

WIRELESS 9-1-1 AND ITS CHALLENGES

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In 1984, at about the time that some (but nowhere near all) major metro areas around the U.S. were just getting the hang of Enhanced 9-1-1 (E9-1-1), a troubling thing happened. Somebody in the USA dialed the digits 9-1-1 from a \$2,000 cell phone, bolted into some car somewhere. We say "\$2,000" and we say "bolted in a car" because in '84 that's what a cell phone cost, and they were only available in "bolt in" models. In fact, the FCC had not yet approved cell phones for handheld use, out of concern that the radio waves emitted from an antenna held too close to the head could cause brain damage.

After that unsuspecting 1st cell phone caller to 9-1-1 pressed [SEND] for that call, they were probably greeted by a recorded message that said "***We're sorry, the digits 9-1-1 are not in service for cell phones in this area***" or something to that effect. Hearing messages like this caused persons who had spent a lot of money and expected to be able to call "*anybody, from anywhere*" to complain. This caused the (then) only two cell phone service providers ("carriers") to react and come up with a way to do their version of "wireless 9-1-1". But because 9-1-1 networks were originally designed to work with wireline telephones, the use of the traditional wireline 9-1-1 network by wireless carriers for 9-1-1 presented new challenges to public safety.

- ▶ While wireless telephone services are is similar to wired phone services in many respects, they are also very different. One of the major areas of difference is how 9-1-1 is handled.
- ▶ In both cases the call is sent from the device from which it was dialed and makes its way via radio frequency to a switching office at which point its further path of travel is determined primarily by what number was dialed.
- ▶ A huge difference from here is that for a given wireless carrier, there is usually one such switching center covering a large land area, often as large as one or two states, whereas with wired, most COs serve a given community or even a small neighborhood area in a larger community.
- ▶ If the wireless call's intended destination is another wireless phone on the same service provider's network, that call will then never enter the "regular" Public Switched Telephone Network (PSTN) at all. Rather, it will go from phone #1 to a nearby cell tower and then to the wireless switching center (called a Mobile Switching Center or MSC) and from the MSC, back out to a tower nearest the desired phone #2.
- ▶ If the wireless call is intended for a wired phone or phone system anywhere else in the world (***and that would include a call dialed to 9-1-1***), it will be switched by that MSC to the PSTN and then make its way to its destination via the regular PSTN. Knowing this, when the wireless carriers first responded to market demands that their devices and services support calls to 9-1-1 from their cell phones, they generally did it in one of two ways:

1. They took that call dialed to 9-1-1 and arriving at the MSC, and if the community in which that MSC was located had 9-1-1 services, they would take the wireless 9-1-1 call and switch it out as a "call dialed to 9-1-1" to the local PSTN.
2. Or, if 9-1-1 service did not exist in the area where the MSC was located, they took the wireless call dialed to 9-1-1 and "translated" it into a local 7 digit number that had (usually) been provided to them by the local public safety answering point as the proper number to which such calls should be "forwarded".

How were early wireless 9-1-1 calls handled in Minnesota?

In the earliest days of wireless service in Minnesota, the only place with cell phone service was the Twin Cities metro by only two carriers. Both carriers had only a few, fairly tall cell sites at the outset in 1983. Because the Twin Cities had operated Enhanced 9-1-1 since December, 1982, that meant that the two carriers chose the option from the above of sending wireless 9-1-1 calls to the local E9-1-1 system. That meant that every cellular 9-1-1 call from one of the carriers "entered the E9-1-1 network" looking like it had been dialed from a phone number assigned to 2020 Minnehaha Avenue in Minneapolis, the address of the cell tower. All these 9-1-1 calls

were routed to the Minneapolis 9-1-1 Center for answering, being selectively routed and arriving at the PSAP with the ANI of 612-720-0911. The ANI display equipment at the Minneapolis 9-1-1 center was modified to flash when it received these ANI digits to alert the 9-1-1 operator that this wasn't really going to be a call from 2020 Minnehaha Avenue (despite what the ALI screen would be saying),¹ rather that it was going to be a cellular 9-1-1 call that had been dialed from some car someplace roughly between Hastings and Elk River, Menomonee, WI and Excelsior, MN. Similarly, cellular 9-1-1 calls dialed from devices subscribed to the other metro cellular system entered the local E9-1-1 network looking like they were dialed from 7900 Xerxes Avenue South, the address of the cell tower of the other wireless carrier, and they were then routed to the Bloomington Police PSAP.

