Association of Public-Safety Communications Officials – International
National Emergency Number Association
CTIA–The Wireless Association®

December 23, 2014

VIA ELECTRONIC FILING

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Wireless E9-1-1 Location Accuracy Requirements, PS Docket No. 07-114

Dear Ms. Dortch,

The Association of Public-Safety Communications Officials ("APCO") International, the National Emergency Number Association ("NENA"), and CTIA–The Wireless Association® jointly submit the attached set of recommendations, *Observations and Recommendations on Uncertainty Estimates and Confidence Levels for Wireless 9-1-1 Voice Calls.* These joint recommendations address the *Third Further Notice of Proposed Rulemaking*'s call for comments on how to increase the utility and use of confidence/uncertainty data provided with location information.[1] They also respond to some concerns in the record regarding the ability to provide consistency in location estimation.[2]

Specifically, the attached recommendations offer a standardized confidence level for all carriers and all positioning methods focusing on uncertainty estimates associated with any given 9-1-1 call/location request level. Location information will, therefore, be more actionable because call takers will be equipped with more understandable data.

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[1] *Wireless E911 Location Accuracy Requirements*, Third Further Notice of Proposed Rulemaking, 29 FCC Rcd 2374, at ¶¶ 150-58 (2014).

[2] *See, e.g.*, Comments of the Boulder Regional Emergency Telephone Service Authority, PS Docket No. 07-114, 25 (dated Dec. 15, 2014); Comments of National Association of Regulatory Utility Commissioners, PS Docket No. 07-114, at 6 (dated May 12, 2014); Comments of Rural Wireless Association, Inc., PS Docket No. 07-114, 8 (dated May 12, 2014).

We look forward to exploring these recommendations further with the Commission and other interested stakeholders.

Respectfully submitted,

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December 23, 2014

Observations and Recommendations on Uncertainty Estimates and Confidence Levels for Wireless 9-1-1 Voice Calls

Background of Current Issue

Public Safety has expressed concern over the variation of confidence levels currently employed by various carriers in computing uncertainty estimates. These variations cause inconsistency and confusion at the PSAP. Uncertainty estimates from different carriers or from different location technologies using different confidence levels have different meanings for a call taker. Many PSAPs desire a consistent approach across carriers, but have not been in agreement on what confidence level should be used.

Definitions and Insights

Expressed in meters, the horizontal *uncertainty estimate* is defined as the radius of a circle centered at the reported latitude/longitude within which the actual location of the caller is expected to fall C percent of the time, where C is the associated *confidence level*.

An uncertainty estimate is a calculated estimate of the quality of a position fix associated with a given 9-1-1 call/location request. It is statistical in nature, and is based on various parameters that affect the precision and reliability of the location estimate that are available to the position calculation algorithm at the time the position fix is determined. The specific parameters that affect the uncertainty estimate vary for different positioning methods.

By way of example, for an AGPS position fix, the uncertainty estimate computation might include the quantity of measured GPS satellites, the geometry of the satellites in the sky (wider angles between satellites result in higher accuracy), and the amount of variation between different combinations of satellite measurements (how well do the various measurements 'converge' onto the same point in space).

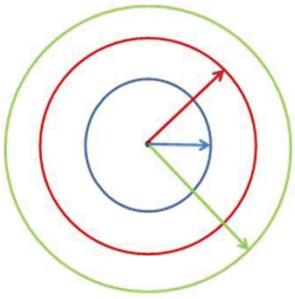
As a statistical measure, taken over a large quantity of 9-1-1 calls, uncertainty estimates are typically well behaved. For example, if uncertainty estimates are computed at a 90% confidence level – one would expect that close to 90 out of 100 location results would have the actual location fall within the uncertainty estimate circle.

For a single 9-1-1 call/location request, the uncertainty estimate can provide a PSAP helpful insight into the quality of the reported position estimate. The larger the uncertainty circle – the more likely the reported position is not close to the actual position. This insight can prompt a call taker to request another location estimate (re-bid), in an attempt to improve the accuracy of the reported location estimate. It can also provide guidance on a 'search area' for first responders, in the case where the caller is unable to provide their own location.

What particular confidence level is used directly impacts public safety stakeholders, as there are inherent trade-offs to higher and lower confidence percentages for first responders. In general, the higher the confidence level, the larger the uncertainty estimate – for a given level of positioning accuracy. Conversely, the lower the confidence level, the smaller the uncertainty estimate.

An uncertainty estimate is not equivalent to the actual accuracy of a given location estimate (which can only be measured if the caller's actual location – or 'ground truth' – is known). A 95% confidence level is not *"better"* than a 90% confidence level. It is simply a different way to compute and interpret the uncertainty estimate. The confidence level at which an uncertainty estimate is computed is independent from the accuracy of the underlying location method. Accordingly, a higher confidence level does not equate to a more accurate location estimate.

