A Public Safety Answering Point Managers' Guide to Geographic Information Technology

A National Emergency Number Association White Paper

October 2002

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Overview

This paper includes information on how to best deal with wireless information coming into the Public Safety Answering Point (PSAP). Any PSAP that is now, or will be, receiving wireless calls will find this paper useful. This focus of this paper is how to best utilize Geographic Information Systems (GIS) in dealing with wireless calls in the PSAP.

A recent National Emergency Number Association (NENA) Critical Issues Forum identified key concerns of GIS technology in the PSAP as being data quality, integration, and data maintenance. Addressing these issues will become increasingly important as the number of wireless devices making 9-1-1 requests continues to increase. These issues, and possible solutions for PSAPs, are addressed in this white paper.

Wireless calls come into the PSAP as either a Phase I or Phase II call. Phase II calls provide the PSAP a longitude and latitude (X, Y) coordinate pair as part of the Automatic Location Identification (ALI). Cellular telephones, Automatic Vehicle Location (AVL) systems, Automatic Crash Notification (ACN) systems, and other sources will be providing information to PSAPs using geographic (X, Y) location information.

Being able to understand how the geographic coordinates relate to a physical location will be critical in providing proper emergency response. Locating wireless devices depends on having accurate, current, and complete geographic data. The geographic data usually resides in a GIS. The wireless service provider will send geographic (X, Y) coordinates with a Phase II wireless 9-1-1 call. GIS technology can display these coordinates, along with streets and other information, on a map display. Having GIS technology integrated into the premise equipment allows for quick and effective location of wireless and wireline E9-1-1 calls.

What is the best and most cost effective means of dealing with this wireless location information? How does one convert longitude and latitude coordinates into an address to which a vehicle can be dispatched? What level of location technology is needed by the PSAP, what is available, what cost, and how can this technology best be used, managed, and leveraged? The operational, financial, management and technical issues of wireless location technology in a PSAP will be discussed. Since every PSAP is different, this paper will discuss the options available.

Wireless location technology is the major force driving GIS use in the PSAP. Since wireless is driving the interest in GIS, a review of wireless technology is in order.

Introduction to Wireless Phase I and Phase II

Wireless technology is increasing the demand for accurate and complete map displays in the PSAP. For those in the PSAPs rushing to determine the best methods of obtaining accurate and current geographical information, there are many questions to overcome. With the advent of wireless Phase I and Phase II, the need and use of GIS has dramatically increased in PSAPs across the United States. Because of this, it is important to mention the history and wireless definitions of Phase I and Phase II.

History

The public safety community, embodied by several national level professional organizations, National Emergency Number Association (NENA), Association of Public-Safety Communications Officials (APCO), and the National Association of State 9-1-1 Administrators (NASNA), united in 1994 to officially lobby the Federal Communication Commission (FCC). They requested that the FCC provide for service parity between existing wireline E9-1-1 systems and wireless services. They requested wireless subscribers have the same level of service currently provided wireline subscribers. The result of their efforts was the FCC's "Notice of Proposed Rule Making" (NPRM), or FCC Docket # 94-102.

The magnitude of the technical challenge became evident to the communications industry, as well as the 9-1-1 specialists, who had not previously been involved, as soon as the NPRM was released for comment. The result of these comments led the FCC to release a "Report and Order" that identified several phases of implementation, occurring over a specified time, to allow appropriate technological adjustments to bring wireless service up to par with wireline service.

The FCC's wireless E9-1-1 rules require wireless carriers to begin transmission of enhanced location information in two phases. Phase I requires carriers to transmit a caller's phone number and general location to a PSAP. Phase II requires more precise location information to be provided to the PSAP.

Under the current rules, two prerequisites must be met before the wireless carrier is obligated to implement E9-1-1.

(1) The carrier's receipt of a valid request from a PSAP capable of receiving and utilizing the data elements associated with the service; and
(2) The existence of a cost recovery mechanism for recovery of the PSAP E9-1-1 service cost.

Wireless service carriers were to provide the requested E9-1-1 service, six months after the prerequisites are met, or April 1, 1998 (for Phase I) or October 1, 2001 (for Phase II). The FCC has allowed these dates to slip.

Phase I Defined

Wireless Phase I requires that the calling party's call-back number, the cell towers location, and the direction of the cell towers antenna which received the call, all be delivered to the PSAP. The logic in support of these requirements was as follows:

- ? The caller's number would be used to call back the subscriber in the event the connection is lost with the PSAP
- ? The location of the receiving antenna would provide a gross level of location information that would allow delivery of the 9-1-1 calls to the appropriate PSAP.

Phase I is the contingency in the event Phase II fails. If Phase II fails, for any reason, then Phase I will be the fall back level of service. Phase I development also creates a migration path to Phase II infrastructure, and creates relationships with all parties involved.

Phase II Defined

Wireless Phase II requires the wireless carrier to provide "more specific latitude and longitude information, known as Automatic Location Identification (ALI) to the dispatcher". (http://wireless.fcc.gov/releases/E9-1-1reconFinalPR.pdf)

Basically two technologies exist to provide the necessary Phase II data, handset-based, and network based. The FCC provided specific requirements and timetables for each. Handset-based requires that existing cell phone be replaced with new models, capable of providing ALI. Network-based works with all existing wireless phones but may provide less accuracy.

Handset-Based ALI Technology

- ? Begin selling and activating ALI-capable handsets no later than October 1, 2001.
- ? Ensure at least 25% of all new handsets activated are ALI-capable no later than December 31, 2001.
- ? Ensure at least 50% of all new handsets activated are ALI-capable no later than June 30, 2001.
- ? Ensure that 100% of all new digital handsets activated are ALI-capable no later than December 31, 2002.
- ? By December 31, 2005, achieve 95% penetration of ALI-capable handsets among its subscribers.
- ? Wireless carriers to deploy Phase II within 6 months of the request for service from the PSAP, or by October 1, 2001, whichever is later.
- ? Accuracy requirement: 50 meters for 67% of calls, 150 meters for 95% of calls.

Network-Based ALI Technology

- ? Within 6 months of the request for service from the PSAP, Carriers are to provide Phase II information to 50% of the PSAP population or coverage area.
- ? Within 18 months of the request, carriers must provide for 100% of the PSAP population or coverage area.
- ? Accuracy requirement: 100 meters for 67% of calls, 300 meters for 95% of calls.