By late '85 these two 9-1-1 Centers had had about enough of taking wireless 9-1-1 calls from a lot of places for which they did not provide dispatch services. They also determined that the vast majority of these mobile mounted cell phone 9-1-1 calls were about accidents, stalled autos and spin outs on the freeways, which made up much of the intended coverage area of early cell services. So they suggested that the wireless carriers change the routing for these 9-1-1 calls and cause for them to be sent to the MN State Patrol metro dispatch centers instead. And, even though the State Patrol did not have E9-1-1 call answering equipment back then (1985), it didn't matter, since wireless 9-1-1 calls were not providing any meaningful ANI or ALI anyway, so the calls were routed to 7 digit numbers at the State Patrol metro dispatch centers.

The significant fact here is that it was determined that these calls could be "selectively forwarded" based on the cell tower where the call was originally received. In other words, if you were in Hopkins and dialed 9-1-1 from your cell phone, and your call was originally received and processed at a cell tower in St. Louis Park, it was able to be known that this call originated from West of the Mississippi River (the Metro State Patrol district's dividing line) and it could be sent to a special 7 digit number set up at the West Metro State Patrol. The above situation became the norm in Minnesota until the late 1990's, and as the wireless carriers multiplied and started to expand their service areas to Greater Minnesota, they merely replicated the same basic technical approach to each of the (then) 10 Greater Minnesota State Patrol dispatch centers.

Cell phones go hand-held, problems multiply.

In about 1992, in recognition of the general problems set forth above, the professional 9-1-1 community became very concerned. This concern was aggravated when hand held (or somewhat hand-held) cell phones began to be marketed. Earliest versions were "bag phones", which were really mobile phones with batteries carried in little purse-like cases. Shortly thereafter, actual hand-held phones came on the scene, but even they were rather large in the beginning.

The issue of the size was very critical for 9-1-1, in that it was the reduction in phone size and increased battery life in the later 1990's that made it more and more practical for these phones to be carried on belts, in pockets and purses, and no longer be tied to vehicles on the street. This meant that the universe of events and places from which 9-1-1 calls could be placed became unlimited, as well as the chances of their being multiple wireless 9-1-1 calls from one small place, all reporting the same incident. ***This convergence of technologies and facts turned the novelty of wireless 9-1-1 into one of the most significant, work altering developments to ever hit the emergency communications industry.*** It is now common to see that of the entire 9-1-1 call workload in a typical metro 9-1-1 Center over 50% of these calls are coming from wireless phones. And with diminished to non-existent location information, each of these calls takes significantly longer to process.

The FCC steps in:

In reaction to these concerns, in 1994 an alliance of 9-1-1 professional associations went to the FCC seeking action. They petitioned the FCC to ***"make cell phones work right with 9-1-1"***. The FCC was the only body capable of regulating cell phone companies, since they issued the radio licenses needed to operate and issued "type acceptance" certifications for the wireless devices. The FCC agreed to look into the matter and opened a "docket" entitled 94-102. For a couple of years, the FCC took competing testimony from both the 9-1-1 professional associations and organizations representing those who answer 9-1-1 on one side, and the providers of wireless communications services on the other. In general, the two sides did not agree. Public

¹ See Metropolitan Emergency Services Board Briefing Paper #1, "How does 911 Work" available at www.mn-mesb.org for a full explanation of ANI and ALI.

Safety wanted wireless 9-1-1 fixed, right now, and as close to traditional wireline 9-1-1 service as possible. On the other side, the wireless carriers wanted little or no change, and very slowly at that, all because of expense and the availability of technology. By 1996 the FCC finally issued their 'Report and Order', which mandated that the wireless carriers implement "Wireless Enhanced 9-1-1" over two phases (Phase 1 and Phase 2) .

What are Wireless "Phase 1" and "Phase 2" and what makes them so complicated?

Phase 1 requires that the phone number of the wireless device calling 9-1-1 and the location of the cell tower (also called a "site") or directional sector of a given tower (*there may be as many as four such directional sectors*) through which the call was originated be delivered to the PSAP with the call. Phase II requires that, in addition to the cell phone's call-back number, the actual location latitude/longitude of the calling phone (within certain parameters) is to be delivered to the PSAP when that wireless 9-1-1 is answered. The specific requirements for Phase II location are based on the type of "location determination technology" that the wireless carrier chooses to deploy in a particular area. This choice strictly belongs to the carrier. Neither the PSAP, nor the State, nor the customer, nor the wired 9-1-1 service provider on whose network the wireless 9-1-1 call will be passing on its way to the PSAP has any say in this choice whatsoever. The two basic types of wireless location technologies, at the sole discretion of the wireless carrier are:

Network Based – Certain intelligence is built into the wireless network (cell sites and handsets) that allow measurements of time and distance to be made resulting in the ability to provide a location via radio signal triangulation.