To illustrate this important point – an AGPS position fix for a given handset location might generate an uncertainty estimate of 35m at a confidence level of 67%, while the same level of accuracy from the same positioning method and handset location might result in an uncertainty estimate of 60m when computed at a confidence level of 90%. The underlying accuracy of the positioning method is the same for both calculations – only the reported uncertainty estimates and how to interpret them has changed.



	Radial Uncertainty	Confidence
Blue	35 m	67%
Red	45 m	80%
Green	60 m	90%

Figure 1 (for illustrative purposes only)

The *optimal* confidence level for emergency services is one that balances these two competing criteria:

1. The desire to have the actual caller location fall within the provided uncertainty circle a high percentage of the time.

2. The desire to have a reasonably small uncertainty circle to be useful for first responders.

A confidence level that is too low may fail to include the caller's actual location within the uncertainty circle too often, resulting in a false indication of the area where the caller actually is. A confidence level that is too high may produce a very large uncertainty circle, resulting in a vast search area that, even though it probably contains the caller's actual location, is nevertheless not helpful in locating the caller. A more useful confidence level will enclose the caller's actual location within the uncertainty circle a high majority of the time, but with a small enough radius that an effective search can be undertaken in cases where the caller is unable to provide his location.

Increasing the confidence to an artificially high level decreases the usefulness of the information transmitted – so as to be essentially meaningless for a call taker. The ultimate example of this would be a confidence level of 100% – for which most geodetic (Latitude/Longitude) based positioning methods would result in an infinite uncertainty estimate.

Note that many practical positioning methods have well defined (essentially Gaussian) error distributions within 1 to 1 ½ standard deviations about the mean, but do not have well behaved distributions near the distribution edges (or 'tails'), typically 2 or greater standard deviations from the mean. Given this, the proper uncertainty magnitude is more difficult to accurately predict when far away from the mean, and therefore the uncertainty magnitude may increase dramatically with only a fairly small increase of confidence – say from 90% to 95%.

Observations and Recommendations

Generally: The best resolution for this issue is for carriers and public safety to converge on a common confidence level for all carriers and all positioning methods.

Rather than focusing on the underlying performance characteristics of various individual positioning methods, public safety should focus on the uncertainty estimate associated with any given 9-1-1 call/location request. Once confidence levels are standardized, this parameter (uncertainty) will have the most meaning for a call taker, and can be consistently applied and interpreted across all carriers and location methods.

***90% Confidence Level*:** This issue has been carefully studied and analyzed by ATIS/ESIF – including participation from public safety, wireless carriers, location technology vendors, network and handset equipment vendors, and other relevant stakeholders – resulting in a recommendation for all carriers to converge on a common confidence level of 90% as a reasonable balance of the criteria described above[3].

Based on extensive empirical experience with various positioning methods and underlying error distributions, this 90% confidence level recommendation was specifically deemed to draw a reasonable balance between having a smaller target area for caller location, while still ensuring the actual location falls within the reported uncertainty circle a high percentage of the time. ESIF warned of confidence levels that are so high as to fall within the "tail of the distribution" –

[3] See ESIF Issue Number 70 Resolution Statement, *"Uniform Confidence Percentage for Uncertainty Calculation",* 29 Nov 2010.

where positioning error behavior can become erratic. ESIF stated *"Empirical experience has demonstrated that a confidence level of 90% is well behaved across a broad range of networks and environments"*.

It is recognized that IETF has a "work in progress" Internet-Draft ("*Representation of Uncertainty and Confidence in PIDF-LO*", 22 Jan 2014) authored by two individuals who recommend uncertainty be expressed at a confidence level of 95% by default. While we endorse the IETF's prerogative and expertise to recommend and develop common data format and protocol standards for encoding and transferring information across the internet, for the reasons mentioned above, we do not endorse their functional recommendation for a default confidence level of 95% for wireless emergency services purposes. These types of technical/operational recommendations are better suited to standards groups such as ATIS/ESIF, where all relevant stakeholders collectively consider the issue with the benefit of diverse perspectives and many years of directly relevant practical experience.

Public Safety believes that as emerging technologies are analyzed and evaluated, there may be merit in revisiting the 90% metric, assuming that there are eventual improvements in the ability of location technologies that at least maintain if not reduce the uncertainty value, while permitting an increased confidence level. The public safety community also understands and acknowledges that changing the confidence level has a significant impact on the carrier's network equipment and/or handsets. As a result, the confidence level should only be revisited if and when new location technologies make it both financially viable and operationally valuable to both Carrier's and Public Safety.