Phase II Redefined

Due to technical challenges, the nation's largest carriers requested Phase II waivers from the FCC. Upon granting the waivers, the FCC redefined the Phase II requirements and made them specific to the technical limitations. (http://www.nena.org/Wireless9-1-1/DeployTable10-01.htm)

FCC Approved Deployment Summary Table

Carrier/Deployment	FCC	Voice-stream	Nextel	Cingular (1)	AWS (2)	Verizon	Sprint
Technology Type		GSM	IDEN	GSM	GSM	CDMA	CDMA
Solution Type		E-OTD	AGPS	E-OTD	E-OTD	AGPS/ AFLT	AGPS/ AFLT
		Handset	Handset	Handset	Handset	Handset	Handset
Handset Activation (3)							
Start date	10/1/01	Before 10/1/1	10/1/02	10/1/01		12/31/01	10/1/01
10%			12/31/02				
25%	12/31/01	Before 10/1/1		12/31/01		7/31/02	7/31/02
40%				3/31/02			
50%	6/30/02	10/1/01	12/1/03			3/31/03	
65%				6/30/02			
100%	12/31/02	3/31/02	12/1/04	9/30/02	Sold Day 1	12/31/03	12/31/02
95% Penetration	12/31/05	12/31/05	12/31/05	12/31/05		12/31/05	12/31/05
Handset 67%	50m	100m	50m	100m	100m	50m	50m
Accuracy 95%	150m	300m	150m	300m	300m	150m	150m
Accuracy Compliance Date	10/1/01	10/1/03	10/1/02	10/1/03	10/1/03	12/31/02	10/1/01
Initial Requests Deployed	Implement	All 10/01/01		12/31/02	All as	12/31/02 (4)	6/30/02
Lucent areas	10/1/01					4/1/02	5/30/02
Nortel areas	10/1/01			12/1/02		8/30/02	8/1/02
Motorola areas	10/1/01					3/1/03	
Ericson	10/1/01			12/1/02			
Network Implement Dates							
PSAP 50% (5)	10/1/01					12/31/01	
PSAP 100%	10/1/02					04/01/02 (6)	
Accuracy 67%	100m						
95%	300m						
Accuracy Compliance Date	10/1/01			10/1/03	10/1/03		
Backup Network		12/31/01		03/31/02	100% as Headset Enabled	None	
Implementation Dates				6/30/02		Given	
Backup method	None	NSS	None	NSS		EFLT	None
Backup accuracy		1000m		1000m		250-350m	

1 – Cingular's network based compliance plan for their TDMA customer base was not approved. Sent to the FCC's Enforcement Bureau for enforcement and a possible consent decree.

2 – AWS' network based compliance plan for their TDMA customer base was not approved. Sent to the FCC's Enforcement Bureau for enforcement and a possible consent decree.

3 – A carrier will generally show compliance with an approved deployment plan by demonstrating that it has complied with the required fractional percentage figures during the period beginning at the date on which that percentage takes effect and ending at the date of the next benchmark. Thus, for the 10 percent benchmark, a Carrier would demonstrate that at least 10 percent of the new handsets it activated during the period between the effective date of that benchmark, and the effective date of the next benchmark were Phase II capable.

4 – Except in markets served by Motorola switches. In those markets, Verizon must complete all valid PSAP requests received on or before 09/30/02 by 03/31/02.

5 – As of October 1, 2001, within 6 months of a PSAP request, carriers employing network-based location technologies must provide Phase II information for at least 50% of the PSAP coverage area or population. Within 18 months of a PSAP request, carriers must provide PHASE II information for 100 percent of the PSAP coverage area or population. Note: for handset-based solutions, the coverage is based on percentages of handsets sold (with 25%, 50% and 100% levels, plus 95% of total customer base).

6 – Verizon Wireless must employ a network based solution for 100% of St. Clair County, Illinois (St. Louis) and Lake County, Indiana (Gary-East Chicago market) by 12/31/01; and, for 100% of Cook County, Illinois (Chicago), St. Louis County, Missouri (St. Louis) and Harris County, Texas (Houston) by 04/01/02. In areas where Verizon receives a valid PSAP request where the majority of the PSAP coverage area is covered by Verizon's analog-only network, Verizon must take affirmative steps to comply with FCC rules.

7 – In all markets served by Lucent and Nortel switches (on or before 04/01/02).

Introduction to GIS

A geographic information system (GIS) allows for the display of database information on a visual map. A GIS does not contain any maps or graphics, it creates maps and graphics from the information contained in the databases. GIS is not a mapping program, it is a complex mix of database management, display technology, and analysis tools that can be used to create maps. All the information in a GIS is referenced to a location. A GIS can contain images of aerial photography, photographs of homes, and floor plans of buildings, and large amounts of text and attribute information, but they are all tied into the databases by their location on the earth's surface.

GIS technology combines a powerful database with the unique ability to display the database information on a map. This ability to visualize information on a map allows quick analysis of information, which makes GIS invaluable to public safety. By referencing all the data in a GIS to a location on the earth's surface, maps can be generated and displayed, information can be visualized, and decisions can be quickly made.

GIS allows every feature on a map to be represented by points, lines, or polygons. Lines can be streets, pipelines, creeks, and railroads. Points could be fire hydrants, cell tower locations, building structures, or milepost. Polygons represent areas in a GIS. Polygons could be city boundaries, county boundaries, ESZ areas, lakes, and others.

GIS stores information about each feature in a database. Each street line has a directional, street name, type, address range, MSAG community, and other information associated with it. Every point, line, or polygon on the map is associated with a record in the geographical database. For example, each street on the map is a record in a table in the database. This allows GIS to quickly answer questions, such as:

Where is the caller located?
What police units are available in the area?
In which Emergency Service Zone is the caller located?
Who is the responding EMS agency?
Where is the nearest trauma center?
Which residents are in a flood zone?

All can be answered with GIS. Integrating the GIS into the PSAP is a powerful tool for improving response time, and locating wireless callers.

GIS can be defined as a collection of computer hardware, software, geographic data, trained personnel, and procedures designed to store, analyze, and display geographically referenced information. Not an easy definition so let's look at the five components of GIS individually. The five GIS components are data, hardware, software, personnel, and procedures. Each component is dependent upon the others to allow the GIS to be effective.

Data is an important part of GIS; it is the information on what the road is named, where an address is located, how far is the nearest fire station, or the fire response agency for that area. GIS stores all the data in different tables. These tables can be considered a layer of information. The streets, creeks, hydrants, city boundaries, and cell tower locations are each a different layer of data.

Each layer of information can be displayed on a map, and turned on or off as needed. The GIS stores all information as a reference to the geographic location on the earth. Being able to retrieve the data based on a location, and turning on and off layers as needed, is one of the benefits of GIS over paper maps. Being able to plot the wireless call location on a map — which shows streets, addresses, ESZ areas, and city boundaries — is a PSAPs asset.

The computer hardware stores the geographic data. Hardware provides a platform that allows for the accessibility of the data. It provides the video display, memory, and input / output connections to the computer. The computer hardware used in a GIS must be dependable, quick, and affordable. The increase in computer processing speed and the decrease in computing cost has allowed GIS technology to be available on every desktop.

While computer hardware is an important part of a GIS, it is not the most important component. Many people become too involved with computer hardware, and overlook the much more important aspects of GIS.

GIS software allows the user to store, display, analyze, maintain, and create the data. The software resides on the computer hardware. GIS software is specifically designed to allow the user to easily acquire, display, correct, and maintain the data. Software selection plays an important part of being able to use and share information for other sources. Software designed to be integrated with your existing PSAP telephony systems leads to fewer problems, and lower cost. This will be discussed in other sections of this paper.

