Map Options:
What Most PSAPs Need to Locate Wireless Calls
By Brant Howard

With the E9-1-1 Phase II era just a couple of months away, public safety answering points (PSAPs) across the country are considering what technology they will use to display the location of wireless phone users' emergency calls. The answer for most is a digital map. But not just any digital map will do.

The map must be georeferenced, which means it contains embedded geographic coordinates for precise identification of feature locations by latitude and longitude. Georeferencing should not be confused with geocoding, a term which usually implies the digital map has been coded with address ranges so that buildings and homes can be located by street addresses.

This distinction is critical because E9-1-1 Phase II digital maps must be georeferenced *and* geocoded to pinpoint calls coming from both wireless and landline telephones.

Currently, very few PSAPs own georeferenced digital maps. The exceptions are those with computer-aided dispatch (CAD) systems integrated with GPS-based automatic vehicle location (AVL) technology. Most other CADs in use today do not use georeferenced maps and will require a map upgrade.

City and county GIS departments are typically limited in resources and the needs of mapping for public safety are now being put into the mix with other departments such as the county assessor. In order for public safety mapping needs to be met, a facilitator must be assigned to champion the project.

Fortunately, there are many cost-effective mapping options available for building new digital map databases for public safety applications. These options apply whether a PSAP is implementing its first digital map from scratch or upgrading an existing CAD map system.

As with any technology, each option has certain advantages and disadvantages which each PSAP must weigh against its particular needs. The three primary digital mapping alternatives are explained in the following sections with a complete description of pluses and minuses.

Option 1: Off-the-Shelf Maps
The least expensive option is to purchase an off-the-shelf digital map data set from a commercial vendor such as Tele Atlas (formerly Etak) of Menlo Park, CA; GDT of Lebanon, NH; or Navigation Technologies of Rosemont, IL.

Many of these products are rich in information, containing all levels of transportation features as well as optional elements such as details on hydrographic features, political boundaries and public buildings. One of the great benefits of these products is that they are updated regularly, with the updates available for purchase on a subscription basis.

The primary advantage of off-the-shelf data is that it's ready for delivery now for any city, county or region of the United States. An order can be tailored in most cases to cover just your service area, and most data sets now can be purchased without troublesome seams or mismatches in data between urban and rural boundaries.

When considering a commercial data purchase, a PSAP should inquire about the accuracy relating to both georeferenced features and address matching. Accuracy of georeferencing is referred to as positional accuracy by these vendors, and most offer products that can pinpoint a latitude/longitude position well within the 50 to 150 meters mandated by FCC Phase II guidelines.

PSAPs should also be concerned about the address matching capability, which refers to the map's ability to correctly locate a given street address. In urban areas, these maps can score in the 95 percent range, but their overall accuracy is often only 70 to 90 percent—too low for a public safety application.

The most obvious solution to the address problem is to add updated information to the commercial map's address database with better information from the master street address guide (MSAG). However, commercial maps are licensed to users or organizations, and these licenses should be reviewed before purchase because some put limits on the user's ability to change the original map content. The user may be able to add thematic layers to the map within their GIS. It's recommended to ask each map vendor about limits on modifications to the data set.

This means that it can be difficult for the end user to add other types of data to the mapping database. It may not be possible, for example, to enhance the basic data with MSAG information. Incorporating other feature layers may also be difficult. Many PSAPs, for instance, want to include locations of police, fire and rescue squad facilities to their maps, but they might be hindered by the map vendor licensing agreement.

The ability to update changes to the MSAG and map data on a daily basis is also important to many PSAPs. Waiting for the commercial vendor to release this new data into their product may take weeks to months.

Overall, commercial digital maps are an inexpensive way to begin building a map database, but a PSAP should buy a data set with an open license agreement so that upgrades and enhancements can be made in the future as needs and applications evolve. Today, many

vendors are trying to work closely with GIS departments in local government to work out data sharing relationships to help upgrade the product and provide standard data where available.

