Cell Phone Calls To 911
Reasons For Bad or Missing Phase 2 Coordinates
FindMeSAR Can Help

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Last update 11-2-2020

When a cell phone user calls 911 the call center can always get **phase 1 coordinates**. This is the location of the cell tower carrying the call. Most of the time the 911 call center also can get **phase 2 coordinates** which are supposed to be good enough to enable responders to locate the caller. But sometimes the wireless carrier will either never produce the phase 2 coordinates or will produce them but with an accuracy value that is so large that the coordinates are not very useful. This report explains several reasons for why these problems arise. And when the standard 911 system fails to produce good coordinates for a caller, FindMeSAR (https://findmesar.com) can often be used to quickly get accurate coordinates.

The information provided here was obtained during an extensive review of documents on file at the FCC website. I strongly suspect that most managers at 911 call centers are unaware of most of these details. Also this information about phase 2 coordinates applies to **standard e911 systems** that have not implemented third party solutions such as Rapid SOS. And these comments do not apply to flip phones since they lack a GPS chip.

Keep in mind that there are more than 6,100 emergency call centers in the USA. No doubt their experiences with phase 2 coordinate data for cell phone callers will vary widely.

Use Russian data for 911? Nyet!

Beginning with the iPhone 4s introduced in 2011 smartphones get location data from both the USA satellites (GPS) and Russian satellites (GLONNAS). The newest phones also get location data from additional satellite constellations. However, some people in congress thought that using Russian data for 911 was somehow a security risk. As a result, the FCC adopted a rule prohibiting data from any satellite constellation from being used for 911 unless first approved for that use by the FCC after a detailed hearing process. See for example this article from early 2015 https://sputniknews.com/us/201501291017526190.

The Russian GLONASS satellite constellation has never gone through that hearing process and as a result has never been approved by the FCC for use in 911. As a result, the standard e911 system uses data **only from the USA satellites** to produce the phase 2 coordinates.

Fewer satellites = Less data = Poorer accuracy	This is 911
More satellites = More data = Better accuracy	This is Uber

Since 911 is prohibited by the FCC from using Russian data, Uber has more accurate locations for callers than 911.

Here are a couple FCC documents noting that Russian data is not allowed for the purpose of 911.

- See pages 14-15, paragraphs 39 and 40 of this 2015 FCC document. https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-9A1.pdf.
- See also footnote 47 at the bottom of p.9 of this March 2018 FCC document. https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0301/DOC-349523A1.pdf

When a wireless carrier produces phase 2 coordinates for a caller the carrier also produces an accuracy value. If the accuracy value is used as the radius of a circle around the location specified by the coordinates then there is supposed to be a good chance that the caller is inside that circle. Thus, small accuracy values are good and big accuracy values are bad.

The wireless carrier does **not** transmit the phase 2 coordinate and accuracy value directly to the 911 call center handling the call. Instead, those coordinates and accuracy value go into a database. The 911 call taker can ask the database for that data. Doing so is often referred to as a "bid" or "re-bid". The initial coordinates that go into the database might have poor accuracy and a bit later the wireless carrier is sometimes able to update the database information with coordinates that have better accuracy. The 911 call taker has no way to know that the database has been updated unless they send another query to the database.

There are **two different methods** that wireless carriers use to produce phase 2 coordinates for cell phone callers. One method does not use satellite data at all but instead uses various technology related to cell tower triangulation. This method is regarded as less accurate than the other method which uses location data from the caller's phone. However, this other method does not simply get the coordinates and accuracy value produced by the phone since the GPS chip in the phone produced that data by using both USA and Russian satellites. Instead, this second method whereby wireless carriers produce phase 2 coordinates for a cell phone caller works as follows.

1. The phone sends the raw data from **only the USA satellites** to the cell tower.
2. Equipment on the cell tower processes that raw data and produces phase 2 coordinates and an accuracy value.
3. The coordinates and accuracy value go into a database as already described.

However, by relying on data from only the USA satellites the wireless carrier might (1) never put any phase 2 coordinates into the database or (2) put coordinates into the database that have very poor accuracy. **Below are some reasons for why these problems arise.**

Years ago I routinely used a Magellan GPS on trips in the Washington State Cascades. That unit only received data from USA satellites. I learned that unless my Magellan had a clear view of the sky that it might not produce any coordinates. This is because any device has to receive data from at least 3 satellites in order to determine coordinates. Line-of-sight to satellites can be obstructed by heavy forest, mountains, canyon walls, buildings, etc.

A second problem relates to the shape of the satellite constellation that a phone or GPS unit can 'see' at any given time. And remember, for 911 we are talking about **only the USA satellites**.

The closer to a straight line the shape of that constellation becomes, the worse the accuracy becomes for any coordinates that are produced.