The most important components of a GIS are people. Trained people, who understand GIS as well as E9-1-1, play a vital role in a successful GIS. People, who create and maintain the data as well as those who use the GIS are key to successful E9-1-1 implementation. The procedures, processes, and techniques these people use in developing and using a GIS are critical to reaching an informed decision.

Introduction to Base Map Data

Location of a wireless call is reported to your PSAP in the form of a latitude/longitude coordinate pair. If displayed on your console, it would look like:

X = -072.2481   Y = +043.6758   or,   Latitude: 43.6758 N   Longitude: 72.2481 W
*Note: X, Y = Longitude, Latitude. X is Longitude, Y is Latitude

Not very useful in this form, is it? If not properly plotted on a map, the coordinate may be miles away from the caller. One will have little time to plot a location on a map in time of emergency. A computer using GIS technology is the only efficient means of converting the X and Y wireless call location into a meaningful location for dispatch. If the wireless call comes from a moving vehicle, a new coordinate will need to be retransmitted, or “re-bid”, every now and then. Doing this by hand is simply not an option.

To make sense of wireless ALI, the call location must be located and plotted on a map. Plotting the location, along with the existing streets and addresses, ESN boundaries, and similar "background" information, will allow the call taker to quickly determine the location of the call. The background information should include the street centerlines, railroads, water features, ESN/ESN areas, city boundaries, county boundaries, emergency service agency locations, and other information.

This background information is your "base map data", which is intended to support all wireless calls in your area. The data layers for GIS should include street centerlines, railroads, water features (lakes, streams, ponds, rivers), ESN / ESZ boundaries, city, and county boundaries, emergency services locations, and other similar types of data.

The recommended data layers of information can be found in the NENA Recommended Technical Standards, 02-010, Exhibit 22, GIS 1.0 Data Model Formats. The provides the recommended "base map data layers", which will allow you to support GIS for all wireless calls in your area. Detailed information on the GIS Data Formats is available through NENA at: (http://www.nena.org/9-1-1TechStandards/Standards_PDF/NENA%2002-010.pdf)

Acquiring Base Map Data

The good news about base map data is that you are not alone in needing it. Much of the data you will need may already be available. Most of the data you will need to deal with wireless ALI is required by many other organizations, for different applications. That means that local, regional, or state agencies may already have this information in a form you can use with the GIS software.

This means you need to take the time and contact all the agencies in the area to determine if they have any of the required data. You may be able to tap into geographic data for water features, political boundaries, road networks, and others. You may only have to create layers specific for E9-1-1, such as cell tower locations and ESN boundaries. You should always double check all data.

The greatest expense of starting a GIS operation is the collection and input of data into the system. It takes time and diligence to make sure the data in the GIS matches with your existing MSAG data. Maintaining the data is probably the next highest cost associated with a GIS. Forming partnerships with other agencies can greatly reduce the cost of obtaining and maintaining data. Forming data sharing partnerships is very cost efficient and beneficial. Data used by members of data sharing partnerships and alliances tends to be more complete, accurate, and up-to-date than any other type of data.

The most important thing to understand about GIS data for E9-1-1 is that there is no central, certified agency whose purpose is to maintain and distribute E9-1-1 capable map data sets. No matter where you get your data, **you have to assume** responsibility for the accuracy, completeness, and currency of the data. The map data must agree with the MSAG data, otherwise the ALI will not display the correct information on the visual map. Remember, when we are talking about map data, we are actually referring to a database of information that a GIS can display as a map.

The truth is, the data used for E9-1-1 must be highly accurate. No matter where you get your data, you must double-check it for accuracy and completeness. The chance of anyone's street and address data layer matching your MSAG data is very small. You will have to spend time and resources making any street and address data match your MSAG data. It is your responsibility to ensure the data is correct.

Even with the very best map data, it will never be complete. New streets are always being built, houses are being addressed, and jurisdictional boundaries will change. Someone on staff will have to be willing to make sure the new information is collected and added to the map data.

Maintenance of map data is an often overlooked and under funded expense. GIS data must be constantly maintained and updated. You would never allow your MSAG to become outdated, so you must understand that map data maintenance is also eternal.
Another often-overlooked aspect of GIS data is that you need to extend the data past your area of jurisdiction. You need to have a "buffer area" of several miles around the PSAP boundary. Wireless cell calls may come into the PSAPs from outside your boundary. The shortest path to an incident may be through an adjacent town. Wireless calls may come from a boater or hikers who are not aware of the community they are in.

Hopefully your jurisdictional area will abut with other PSAPs who are also implementing GIS, and you will be able to share data with each other. Obtaining GIS data will require coordination with agencies in, and adjacent to, your coverage area.

When selecting an integrated PSAP mapping solution, make sure you can easily import and export your data. Since this data is beneficial to so many public and private agencies, one should always strive to form partnerships and data sharing alliances for collecting and updating the GIS data.

So where does one start gathering GIS data? The best place to start looking is asking other local, regional, and state agencies if they have and maintain any GIS data. Even if they do have data, it must always be double-checked and re-checked. There are many sources of GIS data, but few meet the demands required for E9-1-1.

Base Map Data Sources

There are many places where one can obtain GIS data, each with pros and cons. One must be GIS savvy, because the buyer must always beware. It is unfortunate that many sources of GIS data, and some vendors, will try to sell data without making you aware that it is not suitable for E9-1-1. You must assume the responsibility of checking and re-checking the data for accuracy and completeness. This is why it is important to understand GIS, or to obtain the services of someone who knows GIS, 9-1-1, and that you can trust.

In 9-1-1 and public safety operations, the data used must be accurate, complete, and up-to-date. We do not have time to tell a 9-1-1 caller to hold on while we check our data, because seconds count.

Federal Government
There is a national resource of freely available GIS data from the US Census Bureau, called TIGER data. The TIGER data is created for a national demographic count of the population. It (usually) does not have enough detail to be used in 9-1-1.

The Census Bureau's "TIGER" files (http://tiger.census.gov) contains free census based data in formats that can be easily used by a GIS. The TIGER data contains information including roads, water features, railroads, boundary information, and many other layers of data. The bad news is that is inadequate for 9-1-1 uses without extensive revisions, checking, editing, and testing. The accuracy of the data is too poor for 9-1-1 uses; most of the data will have to be re-aligned, and extensively updated.

Note: The Census is embarking on a huge "TIGER Modernization" program that will raise TIGER's standards considerably and institute ongoing maintenance. As we approach the 2010 census, substantial parts of TIGER may begin to meet 9-1-1 specifications.

State Government
Many states are recognizing the value of GIS to state and municipal operations and are investing in GIS databases. A few states (Maine, Vermont, and Rhode Island) have been completely mapped to 9-1-1 standards, and many others are in process. Check with you state GIS coordinator (http://www.nsgic.org) for current status information.