Option 2: Sharing an Existing Map

The wide-spread use of geographic information system (GIS) technology at the state and local government level makes sharing an existing digital map a very practical and cost-effective option. The place to begin your search for a GIS map is in the county or city planning department, although in many cases GIS is a stand-alone department.

Among the best examples of E9-1-1 digital map development projects completed primarily with shared maps are Larimer and Douglas Counties in Colorado. Both have built new maps from existing map sets. The Larimer Emergency Telephone Authority, for instance, made cooperative arrangements with several city governments within its service area to pull together existing GIS maps covering almost the entire county.

A significant advantage of sharing a local GIS map is that it likely already contains many of the features and attributes, such as water bodies, key infrastructure and even parcels, that would be useful to a PSAP but not included on a commercial map.

Because of the applications for which GIS is designed, its base map is always georeferenced, but the borrower should be careful to determine what datum and coordinate system is used. Many GISs use a state plane coordinate system, while most CAD systems are designed for latitude/longitude coordinates.

Converting from one to the other isn't difficult, but it must be carried out by mapping professionals. Someone in the local GIS department may be able to handle the conversion, but it will probably add to the time and expense of the project.

The major downside to sharing a digital map—and this cannot be stressed enough—is the coordination and cooperation that must be accomplished, usually among several different city or county agencies for a successful transition. In theory, it sounds easy, but typically an oversight committee should be established to facilitate the transfer and the updating of the map information. In many cases, the use of an outside consultant may be necessary to act as the facilitator for the project.

An important point to remember in sharing maps is that some degree of customization will be required for their use in E9-1-1 CAD operations. Typically, this will involve field mapping of rural areas not covered by the municipal GIS and possibly conducting GPS data collection of minor roads and alleys not included in the GIS.

Sharing an existing GIS map is often an inexpensive alternative, but it will require supervision by a mapping consultant either to oversee the coordination process or to fill in the map gaps with suitable data. The average cost of building an E9-1-1 digital map database on an existing GIS

map is impossible to determine because the degree of customization will differ in all situations.

Option 3: Build a Map from Scratch

Creating a new digital map from scratch may be the most expensive option, but it also produces the most accurate and highest quality map. From the perspective of a PSAP, greater map accuracy relates directly to faster response times and saved lives.

Since the map is built from the ground up, the mapping contractor can generate the map in any format to ensure compatibility with the PSAP's CAD or other computerized mapping system.

In reality, most new digital maps are not created entirely from scratch in the traditional sense. One of the key source materials, ortho-rectified aerial photographs, already exists in many city and county government offices. These photographs, which must be recent and corrected with a process called ortho-rectification, serve as the foundation for a georeferenced digital map.

In creating a new map, a mapping consulting firm typically will digitize highways, roads, streets and any other desired features from the aerial photography. These are stored in a digital database. Compared with driving all the roads with GPS mapping equipment, digitization is a fast and cost-effective process.

Although ortho-rectified aerial photographs often provide accuracy in the one- to five-meter range—the minimum recommended for E9-1-1 map generation—field verification is a necessity. This involves spot checking specific points with a GPS receiver and running these control points through a computer program to enhance the digitized data.

Rarely will a set of ortho-photos cover a PSAP's entire service area or include all of the needed information. Roads changed or added to the PSAP area since the ortho-photos were taken need to be mapped. In such cases, GPS data collection is performed by attaching a GPS unit to a vehicle and recording street centerline location coordinates by driving the roadways.

In a typical street centerline mapping project, the mapping contractor places a GPS unit in a company vehicle and mounts the antenna to the roof. The GPS is wired to a pen-based computer or data collector containing mapping software, which creates the street map as features are collected.

This software allows mapping technicians to specify the type of feature being collected—such as a roadway centerline, parking lot, house, or fire hydrant—and portrays the points on the map appropriately. The user can differentiate paved from unpaved roads. This information can be critically important to a dispatcher sending help to a wireless 9-1-1 caller.