Handset Based – In this case the intelligence is built into the network and the handset, which uses satellites and GPS to obtain a location and provide it to the PSAP.

The FCC established different accuracy parameter requirements for each of the type of location determination technologies. The location accuracy for each type of solution is: Network-based: Within 100 Meters for 67% of calls; Within 300 Meters for 95% of calls. Handset-based: Within 50 Meters for 67% of calls; Within 150 Meters for 95 % of calls.

The FCC also established that the carriers are not obligated to provide this service until and unless the PSAP or 9-1-1 jurisdictional entity that serves the area requests them to do so. Before a PSAP or 9-1-1 jurisdiction can make such a request they must meet certain requirements, these requirements are often referred to as PSAP Readiness and are outlined below:

- PSAPs must have a cost recovery mechanism to recover the "PSAP" cost (No recovery of carrier cost is required, but it is not prohibited);
- PSAPs must have the ability to use and interpret the data, including the Phase 2 latitude and longitude data that will be received from the carrier;
- The PSAP must have ordered from it's 9-1-1 System Service Provider the necessary 9-1-1 network connectivity to receive the wireless calls.

Over the past six years, numerous deadlines have been missed in this implementation, and numerous "clarifications" or "re-statements" of the rules have been required of and from the FCC. But as it stands now, there seems to be pretty general understanding on the part of the wireless service providers, most 9-1-1 jurisdictions and most E9-1-1 service providing local exchange carriers as to "how to do it". Most of the technical challenges have met at least moderately acceptable resolution for now.

One of the major tasks that requires intense attention during the planning for wireless E9-1-1 is the issue of call routing. On most cell towers each carrier (and there are often antenna arrays from multiple carriers on a single tower) has three sets of antennas for that site, each facing a different direction. (See the photos on the next page) If that tower is located in an urban area it's highly likely that 9-1-1 calls reaching the North facing antennas will need to be routed to one PSAP, the calls hitting the Southeast set of antennas may need to be routed to another PSAP, and the calls hitting the Southwest facing set of antennas may need to be routed to yet another PSAP. Add to this the potential that if one carrier's set of antennas on this tower are out of service or busy, all calls that would otherwise be served by that set of antennas will be "diverted" to a nearby tower, possibly rendering the hard work of making the routing decisions pretty much irrelevant during such diversion.



Add to that the fact that (especially early on) the wireless carriers were very protective of cell tower/sector coverage information for fear that their competition would be able to spot weaknesses in their coverage and use it against them in some marketing campaign. When that happened, the ability of 9-1-1 planners to get good coverage data with which to plan was impacted. Then add the fact that the carriers adjust the coverage areas of cell sites regularly, and whenever they add new sites, the service area of nearby existing sites is affected, perhaps requiring “recalibration” of the routing decisions made based on their earlier coverage areas.

And, while it is the desire that someday Phase 2 wireless E9-1-1 calls will be truly selectively routed to their proper PSAP based on the latitude and longitude of their actual location when [SEND] is pressed, that is almost never the case today, making it an unfortunate fact that many otherwise Phase II 9-1-1 calls that were routed based on their cell site and sector of origination still have to be answered first in one PSAP, and then transferred to another PSAP for proper local handling. On top of this, many times a day persons literally sit on their cell phones, depressing the “1” key, which (on many phones) is programmed to automatically dial 9-1-1! When their phone does this, the call to 9-1-1 is generated, the 9-1-1 call must be answered (the PSAP can’t possibly know it was one of these inadvertent calls until they listen to it), and the PSAP must listen intently to hear what they can hear to determine if this is a real call where in the caller is somehow being restrained, threatened or prohibited from speaking, or just another “inadvertent 9-1-1 call” which can be ignored (at some peril), which is why some PSAPs take the time (and deploy resources not available then to other wired or wireless 9-1-1 callers) to try and call that cell phone back

Determining the general coverage area of this site would be pretty easy!

Its antennas are aimed directly into the tunnel, and no place else. So, this would be a one directional cell sector.

