Zone-based dispatching can save lives by cutting down response time; GIS mapping can make this possible.

Creating Emergency Service Boundaries Using GIS

By Kathy Miiller, Bullberry Systems, Inc.

In a medical emergency, response time can be a matter of life and death. But how can a dispatch center be sure it is sending the response team that can arrive most quickly? This is a question many 9-1-1 coordinators wrestle with daily. 9-1-1 directors have streamlined the dispatch process by creating emergency service zones (ESZs), identified by an emergency service number (ESN). If a call originates inside a particular zone boundary, the corresponding response team is dispatched.

Dispatching based on zone is not without its problems, however. Sometimes 9-1-1 districts send only responders assigned to the region that the emergency call originates in, even when a closer responder exists in an adjacent jurisdiction. In other words, dispatching by ESZ may work well within a county, but a call coming from a site near the border may have a closer responder in the neighboring county. And there are other issues. According to Brent Nelson, Walsh County, North Dakota 9-1-1 Coordin-ator, "In some counties the zone boundaries were originally based on the willingness or availability of medical responders to cover particular areas. Some response teams, especially those that are rural, have felt they could not cover the entire area that would be assigned to them, so they negotiated a smaller region."

These were some of the key issues when North Dakota's legislature passed HB 1409 in August 2001, requiring that beginning in June, 2002, 9-1-1 centers must "ensure that the closest available emergency medical service is dispatched to the scene of medical emergencies …" With the advent of this law, the service that can respond to an emergency in the least amount of time should be dispatched, regardless of its assigned district.

Determining Fastest Responder Zones

9-1-1 agencies were forced to take a hard look at their existing boundaries and determine if they actually had the fastest responders designated for each residential or business location. Many 9-1-1 coordinators had not revised their zone boundaries since they were originally established because of temporal and organizational constraints and the volume of changes necessary. With the implications of the new law, a truly scientific, repeatable and nonsubjective method for determining fastest responder zones would be ideal. These zones would show dispatchers at a quick glance which EMS unit should theoretically be able to arrive first at any given point, including wireless call locations. Using GIS (geographic information system) technology, these zones could be generated automatically by computer.

Creating Emergency Services

GIS software is perfect for finding optimal routes based on specific criteria and summarizing and displaying spatial (data tied to a location) and tabular (database) information in many different ways. GIS uses combinations of spatial data to perform analyses and generate spatial solutions, such as finding the number of buildings in an ESZ or approximating the area affected by a chemical spill or some other event. As a result, GIS has established itself as a critical component in many 9-1-1 operations.

Such was the case for several North Dakota counties that began researching ways to revise their zones to comply with the closest-responder law. They already had implemented a GIS-enhanced dispatch system and wondered if GIS could help here, too. They came to BullBerry Systems (Bismarck, ND) for answers. BullBerry Systems is a software company specializing in GIS programming and consulting. With a tight June 1st deadline, plans were made quickly to implement a GIS-based solution to generate fastest-responder zones.

The zones would be produced by analyzing the spatial relationship between a potential 9-1-1 call location, roads and responder points. Using ArcView GIS from ESRI (Redlands, CA) and some scripting, a grid of potential 9-1-1 call points were generated along each of the roads that made up the digital road centerline map for the county. First, a point representing a potential 9-1-1 call was placed every hundred feet along the roads. This way, even if a wireless call is received it can be matched to a closest responder because all areas have been considered, no matter how rural. Second, sites for the main medical responders were placed on the map (**see Figure 1**).

Third, the closest responder would need to be found for each

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of the potential 9-1-1 points. A custom GIS application was created that would cycle through each potential 9-1-1 point and determine its closest responder. The approximate time to travel each road segment was calculated using the length of the road and its speed limit. The computer then considers each point and determines the quickest responder, factoring not only the time but also traveling constraints such as one-way streets, closed roads, over/underpasses and limited access roads such as on/off ramps. Next, the potential 9-1-1 location was stamped with the name of the responder that was the fastest. After this process was completed, the points were color-coded by the name of the quickest responder. The regions that emerged can be seen in **Figure 2**. This was done using ESRI's MapObjects with NetEngine and again with ArcView GIS and Network Analyst in an attempt to design a solution that could be quickly and easily used again and again.

Of course, other factors need to be considered before the zones could be created from the color-coded grid points, such as the fact that many North Dakota counties also would use these zones as their ESZs in their Master Street Address Guide (MSAG) to define unique addresses. Boundaries might have to be shifted so that the same road name does not appear twice in the same zone (for example, Main Street may appear many

