How 911 works in Tennessee

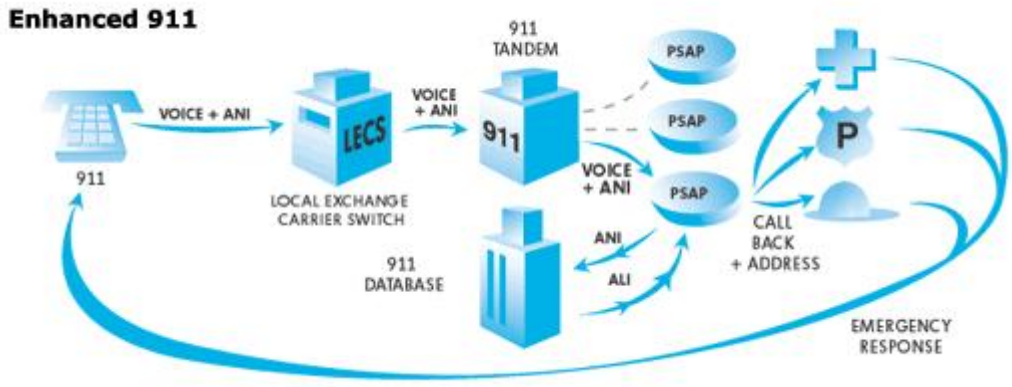
Enhanced 911

When a call goes out from your phone, your voice isn't the only thing being transmitted in the network. The phone company switch that serves your phone is also sending out an Automatic Number Identification (ANI) signal to the network.

Originally, ANI signaling was designed to assist the phone company in accessing toll charges for long distance calls. With advances in technology, it was eventually employed to aid in relaying needed information to the PSAP for 911 response.

How does it work? Within each call, information containing eight digits is embedded in the signal. These eight digits contain the seven digits of the caller's local number. The eighth digit is called a Numbering Plan Digit (NPD). NPD is basically shorthand for the area code of the originating call. Since most 911 tandems rarely dealt with more than two or three area codes, this was an economical way to relay information with one digit instead of three.

With special equipment, the 911 tandem can read the ANI information and route the callback number to a digital display at the appropriate PSAP. Armed with this ANI information, the PSAP has equipment allowing it to request and receive the caller's physical address or Automatic Location Information (ALI).



With this enhancement, the PSAP is no longer totally dependent on obtaining location and callback information from the caller. Instead, the dispatcher can concentrate on helping the caller through the crisis, while instantly passing along needed information to the correct authorities.

This is how E911 has been working for more than 20 years when dialed from a wireline phone. With the advent of wireless phones and the need for **wireless 911**, additional challenges present themselves.

Wireless 911 - Phase I

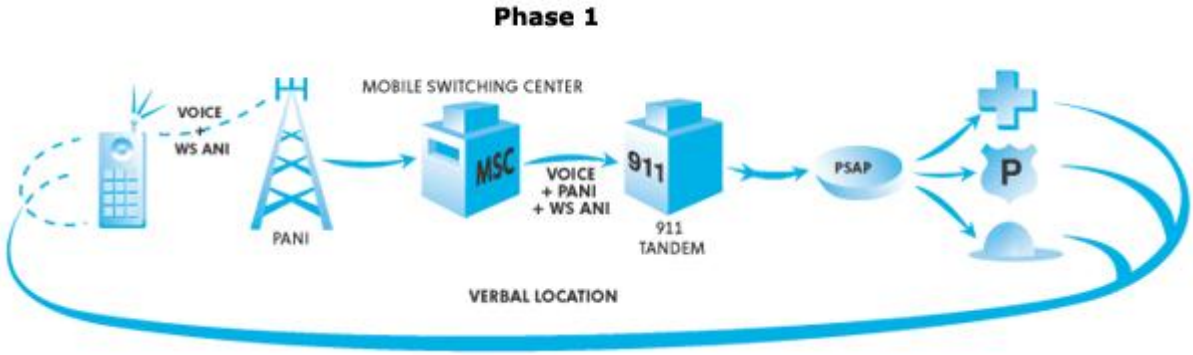
Prior to the FCC order, the effectiveness of calling 911 from your wireless phone had backtracked to the days of relying on the caller to relay the proper information. This presented an additional challenge because now the caller may not even be at a fixed address - he or she could be on the side of the road, in the woods, or in an unfamiliar place. Obtaining accurate location information from the system is critical because getting it from the caller is even more unreliable.