Network/Handset Changes: The modifications to carrier networks and handsets required to adopt a common confidence level will take some time and resources to implement – especially where handset changes are required. Handset changes are only applicable to carriers who utilize a UE-based location calculation methodology for 9-1-1 location purposes. In addition, for these carriers it may not be possible to modify existing handsets to reflect this change. In these cases, there will need to be an understood point in time where carriers can commit that all new handsets introduced by the carrier will conform to the agreed common confidence level.

PSAP Participation: Historically, as uncertainty estimates began to be offered by wireless carriers, some PSAPs were not initially prepared or desirous to receive them. As a result of this, in an attempt to accommodate the transition to wide-scale use of uncertainty estimates, some carriers (or their ALI providers) implemented the means to send or not send uncertainty estimates on a PSAP by PSAP basis. Now that the provision of an uncertainty estimate with an associated confidence level is required by mandate[4], is currently available from all carriers, and PSAPs have had an opportunity to prepare their equipment and call takers to receive and process this information – it is time to eliminate this logistical and technical complexity so that consumers can fully benefit from carriers' ability to transmit uncertainty and confidence level estimates to each and every PSAP. Of course, any PSAP has the option to disregard the information, should they choose to do so.

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[4] See FCC 2nd Report & Order, "Wireless E9-1-1 Location Accuracy Requirements", PS Docket No. 07-114, 23 Sep 2010.

NG9-1-1 Considerations: A question has been raised about the ability for carriers to provide uncertainty estimate shapes other than a circle. Additional geographic shapes standardized by 3GPP do exist but current signaling standards between wireless service providers and ALI providers/PSAPs only allow for uncertainty circles. Given this limitation, and the observation that Next Generation 9-1-1 (NG9-1-1) will include additional uncertainty shape options, the recommendation is that this enhanced functionality be introduced in association with the transition to NG9-1-1. *"As part of the NG9-1-1 standards and equipment design, the PSAP equipment should be able to receive and process any shape description defined in the 3GPP standards."*[5]

Given these observations – the following recommendations are proposed for wireless 9-1-1 voice calls:

1. Public Safety agrees the confidence level for all carriers and positioning methods will be fixed at 90%, and that the uncertainty estimate will vary for each 9-1-1 call/location request.

2. The 90% confidence level agreement should only be revisited if and when new location technologies make it both financially viable and operationally valuable to both Carrier's and Public Safety.

3. Carriers not already computing uncertainty estimates at a 90% confidence level will work in good faith to make necessary changes in their network equipment and/or new handsets introduced by the carrier over time to conform to this common confidence level.

4. The proposed good faith timeframe to implement this common confidence level is as follows:

    a. Network modifications – 12-18 months from the date of agreement

    b. Handset modifications – New handsets introduced for sale 24 months from the date of agreement

5. Carriers will transmit uncertainty estimates and confidence levels for each Phase 2 location result to the PSAP's 9-1-1 system service provider. Individual PSAPs can decide how to use this information (if at all).

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[5] T. Wigren, M. Anderson, A. Kangas, "Emergency Call Delivery Standards Impair Cellular Positioning Accuracy", Section VI-Proposed Solutions, May 2010 (also referencing "Universal Geographical Area Description(GAD), 3GPP TS 23.032,v6.0.0, Dec 2004)

References

[1] ESIF ESM Subcommittee, ATIS Forum/Committee – Issue Identification Form #70 "Uniform Confidence Percentage for Uncertainty Calculation", April 2010. Available: http://www.atis.org/esif/issues.asp

[2] M. Thomas, J. Winterbottom, (IETF), ""*Representation of Uncertainty and Confidence in PIDF-LO*", 22 Jan 2014, Available: http://tools.ietf.org/html/draft-ietf-geopriv-uncertainty-01

[3] FCC 2nd Report & Order, "Wireless E9-1-1 Location Accuracy Requirements", PS Docket No. 07-114, 23 Sep 2010

[4] ESIF Subcommittee-C, ATIS -0500004 "Recommendation for the Use of Confidence and Uncertainty for Wireless Phase 2", Aug. 2005. Available: http://www.techstreet.com/products/1573708

[5] T. Wigren, M. Anderson, A. Kangas, "Emergency Call Delivery Standards Impair Cellular Positioning Accuracy", May 2010. Available: http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5502305&abstractAccess=no&userType=inst

[6] ANSI/J-STD-036-C, "Enhanced Wireless 9-1-1 Phase II", pp. 8-39, Sept. 2011. Available: http://webstore.ansi.org/RecordDetail.aspx?sku=J-STD-036-C-1