreasonably discriminate among providers of functionally equivalent services; and (II) shall not prohibit or have the effect of prohibiting the provision of personal wireless services." State and local governments also cannot deny tower applications based on environmental effects of radio frequency emissions (Knauer, Machtley, & Lynch, 1996). In a recent court decision by the Fourth Circuit U.S. Court of Appeals, the court provided an interpretation of the Telecommunications Act of 1996. The judges ruled that applications for erecting a cellular antenna tower could be rejected based on citizen opposition (Warner, 1998). This creates an awkward position for wireless carriers since the lack of antenna towers means lack of coverage area for WE 9-1-1 service. In essence, by denying tower location applications, citizen opposition creates limitations in the service for which they most often purchase cellular telephones.

Once a solution to the politics of funding, immunity from liability, and tower locations are finally resolved, the wireless carrier must decide upon location technology that will satisfy Phase II of FCC Docket CC 94-102. The technology deployed will ultimately determine if existing wireless handsets will serve callers in an emergency, or if new handsets will have to be purchased that contain updated technology.

Location technology and privacy. The two location technology solutions are (a) solutions involving the subscriber's cellular telephone and (b) solutions involving changes to the wireless carrier's network. Solutions involving changes to cellphones are a disadvantage to subscribers because they will then require new cellphones to take advantage of WE 9-1-1 service. Network solutions will allow existing cellphones to take advantage of WE 9-1-1. Regardless of the solution selected by wireless carriers, a major problem for subscribers emerges as each company selects differing solutions. A company in one part of the country may use a cellphone solution and another company in another geographic area may implement a network solution.

There are three primary methods to accomplish location of wireless callers: (a) time difference of arrival (TDOA), (b) angle of arrival (AOA), and (c) global positioning system (GPS; Dziatkiewicz, 1998). TDOA and AOA are network solutions that will work with millions of existing cellular telephones. GPS, however, requires the customer to purchase a new cellular telephone.

TDOA analyzes the slight time delays from the cellphone radio signal as experienced from several different cell towers. This process triangulates the position of the caller through a process called hyperbolic trilateration. AOA analyzes location through a sophisticated antenna array added to cell sites. The array determines the direction from which a cellphone is entering a cell site territory. Utilization of two cell sites and the cellphone itself triangulates the position of the caller. A GPS solution operates from the array of GPS satellites used for all GPS receivers. While GPS may appear to be the best choice, this solution would require new cellphones for the service to work. Customers with a desire to benefit from this solution would have to replace their cellphones.

All three of the location technologies create privacy concerns. TDOA allows the continuous tracking of the location of a cellular phone. AOA can trace in continuous intermittent mode. GPS technology can also be adapted to operate in an intermittent mode. The location technology that enables the benefits of WE 9-1-1 complicates the societal issue of personal privacy. Since location technologies allow for continuous tracking second by second, location data could be collected and sold to marketing firms. Data could be specific to a customer or aggregated as a whole. For example, local supermarkets could offer free local cellular telephone service while shopping. Since tracking would occur whether the cellular telephone is used for a call or not, customers would be tracked continuously, building a marketing database regarding each individual's shopping patterns. Location technology could also be used to find lawbreakers, corroborate legal testimony, or ultimately track your children on a Saturday night. Fortunately, cellular telephones are under development that would only release location information when the caller dials 9-1-1, allowing for customer privacy.

Conclusion

Once WE 9-1-1 is fully implemented and the regulatory, technological, and societal obstacles are resolved, additional lives will be saved, travelers can feel more at ease, commuters may feel a little safer, and parents may not worry as much. When compared to the regulatory and societal concerns, the development of technology to make the system work seems to be a relatively small problem for WE 9-1-1 implementation. Once these issues are resolved, cellular telephone consumers should finally have a service that will truly benefit a mobile wireless society.

Dr. Tim Obermier is an Assistant Professor of Telecommunications Management at the University of Nebraska at Kearney. He is a member of the Omega Chapter of Epsilon Pi Tau.

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