The first phase of sending this information to the correct PSAP is for the callback number and cell tower of origination to be relayed to the PSAP.

So what happens? When a wireless subscriber initiates a call, the closest tower picks up the signal. The wireless service provider's network also has a switching center that works much like the switches on wireline calls. It reads the digits and forwards the calls accordingly.

The wireless service provider must first program its tower to immediately send any 911 call to the appropriate 911 tandem.

First, there is the Pseudo ANI (PANI). This number identifies the cell face (up to three per tower) or just the tower itself. This can narrow down the location of the caller to several hundred square meters at best, but more often several square kilometers. In addition, there is the Wireless Subscriber's callback number, which is sent along the signal. From the 911 tandem, the PANI, callback number and the voice are forwarded on to the appropriate PSAP. In most Phase I deployments, the callback number is part of the ALI response message.



However, number portability presents a challenge to the system. Today, with the explosion of phone numbers needed for wireless service, pagers, fax and Internet access, the use and number of area codes is in abundance. In addition, wireless phones can now roam all over the country.

Remember the eight-digit number used in wireline calls? There were only four Numbering Plan Digits equaling four area codes. This is no longer adequate.

The capability to use the actual area code and a new signaling protocol between the 911 tandem and the PSAP has required new software to be installed in our 911 tandem switches.

Wireless 911 - Phase II

Phase II of bringing wireless 911 to the public means the PSAP has to receive fairly accurate location information from the wireless subscriber. How accurate? Depending on the technology, anywhere from 50 square meters to 300 square meters.

The responsibility of getting this information from the callers falls to the wireless service providers. *Collecting Automatic Location Identification (ALI)*

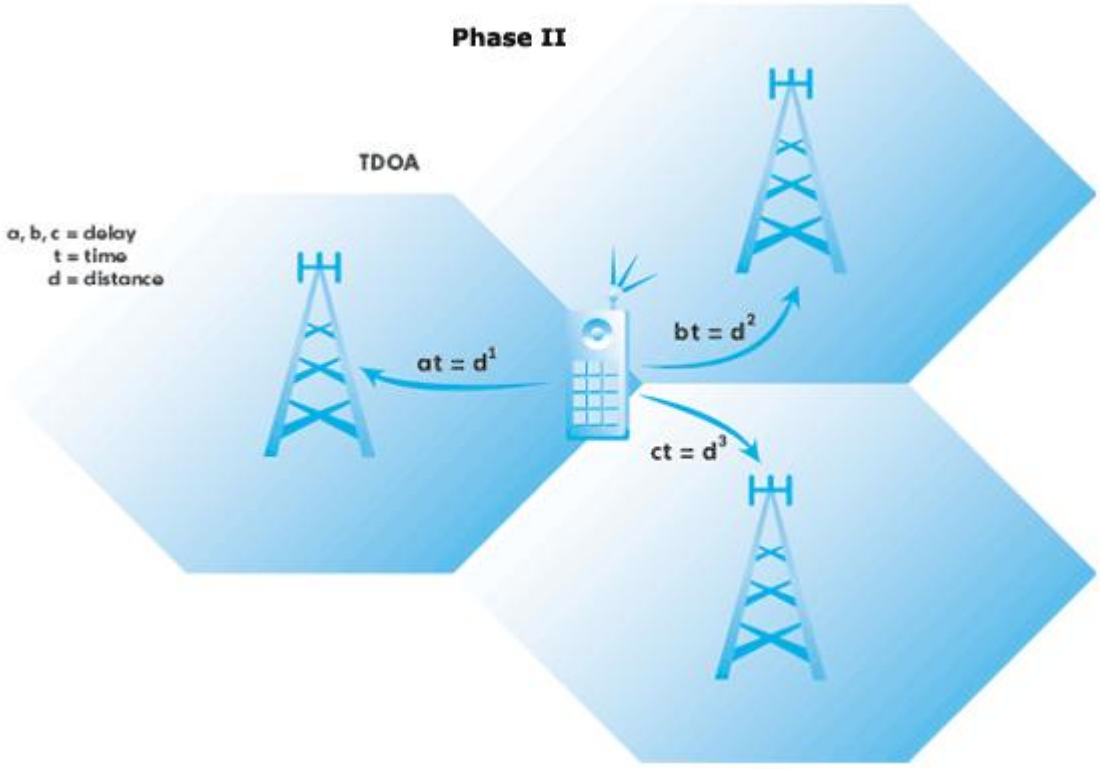
Network Solutions

One way to locate a caller is to use the network of fixed base stations in a wireless provider's network to triangulate the caller's location. Here's how:

Each station in a carrier's network is outfitted with special radio intercept equipment that receives a signal from any active phone. At any given time, two or more towers are able to compare signals from that phone and locate it based on relative readings. The following are the primary ways wireless carriers can use their network to glean location information.

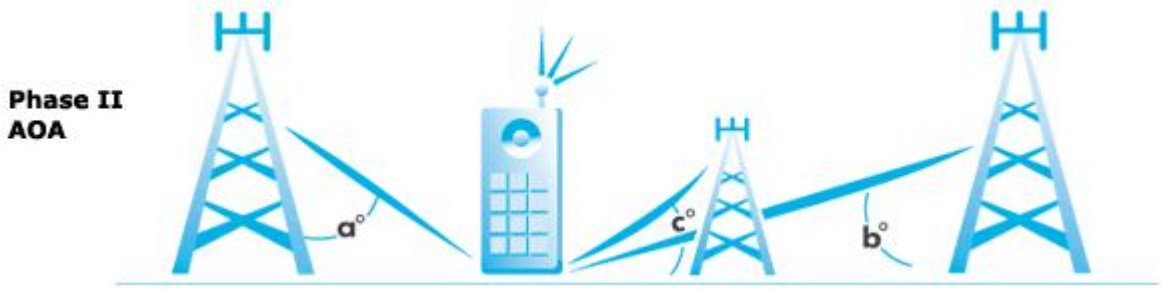
TIME DIFFERENCE OF ARRIVAL (TDOA)

Each tower in a TDOA system is able to measure the amount of time it takes to receive a phone's signal. They can then translate this information to estimate the distance of the phone from the tower. By cross-referencing this information from other towers in the system, a phone's position is expressed in X and Y coordinates based on longitude and latitude readings.Reprinted by permission of Bellsouth



ANGLE OF ARRIVAL (AOA)

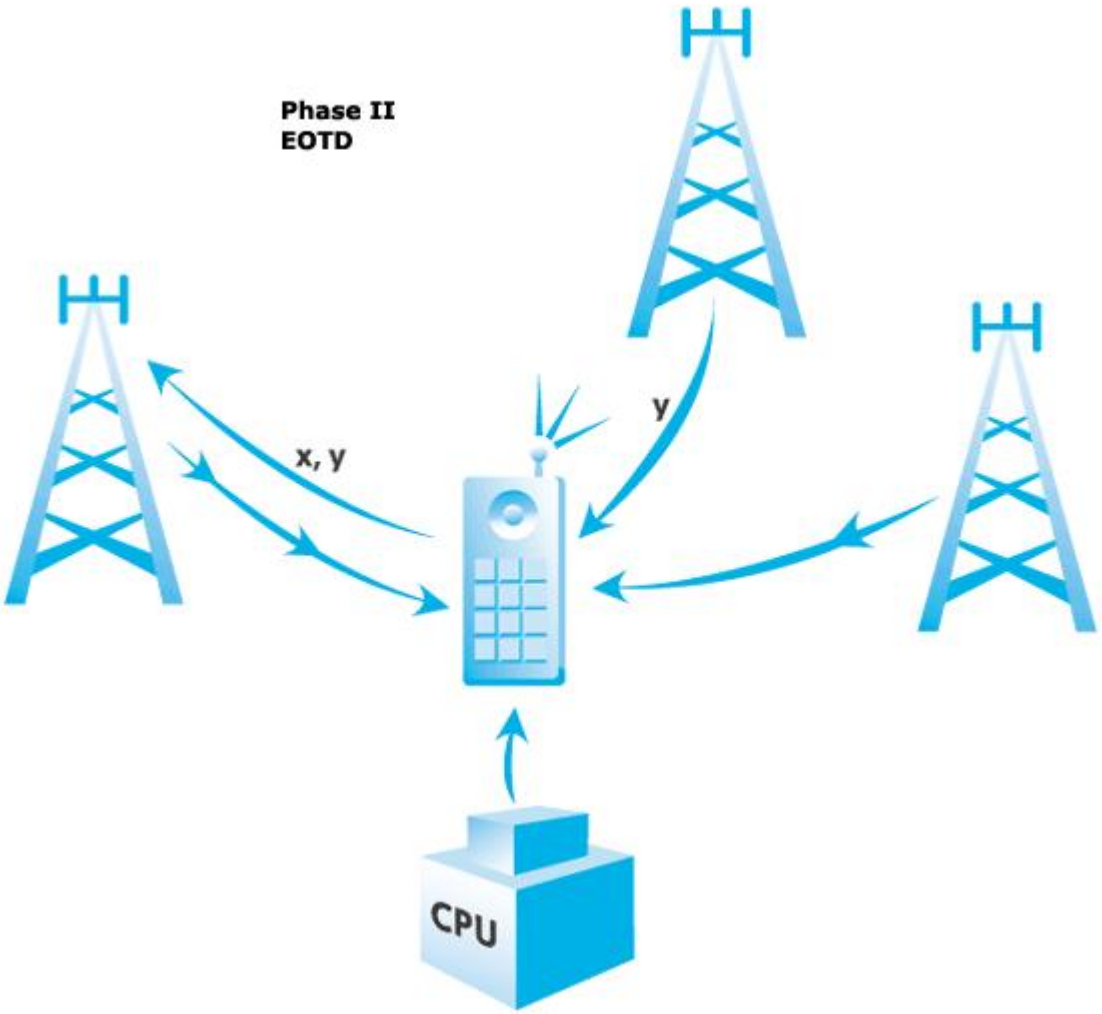
The AOA system uses the antenna arrays at a base station to determine the angle at which a wireless phone's signal arrives at the station. By comparing this angle of arrival data among multiple base stations, the relative location of a wireless phone can also be triangulated. This is also expressed in X and Y coordinates.