These sources may have financial support, or cost sharing agreements, and certainly have opportunities for data sharing. The downside is this data probably will not agree with your MSAG, may not be available in your area, and may require some updating and editing to correct and make current.

Private Database Vendors
There are three national vendors that have various data products available. The data from these vendors will vary by vendor and your area. The best coverage is in the larger population areas, but rapidly evolving technology is improving the data. Some companies have cost benefit models that may make them attractive. The data is readily available, and some companies offer Internet based map updating. The downside may include the cost. It is always your responsibility to match their data to your MSAG, and you will be responsible for finding and correcting (or notifying the vendors to correct) errors and omissions.

Some companies limit further data distribution, which greatly limits any data sharing. Some companies require license fees and maintenance agreements, and the data may be no better than TIGER data. Other companies will go out of their way to assist you, can help with starting data sharing partnerships, and can provide technical expertise. Identify all the national vendors and determine which has the data and options that best suit your needs.

Local / Regional Government
Part, or perhaps all of your region may already be mapped in digital form by municipal or regional agencies. This is why collaboration, communication, and coordination with local and regional agencies are so important. Existing data may meet the demands of 9-1-1, with little editing or updating of the data required. The only downside is it takes a bit of effort to find the data. The benefits of data sharing and building collaborative relationships greatly

outweigh the effort required to find or start such an endeavor.

Several local governmental agencies have GIS data being used with tax appraisal, police and fire computer aided dispatching, public works, planning, and utilities management. This data may fit most of your needs, or it may need extensive updating, editing, and matching with your MSAG. It is well worth checking with all agencies to determine what is already available. These same agencies are potential data (and cost) sharing partners, so always contact them before trying to “go it alone”.

Custom Data Firms

Several firms specialize in building databases for 9-1-1 and general municipal applications. Many are active members of NENA, and do a great job. It is unfortunate that many firms state they can build effective geographic data, but lack the knowledge and understanding of the high level of detail and correctness that is required for 9-1-1.

Be sure to take the time to check **all** the past customers of the data firms. Request and obtain warranties or guarantees of accuracy of the data, and examine past data products. Customer service and data integrity is more important than the lowest bid when obtaining 9-1-1 GIS data. Several firms will work very closely with you, correct and verify the data to the MSAG, and help you get started with local and regional data sharing partnerships with other entities.

Respectable custom data firms use a variety of sources and technologies to ensure accuracy. The best firms will use Global Positioning Systems (GPS) for all road centerlines (including driveways for houses not visible from the road), take photos of all structures, locate all hydrants and payphones, and verify completeness by linking to utility company records. Many will use existing orthophotography, validate against the MSAG, provide discrepancy reports, and work closely with the PSAP. With this excellent quality, you can expect to pay a premium price, but the attractiveness and detail of data makes it easier to obtain cost sharing partnerships from others who can use the data.

When selecting a consultant, follow the recommendations above, clearly define the deliverables, get everything in writing, and allow for scope changes and costs associated with those changes. If all this is properly executed, and you have checked all their references, then you should trust the consultant with the work.

Determine what the completion statistics will be when it is turned over to your agency. There must be a clear demarcation of when your agency accepts responsibility for completion of services. This is all part of the initial request for bid and contract negotiations.

Other Considerations

Remember, you are not acquiring maps; you are acquiring detailed geographic data that can be displayed as maps. Always check all references provided by vendors, and ask others within NENA if you have any questions or concerns. Many of us have, “Been there, done that, and learned this”, so do not hesitate to ask. Unfortunately, you must always remember the old adage, “Let the buyer beware”.

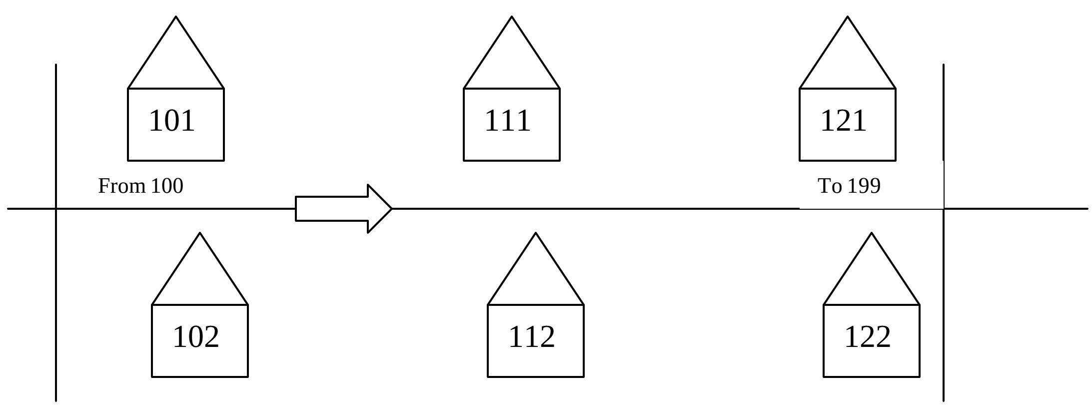
It is probably safe to state that if a potential data vendor does not know what NENA is, you should probably keep looking for one that does. There are many firms around that say they can create street centerlines, but they often do not understand the high standards required for 9-1-1 operations.

Consider "Potential" versus "Actual" address ranges on street files. The standard practice for the past three decades in Census Bureau and Postal Service address databases has been to record the maximal "potential" address range for each street segment. In areas with one hundred block style house numbering, and in many rural areas, this method of addressing can lead to errors of many hundreds of feet. For small to medium size PSAPs, locating each structural address in your ALI database will negate this problem. For larger PSAPs, splitting arcs to match structural addressing is one way around this problem, but it makes the database much larger and difficult to correct.

Addressing individual structures or breaking a street centerline at each addressed house, will make maintaining the data more difficult, but will remove "potential" addressing errors from the data. Some Computer Aided Dispatch systems (CAD), and other applications using the GIS data may require "potential" addressing of the street centerlines. Always coordinate with everyone who will be using the data to determine the data needs.

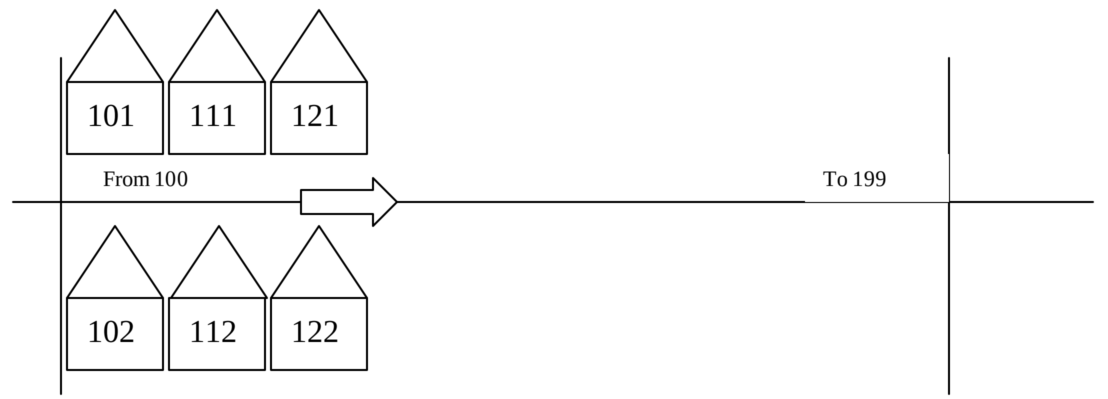
Geocoding is when the computer "reads" the ALI address, and plots the correct location (of the address) on the map display: Geocoding is limited due to having a linear relationship between the distance along a segment of road and the address ranges. If this requirement is not met, then geocoding will not return a valid position, which is often the case.