My first cell phone was an iPhone 4s (USA and Russian satellites). I tested that phone's ability to produce coordinates with a good accuracy value on various trips in the Cascade Mountains. I watched for locations where my Magellan GPS (USA satellites only) did not work very well due to a poor view of the sky resulting from heavy forest and/or mountains. There was only one time in an old growth forest when my iPhone 4s failed to produce coordinates with a decent accuracy value and that was easily fixed by moving a few feet along the trail.

In short, the location problems caused by only using data from USA satellites largely go away when using data from both USA and Russian satellites.

What if Russia used its GLONASS satellites to send bad data?

One concern with using GLONASS data for 911 is that Russia could intentionally tell its satellites to transmit bad data. Should that happen it has the potential to affect Uber and everyone else that has devices that use both GPS and GLONASS data to determine location.

How would this affect 911?

- Standard e911 systems **would not** be affected since they do not use GLONASS data.
- RapidSOS and all other 3rd party 911 location enhancements **potentially would** be affected since they use both GPS and GLONASS data.

Does all this sound unlikely? Maybe not. Here is a link to an article discussing problems NATO experienced with location data during a 2010 exercise.
https://jamestown.org/program/russia-upgrades-glonass-satellite-navigation-system-as-concerns-rise-about-its-use-in-spoofing-incidents/

FCC allows wireless carriers to exempt themselves from having to provide any coordinates to 911.

Just when you thought the problems regarding location data for 911 could not get any worse, they do get worse. Consider a wireless carrier that determines the caller's coordinates using technology related to cell tower triangulation. If that company lacks sufficient cell tower density in an area to make this technology work, then the company can file a piece of paper with the FCC and exempt itself from having to provide any coordinates to 911 for calls made from within that area.

Does the FCC review those self-claimed exemptions for valid justification? Nope.

Likewise, consider a wireless carrier that determines the caller's coordinates by using data from just the USA satellites. Recall my point that this does not work so well in heavily wooded areas. As you may have guessed, the FCC allows wireless carriers to file a piece of paper that identifies an area as heavily wooded and then exempts itself from having to provide any coordinates to 911 for calls made from within that area.

The Colorado 9-1-1 Resource Center has a web page at
https://sites.google.com/a/co911rc.org/co911rc/home

One of the projects of this Colorado group is to keep track of the phase 2 exemptions filed by the wireless carriers. Below is a link to their current data on this topic.
https://docs.google.com/spreadsheets/d/1HbBgD2KKx_umIOEYZx0UgBMu3Vg0t7nztBTI5jpJJuM/edit#gid=0

Now that you have a detailed understand of why sometimes 911 does not have accurate coordinates for wireless callers, I am next going to show you a **simple, easy, no cost solution** that will usually produce accurate coordinates for cell phone callers.

FindMeSAR displays the user's coordinates and accuracy value

Several years ago I developed the **FindMeSAR webpage** (https://findmesar.com) to help solve the problem of bad or missing phase 2 coordinates. This is a public service project and part of my way to "pay it forward".

FindMeSAR is a webpage (**not a native app**) that displays the user's coordinates and the related accuracy value. It can display four different coordinate formats and each one has a different colored background.

Blue	U.S. National Grid (USNG)
Yellow	Latitude longitude, decimal degrees (same format as phase 2)
Red	Latitude longitude, degrees and decimal minutes
Green	UTM

If a cell phone call comes into a 911 call center and the wireless carrier does not provide phase 2 coordinates with a good (i.e. low) accuracy value, then the 911 call taker can ask the caller to:

1. Browse to findmesar.com
2. Tap the "Next format" button until the screen displays the color of the coordinate format preferred by that jurisdiction.
3. Wait a few seconds for the accuracy value to get to 50 feet or less. (It will likely get to around 15 feet rather quickly.)
4. Tap "Stop".
5. Read off their coordinates and the accuracy value.

Below are a few links to places where FindMeSAR is being used.

New Mexico Search and Rescue
https://www.nmsarc.org/uploads/6/3/5/6/63569937/2017_mission_stats.pdf See page 2
In an email exchange with Robert Rodgers, State SAR Coordinator, he said:

> "As for the FindMeSAR app, we in the NM Search and Rescue program have utilized it on numerous occasions and have always found it to be accurate. It was first presented to the program from one of our volunteers. It is typically initiated by my SAR Incident Commanders who send the link to the subjects to obtain location information."