Some systems may actually use a combination of TDOA and AOA to get an even more accurate fix on location.

ENHANCED OBSERVED TIME DIFFERENCE (EOTD)

This works much like the TDOA, except the reading is made in the reverse. Instead of a tower making time differential readings, the individual wireless phones have special software installed that receives time-synchronized signals from the towers. They then transmit their location back through the system.



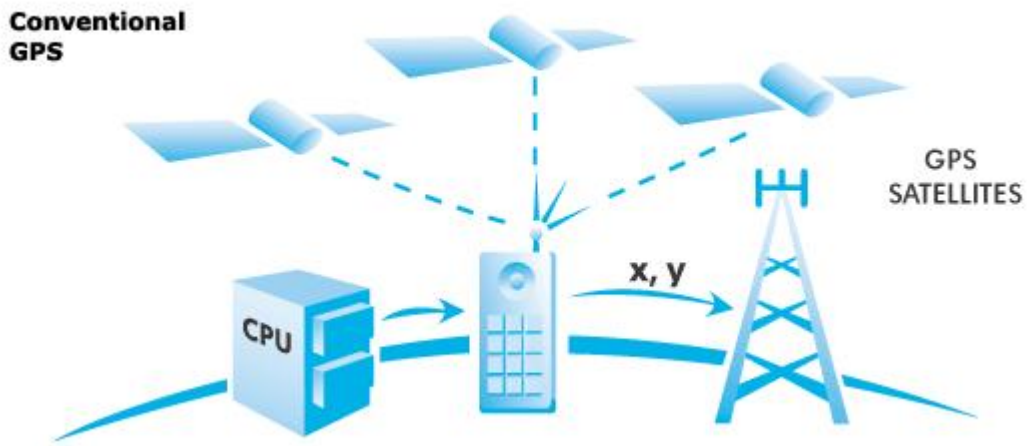
Handset Solutions

Another way wireless service providers can bring better location technology to 911 is to use modified handsets that receive Global Positioning System (GPS) signals. GPS technology uses 24 Navstar satellites that broadcast position and time information to location units on the Earth. Like the triangulation method mentioned earlier, the unit uses information from three satellites to fix its position on the Earth. In the case of the modified handset, this information is sent back through the network, ultimately to the PSAP.