Consider a city block arrangement (100 block, 200 block, 300 block, etc.). Each block is assigned a 100 block range of addresses (e.g. 100-199, 200-299, etc.), regardless of the actual distance or length of the block. However, the addresses typically get assigned based on a distance from the beginning point (an intersection). As one proceeds along the road assigning addresses, the last structure will rarely match the theoretical range because of the discrepancy in the actual road segment length. For example:



Actual address locations

If 100-199 is used as the range, all existing addresses {101, 102, 111,112, 121, 122} will geocode to the first 20% of the segment, which will produce an error of approximately 80%. If the block is 400 feet long, then the error could potentially approximate 320 feet or 100 meters!



Geocoded address locations

Use of "potential" address ranges isn't limited to Postal and Census data, commercial databases derived from either TIGER, ZIP+4, or for other considerations, may have chosen the "potential" range option.

Make sure that you know the addressing conventions in your area and are prepared to field-check and update ranges in areas with century addressing and rural roads. Some PSAPs have invested in individual address registers to avoid this problem and provide the best possible representation of address locations. Potential address ranges are fine, as long as you know the possible problems associated with them.

While it's great to have map databases as positionally accurate as possible, remember that there are limits to the accuracy of cell calls reported by either handset or network based system methodology. While current TIGER accuracy is not acceptable for 9-1-1 uses, centerlines derived from public domain DOQs (Digital Orthophoto Quads), that can be field verified to be within 7 to 10-meters, are entirely accurate enough.

The more accurate your data, the more it will cost to obtain and maintain. There is a certain cost-benefit point where it becomes too expensive to obtain higher levels of accuracy. If data sharing partners require high levels of accuracy, say for engineering applications, the savings from cost sharing may easily offset the cost of obtaining the increased accuracy. Data sharing and cost sharing lowers overall cost while improving the data quality.

Data sharing is technically in its infancy; transactional update of map databases is very rare, updating is usually done by replacement. Unless all your data-sharing partners are using the same format, or can import and export to a common format (ESRI Shapefile, AutoCad MAP, MapInfo, and Intergraph), there may be format conversion issues.

Assessing PSAP Size

Assessing the size of a Public Safety Answering Point (PSAP) can be measured using many criteria, such as call volume, number of positions, population, and number of agencies or officers the center will support. Typically the call volume the center experiences determines size of the PSAP. The larger the population the more likely higher numbers of 9-1-1 calls will be received. Often times, the more calls received to a 9-1-1 district, the larger the number of call-taking positions, and staff to answer the calls.

Population growth of a service area could result in the need for a PSAP to increase the number of call-taking positions to handle a higher call volume, or a secondary PSAP may be an option to handle overflow during heavy calling hours.

Looking at call volume and number of call taking positions there are four sizes of PSAP: Small, Medium, Large, and Very Large. The breakdown can be calculated as follows:

Percentage of PSAP	Call Center Size	Annual Call Volume [1]	Average Number of Call Taking Positions [2]
85%	Small	10,000 - 249,999	1 - 7
10%	Medium	250,000 - 749,999	5 - 15
5%	Large	750,000 – 1,499,999	15 – 50
<1%	Very Large	1,500,000 and above	50 and above

System Capabilities (Present and Future)

What worked fine for PSAP in the past will not necessarily work today, or in the future. Technology changes very quickly, and the E9-1-1 center equipment needs to grow as the center's needs grow. Scalable systems are standard by the leading 9-1-1 customer premise equipment (CPE) vendors. With a solid E9-1-1 back room equipment foundation, the front room integrated workstations are flexible and able to add modules.

Many industry-leading vendors have worked closely with NENA, PSAPS, and E9-1-1 related agencies for years, resulting in innovative solutions to support PSAPs today and in the future. It is estimated that of the 150 million calls made to 9-1-1 in 2000, 50 million came from wireless telephone users—a ten-fold increase from nearly 4.3 million wireless 9-1-1 calls just 10 years ago—and the number of calls is expected to double to 100 million in the next five years. Locating wireless callers is the largest issue in the industry today.

Many systems across the country are being upgraded to accept the latitude and longitude coordinates being sent from the wireless carriers. How will dispatchers translate the X and Y coordinates into real world locations that can be communicated to responding agents? Thumbing through paper map books is simply not an option. Map display applications at the workstation puts the wireless caller on the map and answers the "where is the

[1] Annual incident volume is estimated at ½ the annual call volume.

[2] These numbers vary dramatically based on position types (call-taking vs. dispatching…) and staffing strategies.

emergency" question quickly, saving time and lives.

With the original FCC Phase II mandate past, proposed implementation looming, and various areas of the United States beginning to experience Phase II, the time for adding mapping to a system is now. The good news is that the advantages of bringing GIS into a PSAP go beyond caller locating. An accurate and current map and spatial database can be used by all agencies in the public safety sector to increase response efficiency. Implementing mapping and GIS within a community is advantageous for future integration with automatic vehicle location (AVL) systems for officer safety, crime and fire mapping for incident and response analysis, and in-vehicle mapping for response efficiency and even incident management once on-scene. PSAPs must look into the future, and consider that today's innovative technology such as automatic crash notification (ACN) will soon be reality. With so many uses for mapping, now and in the future, a flexible, integrated mapping application has become a required tool for call-takers, and will continue to be valuable in the call center and emergency response for years to come.

Here are some standard mapping functions that are recommended for map display applications in the call center:

Phase II wireless compatible

Single support mechanism (Both CTI & mapping—saves time/money)

CPE / IWS integration

Third party system compatibility to integrate with CAD and AVL systems

Ease of use, ease of implementation

Immediate ALI plotting on map and zoom to location

Geocoding functions should be able to handle missing addresses, alternate street names/aliases, and structure-based addressing

Identify closest intersection, landmark, or common places

Reverse geocoding for determining closest address to X, Y coordinates in ALI

Can use as many map layers as is practical without cluttering the screen

User can turn map layers on and off as desired

Pan around the map and zoom in and out

Features in map layers can be identified

Distance can be measured

Enterprise data update/synchronization solution

Uses standard data format for ease of data sharing, and availability. Map maintenance tools available

Expandable to meet your center's growing needs

Able to show pre-plans, floor plans, photograph, digital orthophotos, and site photos

System Integration

Integration of various applications and systems can be complex, and trying to make an application integrate when it is not certified to do so, can be painful and expensive. Implementing a map display component certified to co-exist with the CPE can save time, money and headaches down the line. Many times, adding mapping at the time of a CPE upgrade will significantly reduce costs compared to adding mapping after the fact, especially in the services areas. Benefits of integrating mapping on the same workstation as the computer telephony (CTI) are multifaceted.

