By Pete Koenig, GPS Mapping Coordinator

Do Cell Phones with GPS Have Accuracy to Locate Utility Infrastructure?

The Global Positioning System (GPS) is more than a handheld device that tells you where you are. The entire system is the receiver device, a number of ground stations, and the network of Earth-orbiting satellites that the U.S. Military (primarily the U.S. Air Force) developed, implemented, and maintains. The U.S. Military developed the system and provides the civilian signal to any user on a continuous, worldwide basis, and free of any subscription charges.

Keeping up with technology is a challenge. It's not a matter of keeping up to stay busy "keeping up" – it's a matter of keeping up because new technologies generally provide improved services.

Several recent phone calls to the KRWA office have prompted me to investigate whether modern cell phones can be used adequately to locate utility infrastructure that has been GPS collected. Today's smart phones have the ability to take a call, take a photograph, surf the Internet and determine a specific location. But it is not about determining if the location is in a certain city, or near a specific restaurant. When locating utility infrastructure, people are generally trying to find something that is no larger than a pie plate. Are those phones, which are no larger than an oversized credit card, powerful enough to navigate to something like a water meter or a manhole?

There is a misconception about GPS that leads people to believe that "GPS enabled" means "spot-on accurate". This is not the case and people seem to waste a great deal of time testing their phones or commercial grade GPS receivers trying to "see how close it is". Phones and commercial grade receivers are not designed to be "spot-on accurate". They are created with the intent to "get a person in the general vicinity". Once you are within a certain distance, you can use your eyes to find what you are looking for – and the developers know this. But if the search is for an item that has been covered, "the general vicinity" isn't good enough.

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In order to understand this a little better, think about the location and the velocity of the satellites in the GPS System. The System consists of 27 satellites (24 in use with three backups) orbiting the Earth at about 12,000 miles. Each satellite circles the Earth twice daily. The satellites are traveling at about 8,700 mph. The high-frequency, low-power radio wave that each satellite transmits is beaming through the atmosphere at the speed of light, or about 186,000 miles per second. When we just consider the amount of distance that is covered by the GPS radio signal, it is almost inconceivable to imagine that we can get a GPS location at all! Put into perspective: we are using a radio signal that is traveling 982 billion ft./second, from a satellite that is 63.3 billion feet above the Earth and traveling 12,760 feet per second. Using that radio signal and three others just like it, we are asking a phone or receiver to determine the location of a one-foot diameter meter box lid on a planet that has roughly 197 million square miles of surface area. No wonder we have such a hard time locating our infrastructure!

The question, though, is whether a smart phone can interpret that signal into an accurate position. The answer depends on the user's definition of "accurate". If "accurate" means within 10 meters (about 30 feet), then the answer is yes. If it means "between five and 10 meters", then the answer is "yes, under optimum conditions". But if it means, "less than a meter", the answer is usually "Absolutely not!" It seems that smart phones have too many other functions operating within them at any given time to provide a sub-meter or sub-foot accurate position.

Latitude/Longitude seems to be the accepted means of measurement for today's phones and commercial GPS receivers. However, if someone is using a Lat/Lon coordinate to navigate to a feature, he or she needs to be aware of the implications. Lat/Lon is usually delineated by Degrees, Minutes and Seconds. (written DD° MM' SS") One degree of latitude is approximately 69 miles. A minute of latitude is about 1.15 miles and a second of latitude is just over 100 feet. The coordinate 35°27'38" could therefore be one side of a building or the other? Using decimal seconds is the way to gain greater accuracy. 35° 27' 38.5" would be within a tenth of 100 feet or within 10 feet, and 35° 27' 38.52" would be within one hundredth of a hundred or within 1 foot. When navigating in the field, the person trying to locate a facility needs to know how close he/she potentially is to a sought-after feature based on the unit of measure being used.

"Assisted GPS" or A-GPS is a system used by smart phones to quickly determine a location. It is a system that uses the cellular network to locate and utilize the satellites under poor signal conditions. For example, the almanac and ephemeris files have to be received by a GPS unit to

You're talkin' Greek – what these terms mean . . .

Several terms used in this article are new for those who only touch on the topic of GIS/GPS.

Ephemeris data is a set of parameters that can be used to accurately calculate the location of a GPS satellite at a particular point in time. It describes the path that the satellite is following as it orbits Earth.

To accurately calculate a location, ephemeris data is only usable for a limited time (a few hours or less). Up-to-date data is needed to minimize error that results from minor variations in a satellite's orbit.

Almanac: The GPS almanac is a set of data that every GPS satellite transmits, and it includes information about the state (health) of the entire GPS satellite constellation, and coarse data on every satellite's orbit. When a GPS receiver has current almanac data in memory, it can acquire satellite signals and determine initial position more quickly.

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properly determine the location. Download of those files from a satellite may require up to twelve minutes by a standalone GPS receiver. An A-GPS system can obtain those files from the network provider that will allow it to more quickly lock onto passing satellites. Once locked, it can then determine position. However, in poor signal conditions such as near high-rise buildings or under tree cover, a cell phone may utilize Wi-Fi positioning or cell-site triangulation to acquire a position. These processes will not provide an accurate location, however. The system was designed for emergency services and was designed to approximate a person's location, thus being very efficient, but somewhat inaccurate. In the world of utility locating, it would prove to be largely useless.

The accuracy of the data that was originally collected and is now being navigated to can also be called into question. If the data was collected with a GPS unit that is less accurate than the accepted tolerances, it may be possible to be attempting to locate a feature within a distance that is unattainable. This is often the situation with aerial photography. I have entered GPS positions from a phone onto a map with a base layer aerial only to see that the position shows up on the wrong side of the street. If the acceptable georeferenced error of the aerial was 4 percent upon delivery (which could translate into 10 feet or more) but the accuracy of the point taken by the phone is very good, it could appear as though the unit (the phone in this instance) is very inaccurate.

This display shows the estimated accuracy of a new smart phone that had been on for several minutes at a location in Seneca, KS. The halo around the blue dot indicates where the phone *"could"* be. As the photo shows, the point could be anywhere within a 3,200-foot radius. That distance is out of the question when locating utility infrastructure.

All of these various issues, which didn't touch on the subjects of different atmospheric disturbances and anomalies, contribute to the opinion that GPS-enabled cell phones are not as accurate as standalone GPS receivers. For the purposes of navigating to an address or business location, phones are very fast and very helpful. But as the graphic to the left, illustrates if you use one to find a manhole, it may take a long, long time.

Conference session

"GIS / GPS Mapping – An Ever-Changing Technology" is the title of a session at the upcoming KRWA conference. This session will provide a review of GPS data collection and the development of a basic Geographic Information System. Attend the session to find out what information is available without cost. See the differences between scanned "as-built" maps and maps created based on GPS data. This session will also discuss the potential for future online mapping. The session will be held Thursday, March 29 at 9:30 a.m. Hope to see you there.

Pete Koenig is GPS/GIS Mapping Coordinator at KRWA where he has been employed since 2004. He also has worked on KAN STEP projects and has been involved in other Association activities.

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