Figure 1

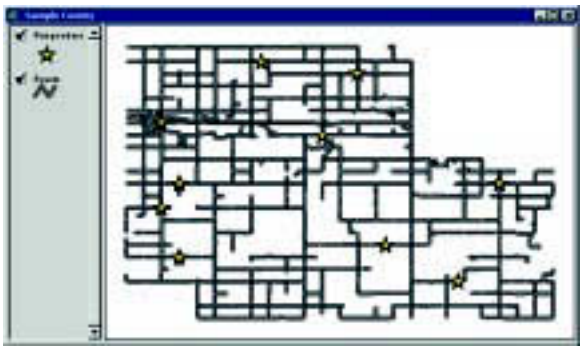
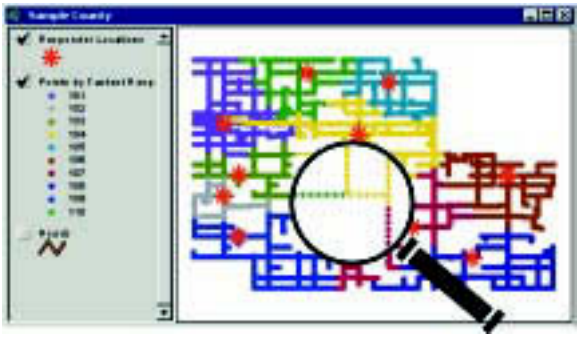
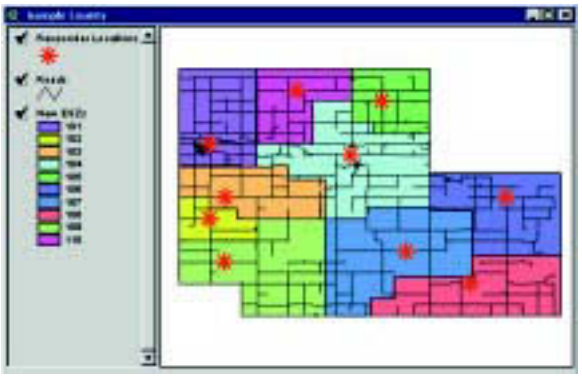


Figure 2



Map showing potential 9-1-1 call locations color-coded by fastest calculated responder.

Figure 3



Zones created using fastest responder calculations.

Photos courtesy of Bullberry Systems, Inc.

times in rural areas with small towns). Factors such as mobilization delays (volunteer versus full-time responders), rush hour, road construction, road surface, stop lights, left/right turns and other timing factors were not considered (but could have been) and were left to the discretion of 9-1-1 administrators in the final determination of ESN zones (**see Figure 3**).

Making the Deadline

Administrators were able to meet the June deadline because of GIS. They have noted several other benefits arising from this process. As Becky Ault, Pembina County 9-1-1 coordinator states, a computer-derived zoning system was ideal "because the computer does not lie … Disputes among agencies as to who is the closest were greatly reduced when they could be shown how the system derived the zoned areas." And GIS has

benefits when servicing wireless calls: "Additionally, the system is very useful for cellular 9-1-1 calls, because the GIS mapping system plots the point automatically and reports which responder should be closest. This lessens the time for dispatch to make a decision," says Ault. Phase II wireless has made this a reality in Stark County, ND. Imagine getting a call from a fisherman in the middle of a lake who needs emergency assistance. A GIS may be programmed not only to find the closest access road and route to the scene, but also to give the directions to get there.

Using GIS to help create mandatory emergency service documents such as ESZs and MSAGs adds credibility and certainty to decisions that 9-1-1 teams make every day, further empowering them to provide the best possible service to their communities.

In counties needing new MSAGs, ArcView could then be used to generate this information automatically by combining the new zone, road, and community information to create a report showing the minimum and maximum range for each road. The GIS, in conjunction with some additional scripting, calculated a brand new MSAG and very accurate report in a very short amount of time. It also reported any duplicate roads and calculated gaps in address ranges. According to Gary Kostelecky, 9-1-1 Director for Stark and Dunn Counties, "The ability to update zone boundaries and MSAG information has been made much simpler through our 9-1-1 mapping program. It can be accomplished simply by redrawing the boundary line, and the computer automatically updates the MSAG information."

Once the zones have been created, a GIS can be used to calculate approximately how many people each responder location is responsible for, determine the distance from the responder to the farthest point in the zone and the approximate response times. A GIS can span jurisdictions, so that the fastest response is sent regardless of district, or even help to determine the best location for establishing additional response teams.

GIS-based applications can bring consistency and automation to many tasks that were previously subjective and tedious, enabling novice personnel to produce results similar to that of veteran staff. Using GIS to help create mandatory emergency service documents such as ESZs and MSAGs adds credibility and certainty to decisions that 9-1-1 teams make every day, further empowering them to provide the best possible service to their communities.

Kathy Miiller is the director of educational services for BullBerry Systems, Inc. (Bismarck, ND). She can be reached at (701) 355-8720 or via e-mail at kmiiller@kljeng.com.

One of the main benefits of GIS is improved management of your organization and resources. A GIS can link data sets together by common locational data, such as addresses, which helps departments and agencies share their data. By creating a shared database, one department can benefit from the work of another—data can be collected once and used many times.
—*www.gis.com*

The National Center for Missing and Exploited Children (NCMEC, http://www.missingkids.com) is using GIS technology to help in their efforts to protect children from exploitation and find missing children.

NCMEC uses GIS technology in a variety of ways. The NCMEC Hotline receives leads from the general public. As the information is entered into the NCMEC database, location information in the lead is automatically geocoded, and based on the geographical relationship to current or former address information in the case record, the lead is automatically ranked as to its geographic validity. This assists the analyst reviewing the leads as well as the case manager responsible for the case. A cluster of high-ranking leads in a given geographic area may warrant a targeted poster distribution either by fax or by mail.

NCMEC is also using GIS in its effort to keep track of the locations of attempted child abductions, comparing that data against locations of confirmed nonfamily abductions or lost injured or otherwise missing cases. NCMEC continues to use GIS in identifying possible geographical patterns in family abduction cases as well.
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