Adding mapping to the CTI workstation ensures that all calls are mapped even if the CAD system is unavailable due to servicing or unscheduled downtime. Integrated mapping has been proven to save set up time, valuable desk space, and of course the cost of adding a stand alone PC for a non-integrated map system.

The integration of any GIS data into an existing E9-1-1 system can be a potentially sticky situation. There is a general shortage of quality GIS expertise in the CAD industry. The unfortunate result of this particular scenario is that a great many 9-1-1 agencies opt to stay with a long time CAD vendor who is attempting to write GIS software components with their CAD products. The result is that the agency remains with the vendor until the product either does not work at all, or works poorly.

The key to integrating GIS into an existing system is to find a GIS solution that is not dependent upon any particular CAD. This concept affords an E9-1-1 agency two options. One, software programs do not have to be housed under the same package; they can be implemented as separate entities that complement each other indirectly. Alternatively, find a GIS solution that can be delivered in an open format, which can be easily converted and implemented into any mapping software, whether it is mapping software a CAD vendor developed or GIS mapping software that has been developed specifically for E9-1-1.

The integration of GIS mapping into an existing E9-1-1 system can be a relatively painless experience with great benefits as long as an E9-1-1 agency does its homework and research. In any given state, ask around and find out who has been successful in integrating GIS mapping with their E9-1-1 system and who hasn't. Find out what the pitfalls and traps are to better avoid them. Find out what methods have worked well to model them. Seek out GIS talent either at the governmental level or in the private sector.

If a CAD system is present in the call center, choosing a mapping application that is flexible and can integrate with both the CTI and CAD ensures continuous availability for mapping callers and can provide the visual display of responding units on the map. Additional integration with the mapping application could consist of reverse emergency notification, 3-dimensional pictorial map application, management information systems, or call records useful for displaying where calls had come from over a period or time for analysis.

For larger call centers or multiple agencies within a 9-1-1 district, automated map distribution can optimize your workflow. The time and money spent on manually updating the workstation with map updates can be greatly reduced or eliminated with a map data distribution component. Selecting a suite of integrated mapping applications that provide map maintenance tools, automatic map distribution utility, and the workstation map display ensures consistency, reliability, and efficiency.

When implementing mapping into a call center there are many factors to consider, such as:

- ? Proven record of reliability?
- ? Meets the standard mapping functions outlined in System Capabilities in the previous section?
- ? Will the mapping application reside on the same integrated workstation as the CTI ensuring reliability?
- ? Will my current support representative have knowledge of this added technology to ensure proper maintenance in a timely manner?
- ? Does the mapping vendor have 24x7 technical support and product training available?
- ? Can I add another monitor for fast, easy viewing of the map?
- ? If there is not enough desk space to add another monitor, is a single monitor adequate, and can both the map and text data be viewed on the single monitor?
- ? Are there additional products available and do they integrate easily for addressing, MSAG comparison, and data distribution?
- ? Is the product scalable to grow with my needs?
- ? Will the vendor be around in the future for support and upgrades?

It is also important that mapping applications meet functional standards of the call center, are user-friendly, and are able to integrate with various 9-1-1-industry tools such as CAD systems, AVL, and mobile data technologies. The mapping software should support GIS industry data standards formats, which will allow for data sharing and accessibility of quality data. Proprietary data format requirements inhibit the ability to share data with other agencies in and around your community. The first step towards implementation might be to start with your existing system vendor. See if they carry an integrated product that meets your needs.

Inter-Agency Involvement (Sharing Data and Costs)

It is important to keep in mind that the performance of any mapping application is dependent upon the completeness and accuracy of the map data. As automobiles require fuel to run the engine—you would not get too far without it—the map data is crucial to the power of the map display application. Using GIS data (base map) from your county or city GIS department, planning or assessors office is often the best approach as the level of completeness is more likely higher than from other sources, simply because of the local knowledge.

Agencies outside 9-1-1 will be extremely interested in being able to obtain highly accurate address and spatial information. The interested agencies may include the local tax appraisal district; the water and wastewater departments; the city and county engineer; city council; county commissioners; planning agencies; building code enforcement; regional and state governments; and private companies. Private companies such as the regional provider of electricity, gas, telephone, cable television, realtors, and others will benefit from having highly accurate street and address data. Talk and meet with all these agencies, the idea of sharing resources, information, and cooperative purchasing must always be considered, investigated, and fostered between agencies and organizations.

Commercial map data and services will allow those 9-1-1 call centers who do not have GIS data available from a local agency or the resources to create their own base map to jumpstart their mapping implementation. Continued maintenance on the commercial map data at the local level can help yield higher ALI hit rates.

Sharing existing map data in a standard format is one way to lower the cost of obtaining and maintaining a GIS in your agency. Multiple agencies could also pool their funds together to purchase map data, or hire a designated GIS administrator to maintain the data. Many accredited colleges and universities offer GIS courses and certificates, and could be a valuable resource for finding candidates for employment.

Resources and Training

Training of call takers is key to the successful implementation of GIS data. You can have the most complete and accurate GIS data, but if a call taker does not read the data appropriately, it can impact the handling of a 9-1-1 call. Call takers not used to working with a map will need to spend some time orienting themselves to using spatial information along with ALI. They need to acquire map-reading skills and be comfortable with the map display data. Often actually going out and “riding the streets” with a hardcopy of the map is the best way to orient a call taker to mapped data. This may not be cost efficient, but it is among the most effective.

Lesson’s Learned

Follow up on the testing of new cell sites. Make sure that the correct information is displayed on the Phase 1 calls. Make sure that with the addition of the new site, the coverage did not change on a nearby site.

Know all of the players involved with the implementation. Name, Company Name, phone number, fax, and email and what part each play a role in.

Monitor the display of 9-1-1 calls. Changes occur that you might not have been told about. These changes can keep the Phase 1 or Phase II call from correctly locating on the map. On going monitoring, is often the only way you will find out if there is a problem. Train dispatch to identify a problem and work out a procedure to have it reported to you for investigation and/or correction.

Another benefit of using a GIS is the capability of being able to combine data and information from many different sources into a seamless spatial database. By collecting information from many different sources and formats, the GIS can be used to organize this disparate data into layers.

Maintaining data integrity within the GIS and keeping the data synchronized with existing tabular files, MSAG, and ALI files requires high levels of coordination. The database personnel and the GIS personnel must work closely together to resolve MSAG and GIS discrepancies.