Handsets are able to process GPS readings in the following ways:

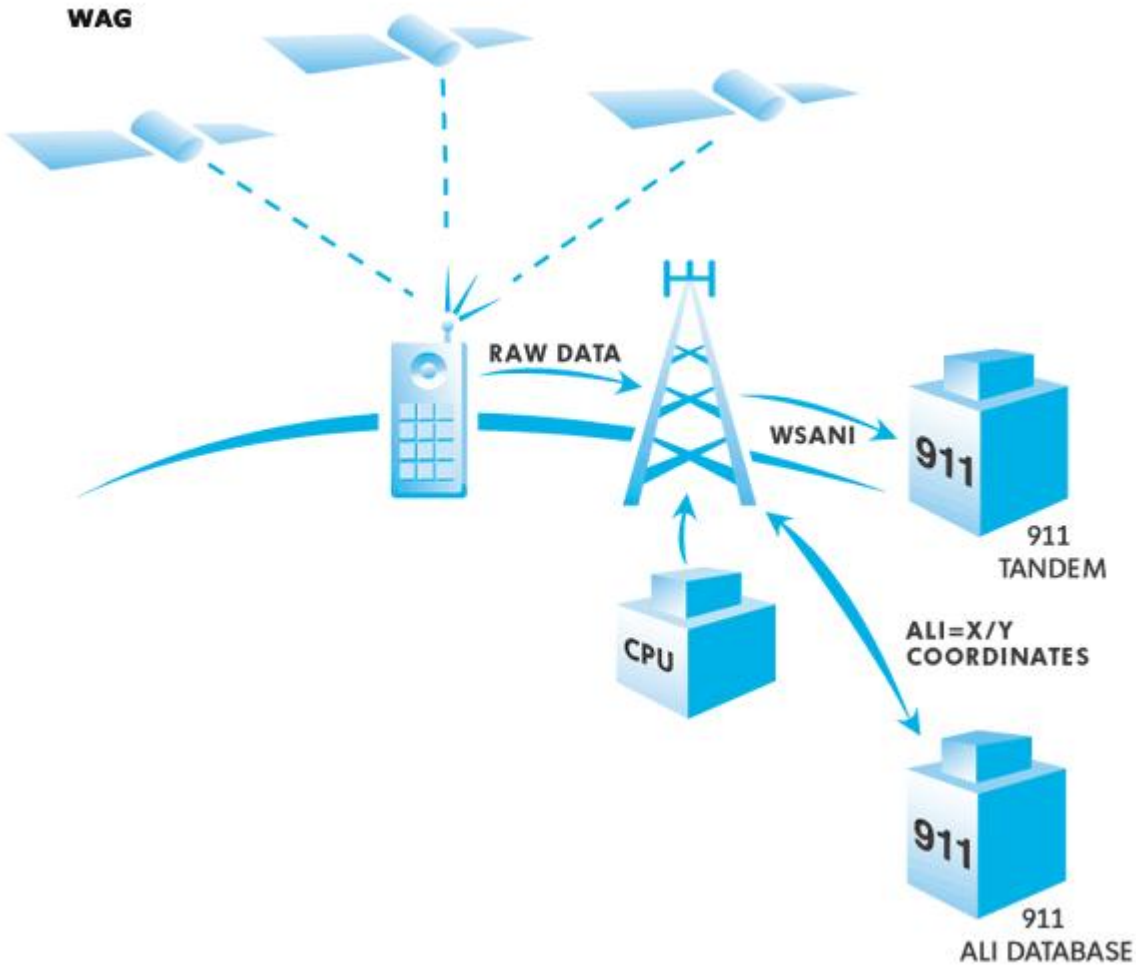
CONVENTIONAL GPS

These systems use modified handsets that receive and process GPS satellite signals without any external assistance.



WIRELESS ASSISTED GPS (WAG)

WAG systems use modified handsets that receive GPS signals and then transmit those readings to a computer. This computer then completes the calculation process, relieving the phone of having to process complex location information. With the extra computing strength, the system can use multipath mitigation and signal processing techniques to locate phones indoors, in urban canyons or other places that are a challenge for conventional GPS.



Getting it to the PSAP

As you can imagine, the information received at the PSAP is now becoming much more complex than the original ANI and ALI information coming in from wireline 911 calls. The systems that transmit information need to be coordinated and expanded to help the information move seamlessly.