If ortho-photos are not available, the GPS mapping crew, composed of a driver with data collector, simply drives every highway, street, and back road in the district. The GPS should be set to collect a precise latitude/longitude coordinate point about every five seconds at 50 mph,

and the collection should occur with an offset of about 1 meter horizontally to compensate for the vehicle driving in the right lane, not on the centerline.

Data collection on long, uninterrupted stretches of rural roadway is much quicker than in the stop-and-go traffic of a city. A professional mapping contractor can cover up to 100 kilometers (about 62 miles) of roadway in a day in rural areas and about half that in urban.

Mapping transportation features is only one part of building an E9-1-1 map, however. Many PSAPs wish to include individual parcels in their map databases so that addressing can be established for each property. Parcel maps may be available in digital formats from county assessor offices and can be added to the new map.

And because the map is being built from scratch, any other features desired by the PSAP can be added. For example, a professional mapping crew can map the precise locations of all public safety facilities or schools and add them to the map database.

By far the most important advantages in building a digital map from scratch are the greater accuracy, especially in matching addresses to properties, and the ability to tailor the map with features requested by the PSAP. Many other agencies in the area may also benefit from the accurate maps and road centerline data created for public safety.

Additional Mapping Tips

Regardless of which mapping option is selected, two issues must be considered from the project start: MSAG compatibility and map maintenance.

The MSAG database is the backbone of the E9-1-1 system, and although it doesn't necessarily play a role in E9-1-1 Phase II operations, the MSAG must still be considered when creating a new digital map. As mentioned before, a PSAP map must handle wireless *and* landline calls. The MSAG database is used to match the landline call to an address.

During the creation of new digital maps for public safety applications, a knowledgeable mapping contractor will run a computerized comparison of addresses in the new map with those in MSAG. The objective here is to make sure the public safety map is fully compatible with and accurately recognizes incoming addresses from MSAG.

On the first run, the public safety map may not recognize 15 to 40 percent of MSAG addresses. Usually, though, these exceptions are merely differences in semantics between the two databases. For instance, one may recognize Park Avenue as Park Ave., while the other spells it out completely. These exceptions are easily rectified.

The remaining errors are more difficult to eliminate and may involve mistakes in the new map data set. Resolving these additional exceptions requires an intimate understanding of MSAG/PSAP operations and is easiest to accomplish when building the database from scratch.

The second key issue to consider in building a new map is how the map will be updated and maintained once it is operational. Maintenance programs must begin with a plan as to what data will be updated and how often. The next step is to learn where the update information can be found most quickly and easily.

For most PSAPs, the challenge in maintenance is keeping track of the new streets that are being built. The most likely source of this information is the county engineering or planning department. Arrangements should be made for someone to contact the appropriate department every three months to obtain, preferably in digital format, plans for the newly built roadways and parcels.

Next, a mechanism must be established to ensure the flow of this information from the source to the mapping coordinator who is overseeing the maintenance project. Or if the project is cooperative and involves many agencies, each office must funnel its data to the mapping coordinator, who will coordinate the changes and add them to the master data set. Maintenance is crucial to keeping the map data accurate and to insure accurate call location.

The Bottom Line

Accurate maps save lives. And spending additional money now on a better map than you think you need will pay off in the future. Many other agencies within your area also want and need accurate maps. A new georeferenced digital map is a necessity in the E9-1-1 Phase II era, and it establishes a foundation for other time-saving technologies—such as automatic vehicle location—that are becoming more popular every year.

As surprising as it may seem, mapping technology comprises only about 40 percent of the effort that goes into building a CAD map database. The remaining 60 percent is consumed by coordinating different agencies and getting them to work together. Once a PSAP gets beyond local politics and gets people in different offices to work together, a new digital map is just around the corner.

Mr. Howard is President and Founder of CompassCom, Inc., a product and service provider for the geographic information systems (GIS) and automatic vehicle location systems (AVL) industries. Mr. Howard utilizes his 20 years experience in contract engineering, technical sales, marketing and management to provide direction for the company as CompassCom provides solutions for GIS and AVL users. He has been an advocate of using Global Positioning System (GPS) to automate field data collection for industry and government.