An ongoing spirit of cooperation and coordination with other interested agencies must also be maintained. These efforts will reduce redundancy of data gathering, lower cost, improve accuracy, increase precision, and maximize resources in maintaining and updating geographic information related to public safety operations. This can also lead to synergies and accomplishments that you could not have envisioned happening.

Wireless carriers play a very important role when it comes to GIS data. PSAP jurisdictions rely on the wireless carriers or third party vendors to provide accurate and up-to-date cell tower and sector information. Again, the synchronization of both GIS and ALI databases is important. The GIS information regarding cell sector and cell site information needs to match ALI records in order for the map display to be effective. PSAP jurisdiction approval of this information is required before it is entered into the ALI database. If either the GIS or the ALI databases are not synchronized, then many “No Record Found” errors will result.

Wireless Phase II does not eliminate the need for accurate cell tower and sector information. When Phase II location cannot be provided, Phase I information is the backup. Wireless carriers need to recognize the need to provide this information and PSAP jurisdictions need to insist on accurate information from the wireless carriers.

Budget / Funding Considerations

The E9-1-1 system today requires significant ongoing and developmental funding. This section addresses two areas of interest: first, *what* must be funded for the development and maintenance of the technology components, and second, *what* potential financial sources are candidates to be pursued for funding this development. The *how* to capture this funding is left to the reader’s tenacity and perseverance.

This section directs general attention to the budget considerations for the technical development of the GIS component of the PSAP/dispatch portion of the system and is not intended to address the entire range of other components. Staffing, office rental, and support cost for staff are not covered. The portion of this section addressing potential sources of funding is more general in nature and therefore more broadly applicable.

Budget Considerations

The subject of budgets requires a context (i.e., what budget?). Very broadly stated, the process starting with a 9-1-1 call and ending with the dispatch of emergency response can be considered in two parts; in the first part, the telephone company receives the call and associates it with an address and routes it to a PSAP. In the second part, the PSAP routes the call and call location to the dispatch operation to mobilize emergency service providers. As wireless E9-1-1 evolves, the “address” will become a geographic coordinate and the PSAPs must still pass the caller’s location to the dispatch operation. Early “GIS” functions were as simple as having the dispatcher look up the address on a map or in the simplest system; the emergency service providers just knew where the address was and went to it. GIS technology has rapidly evolved but in many cases, this technology remains in its early evolutionary stages within the PSAP/Dispatch environment. As E9-1-1 is implemented, the GIS component of this system must become more sophisticated and budget considerations for the development of this component is the context of this section.

Although this discussion is directed at GIS development in particular, it should be noted that the listed activities could also be associated with the establishment of information technology systems in general. Each of these activities should require some degree of budget consideration. The basic activities addressed here are:

? Overall Requirements Definition
? Logical Design and Specifications
? Data Base Design
? Technology Installation
? Institutional Structuring and Training
? Data Capture and Development
? Application Development and Testing
? Production System Implementation

Overall Requirements Definition
Organizational reviews are done to establish a clear and unified understanding of the basic work process definitions and to identify the related technology requirements.

Logical Design and Specifications
Based on the requirements for the technology, a logical design is created with the focus on specifying *what* needs to be put in place. The primary foci for this design are functional definition of computer applications, core GIS and database software, computing and network hardware configurations and data specifications. This design is typically made in the context of the existing institutional structure (organization and anticipated technology users) and additionally includes a design of the staffing to oversee and operate the system.

The design is usually associated with strategic and tactical implementation plans.

Data Base Design
GIS systems are rarely installed solely for the use of emergency dispatching. The data structure consisting of street centerlines, addressing, cadastral (land survey) and property information and numerous other data sets can be and frequently are shared by other departments and agencies; indeed, the ongoing updating of nearly all of this data is rarely done by emergency dispatch personnel. Given this, the GIS is typically integrated with the emergency dispatch operations but usually maintained and operated by other agencies (typically either information technology departments or public works, engineering or planning departments).

The design of this database then becomes a much broader aspect of the establishment of this enabling technology. Data standards and sharing issues also come into play at this point.

Production System Installation
System procurement and startup includes hardware and core software purchases and system installation and testing activities. System maintenance activities also begin at this point.

Institutional Structuring and Training
A wide variety of training will be required at various points for users, management, and technical support staff. This trading must be planned in the context of the implementation activities and the organizational structure.

Data Capture and Development
Data development represents a significant aspect to the budget considerations; indeed, data capture and data maintenance efforts remain the single most significant cost of these technology implementations. Of particular interest to 9-1-1 systems is the address component of the needed data and addressing data standards particularly across shared jurisdictional boundaries, are very important in the context of this data.

Application Development and Testing
GIS technology rarely comes "out of the box". This technology is typically delivered with a wide range of capabilities that must be orchestrated into *applications* programmed and configured (*customized*) to meet the needs of the individual users of this technology. Earlier in the process, a logical design was proposed for this application development. This activity includes the translation of that logical design into a *physical* design and then the development (computer coding) and testing of these applications. These application developments must be considered as separate budget line items and typically are separate for each application developed.

Production System Implementation
The actual implementation of these systems involves linking the user agencies/departments/units work process with the technology and data. Implementation includes training of users and technicians, as well as data loading processes and a period of initial system testing.

Ongoing system and data maintenance and routine training should also be considered as separate budget line items.

On a final note, when something is problematic, budget estimates are typically too low so looking for trouble should always be a good method to uncover underestimates to budgets. A case in point here would be the subject of city/county property addressing:
Every complex system has particularly difficult aspects and the 9-1-1 systems are no exception. In terms of GIS, the data element referred to as "address" seems to evoke the most emotion in this field.

From the state level all the way down to local jurisdictions, it is rare that unified address standards have been adopted so differences between addresses provided by telephone companies and addresses used in the dispatch GIS functions are real headaches. For example, telephone company Address Location Inventories (ALIs) contain addresses that do not match address names and formats maintained by local government agencies; this creates difficulties when trying to match this address from the PSAP to a GIS address listing taken from government sources.

ALIs are essentially a listing of the telephone company's customer's addresses and, as such, are at least business proprietary so in some cases, even simple requests to have the lists reviewed to adjust for the differences with the GIS are subject to considerable resistance. It is for these types of complicating reasons that NENA is active in the establishment of addressing standards.

Even after the considerable effort to adopt standards and bringing both data sets into synchrony, maintaining them concurrently will remain somewhat problematic and the subject of budgeted activities.

Funding mechanisms
Funding for technology developments may be available today from a number of sources. This section will review the following seven sources of funds:

? Federal Programs and Grants
? Private Grants (Foundations, Corporations and Individuals)
? Sales Taxes and Directed Fees
? Governmental Bonds
? Local Governmental Directed Budget line items
? Local Collaborative Efforts
? Telephone Company User Fees

This list is not all inclusive and continues to change but it represents a good starting point for those interested in researching funding mechanisms for technology growth in this field.