Below is a news story from New Mexico about a hiker stuck in snow high on a mountain. FindMeSAR is mentioned in the second part of the video and in the text.
https://www.krqe.com/news/albuquerque-metro/three-people-rescued-from-popular-sandia-mountain-trail-in-one-day/?fbclid=IwAR1i-71FLOqoCcv7AfJnyZoAu-wGKo27IY-Z41I1aD2JTMQpvjcmah8rssY

Arizona Search and Rescue
https://arizonasar.org/wp-content/uploads/2019/07/FindEm.pdf See page 126
I traded email with Aaron Dick, Search and Rescue Coordinator for Coconino County and one of the co-authors of the above "Find 'Em" guide. He reports they use FindMeSAR fairly regularly in his county and have also taught their patrol deputies to use it to help report locations of emergencies. In addition they have a class they teach based on the "Find 'Em" guide and FindMeSAR is discussed in the class.

Southern Nevada Off Road
There is a group of off-road enthusiasts in Nevada that post FindMeSAR screenshots on a Facebook page when they get stuck or breakdown and need help. I need to post some "tips" for this group since I see that some of them are posting screenshots with a coordinate accuracy of a few *miles*. FindMeSAR will routinely report coordinates with an accuracy value of around 15 feet.
https://snorr.vegas/

Cor PowerSports Race
And here is a group that was organizing snowmobile races in early 2019 and asking participants to have FindMeSAR on their phone in case they ran into trouble and had to report their location.
https://www.facebook.com/CorPowerSports/posts/2020-park-rapids-schedule-online-registration-closes-thursday-january-16-at-800p/2571081349677508/

FindMeSAR is **open source**. Anyone that can read code can look at the source code via their browser and confirm there is no evil intent. There is an icon that can be saved on the homescreen and a "Tips" button with more information.

The first time a person opens FindMeSAR on their phone the code is saved in a special part of the browser's memory. This webpage will then open and work **offline**. (This is done with service worker technology plus AppCache as a fallback.) This would be useful for someone that only has such a weak cell connection that they can text for help but cannot make a voice call. They could get their coordinates and accuracy value from FindMeSAR and paste that data into a

text. Of course this assumes the person previously opened FindMeSAR when they were online so that the code gets saved on their phone.

Finally, let's look at some of the reasons for why FindMeSAR might appear to not work well or not work at all.

1. Location services in the phone have to be turned 'on' otherwise FindMeSAR will not work.

2. Android phones
Depending on its settings, an Android phone can produce coordinates with very poor accuracy (i.e. large accuracy value). If this happens, the user can be asked to:

1. Open up settings
2. Go to the screen where location services are turned on/off
3. Find the 3 options for location "mode" or "method". The phone is likely set to "Power saving". That setting does not use any data from the satellites and can result in very poor accuracy. The caller should change that setting to the middle one which often is called "GPS only".

The **"GPS only"** setting on Android phones produces coordinates just using satellite data. This method produces the **best accuracy**. Note that the first of the three options in the list is often called "High accuracy". When this first choice is selected the phone determines coordinates by using satellites, cell towers, wi-fi hotspots and anything else it can find. However, this first setting allows data from cell towers to degrade the more accurate data from the satellites. Thus, this first choice should be called medium accuracy.

3. iPhones
A new feature in iOS 14 lets the user tweak the phone's settings to intentionally degrade the accuracy of coordinates produced by the phone. For more information see this article:
https://9to5mac.com/2020/08/12/ios-14-precise-location/

I tested this by turning off "precise" location for the safari browser on my iPhone 11 and then opening the FindMeSAR webpage with safari. FindMeSAR gave me coordinates with an accuracy value of just over 2 miles. Yikes!
If someone reports very poor accuracy using FindMeSAR and they are using an iPhone, then they can be asked to:

1. Open up settings
2. Go to the screen where location services are turned on/off
3. Scroll down to their default browser
4. Do they see a switch for "precise" location (new in iOS 14)? If so, turn it on and try FindMeSAR again.

4. 911 call handled by wireless carrier where caller does not have a cell plan

Q: What happens when a cell phone is used to call 911 but the phone cannot see any cell towers for the wireless carrier where the caller has a plan for cell service?

A: The phone will try for 17 seconds to connect to a tower where the user has a plan for cell service. If a connection is not made within 17 seconds then the phone will try to connect to any compatible cell tower. If you want to read more about this 17 second rule see:
https://transition.fcc.gov/Bureaus/Wireless/Orders/1999/fcc99096.txt at paragraph 41
https://apps.fcc.gov/edocs_public/attachmatch/FCC-08-171A1.pdf p.2 and p.7-8

All wireless carriers are required by FCC regulations to carry all 911 voice calls as long as the tower and phone have compatible technology. **The user does not have to turn on any roaming for this to work.** The phone might say there is no service but the user will still be able to call 911.

Most people likely keep 'data roaming' turned off to save money. Thus if the caller's phone says **no service** then before they try to browse to findmesar.com the caller will need to **turn on data roaming**. However FindMeSAR still might not work. This will happen when the wireless carrier where the caller has a cell plan does not have a roaming agreement with the wireless carrier handling the 911 call.