E9-1-1 implementation activities will require a tremendous amount of funding to come to full fruition. Of the above list of sources above it needs to be noted that far and above all others, the largest funding source today is through funds collected as user fees collected by telephone companies and passed on to local government agencies developing and maintaining 9-1-1-related technology and operations.

Federal Programs and Grants
Typically, this type of funding is available more for early adoption and innovative activities and less for established or growing programs. These funding options are less available for E9-1-1 technology development than in the mid-1990s. Nonetheless, it is worthy of consideration.

It is common for Federal grants to be contracted by local and government agencies to research for available grant monies based on needs.

To help in the research of *ongoing* funding, the federal government has the *Catalogue of Federal Domestic Assistance* (available on-line at http://www.cfda.gov/), which lists more than 1,000 existing funding programs.

For deeper research waters, one may wade into the *Federal Registry* (http://www.access.gpo.gov/su_docs/aces/aces140.html), which has literally thousands of notices. A classification exists that lists funds available by selected funding programs.

It is worth mentioning here as an example that the State of Kentucky just recently received a large grant from the Center for Disease Control to help set up a virtual Emergency Operations Center.

The issues and changing emphasis on Homeland Security need to be watched closely in anticipation of the availability of an undetermined amount of federal funds and other assistance in fields that may be useful to those organizations managing emergency response systems. It is also reasonable to assume that there could be funds coming out of the Department of Justice to support new anti-terrorist initiatives and those funds may end up spilling over into supporting enhancing the 9-1-1 system to better process reports of terrorist activities.

The federal government has a number of ongoing mapping data initiatives that provide a good foundation for information and data for maps used by GIS developers; these are not exactly a funding source but may reduce data collection funding needs by providing alternatives to map data acquisitions. The following initiatives can serve as examples of such offerings:

1. The National Map Program site at http://mapping.usgs.gov. and http://nationalmap.usgs.gov/)
2. The GeoSpatial One-Stop Web site at http://www.bts.gov/gis/geospatial_onestop/

These initiatives are primarily directed towards state and local government involvement.

Private Grants (Foundations, Corporations and Individuals)

Grants are frequently directed at modernization and an example of this type of grant is seen in West Virginia where Verizon Wireless has granted the state millions of dollars to support the development and implementation of a state wide addressing system.

State regulatory agencies sometimes work to support GIS development funding. As an example of this, the State of Texas has implemented an innovative way to enforce statewide GIS mapping and data standards. State grant funds are collected from Public Utilities Commission-authorized telephone subscriber surcharges. These grant monies are provided only to local government organizations that promise to abide by the statewide GIS mapping and data standards while using these funds.

Private or corporate grants may also become available as increased awareness of homeland security issues justifies the improvement and modernization of emergency response capabilities in selected communities.

An on-line foundation directory listing can be found and researched by going online to http://dmoz.org/Society/Organizations/Grant-Making_Foundations; a number of these foundations direct funds towards the betterment of the health and welfare of the general community.

As is the case with federal funding, a considerable amount of research is required to match available grants to identify needs and to propose appropriate grant applications.

Sales Taxes and Directed Fees

It has been reported that so-called Special Purpose Local Options Sales Taxes (requiring approval by vote) have been levied in many states (albeit the typical percentages of these types of revenue are less than five percent and much less than that specifically for emergency response); these taxes are levied by telephone companies and directly earmarked for development or improvement of emergency services.

Local governments assess a number of development fees on developers. Some of these fees are specifically earmarked for the development of local government GIS cadastral mapping.

Governmental Bonds

Local government bonds have also been the source, in part, for technology developments. Again, this is a case where careful identification of technology needs in regard to necessary agency processes is important; a clear identification of these needs can then be made into convincing arguments for inclusion into the scope of selected bond issues.

Local Governmental Directed Budget line items

Within the budget definition process governmental budget line items are specifically directed at emergency response development, enhancement, and maintenance activities. Emergency response organizations tend to draw larger budget approvals if the operations and needs are clearly defined and measured.

Local Collaborative Efforts

A number of groups of organizations and agencies are forming to consolidate and standardize their needs for GIS and other data. In the interest of both sharing data and organizing the unified and ongoing update of that data, these groups or consortiums are frequently combining funding sources and then redirecting them to these specific goals and efforts. This consolidation concept is frequently the only way smaller governmental entities can be funded.

Telephone Company User Fees

To repeat a point made earlier, the largest funding source today is through funds collected as user fees by telephone companies and then passed on to local government agencies developing and maintaining 9-1-1-related technology and operations.
It should be noted that in some cases, these fees are directed toward the telephone company's call routing process development and maintenance, while in others, these fees may be wholly or in part directed to local emergency dispatch operations.

In a brief article, "Shirking 9-1-1 Duties" by Carl Peckinpaugh in the May 13, 2002, issue of *Federal Computer Week* magazine (p. 43), it was noted that a recent and controversial Government Accounting Office ruling has made government phone users exempt from having to pay these fees/taxes. As it turns out, this will represent a significant reduction in available funds to areas with considerable federal telephone installations (such as Washington, DC).

Conclusion

The above are only some of the challenges that PSAP will face as they address the issue of GIS data for their PSAP. The ALI Database is the original database component for Enhanced 9-1-1. Now and in the future, the GIS database will be the ALI database partner.

While maintaining ALI data accuracy, maintenance of both positional and attribute information is fundamental for a 9-1-1 GIS data set. Mechanisms need to be in place that ensures the continued accuracy and synchronization of both ALI and GIS databases.

Acknowledgements

Thanks for everyone who assisted on creating and completing this paper.
Marc Berryman – Wireless 9-1-1 Call Location Sub-Committee Chair
Norm Forshee – Wireless Implementation and Operations Co-Chair
Susan Sherwood – Wireless Implementation and Operations Co-Chair
Blake Abercrombie – Intrado, Inc
John Auble - Geographic Data Technologies, Inc
Erica Aubut – State of Vermont E9-1-1 Board
Jim Ballard – Reno Police Department
Marty Bausano - St. Clair County 9-1-1
Don Cook - Geographic Data Technologies, Inc
Ron Cramer - Digital Data Technologies, Inc
Annette DeVaughn – Elmore County E-9-1-1
Toni Dunne – Positron, Inc.
Kevin Graczyk _ ESRI, Inc
Brant Howard – CompassCom, Inc
Doug Hurd – Geographic Data Technologies, Inc
Ervin Kral – Las Vegas, Fire and Rescue
Kathy Lillequist – GeoComm, Inc
David Lucas – Kentucky Governors Office of Technology
Gracie Martinez - Tarrant County 9-1-1
Jerry Merlick – Contact One
Anthony A. Parrott – MicroData GIS
Larry Raper – Plangraphics
Chuck Ronshagen – Plant Equipment, Inc
Penny Rogers – City of Henderson
Russ Steffee – Montgomery County 9-1-1
Ronald B. Smith – Calgary Police Department
Bob White – State of Maine
Rob Writz – Indrado, Inc
and anyone whom I may have left off the list