Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Wireless E911 Location Accuracy Requirements	)	GN Docket No. 11-117
	)	

COMMENTS OF T-MOBILE USA, INC.

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I. SUMMARY

T-Mobile USA, Inc. ("T-Mobile")[1] is pleased to submit these comments in response to the Commission's recent Public Notice announcing the Public Safety and Homeland Security Bureau's ("Bureau") October 2, 2013, workshop to address current trends that may be affecting the provision and quality of 911 location information delivered to PSAPs, including the growing volume of wireless 911 calls and the increase in wireless calls originating from indoor locations.[2] T-Mobile believes that continued conversation regarding wireless Enhanced 911 ("E911") issues and exploration of new technologies to support wireless E911 are critical to ensuring that wireless customers continue to have access to the best possible location technology in the event of an emergency.

Wireless E911 continues to improve as carriers and PSAPs work to ensure that wireless calls to 911 are accompanied by the most accurate location information possible. This is borne out by the reality—for the vast majority of wireless 911 calls, the caller is able to summon the assistance he or she needs. This is true despite the tradeoffs inherent in today's location technology, which require a balancing among accuracy, yield, uncertainty, and latency. As the Commission moves forward, it should focus on three critical aspects of the ongoing discussion: first, all parties must have a better understanding of how PSAPs would prefer to prioritize among those location parameters; second, the Commission must facilitate the collection of hard data on how competing location technologies perform in a common test bed, preferably through the Commission's Communications Security, Reliability, and Interoperability Council ("CSRIC");

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[1] T-Mobile USA, Inc. is a wholly-owned subsidiary of T-Mobile US, Inc., a publicly-traded company.

[2] *Public Safety and Homeland Security Bureau Announces Workshop on E911 Phase II Location Accuracy*, Public Notice, DA 13-1873 (rel. Sept. 9, 2013) ("*Location Workshop PN*").

and third, the Commission must ensure that, if it mandates changes in a way that requires adoption of new technologies, those technologies can actually be implemented commercially. Above all, the Commission must ensure that the touchstone for any future action is feasibility, as required by the Administrative Procedure Act.

II. ALL STAKEHOLDERS MUST ACKNOWLEDGE THE LIMITATIONS OF CURRENTLY AVAILABLE LOCATION TECHNOLOGY AND WORK TOGETHER TO ENSURE PROVISION OF THE BEST POSSIBLE LOCATION INFORMATION TO PUBLIC SAFETY.

As we all know, a 911 call may well be the most important call anyone ever makes. And when a person makes that call, it is important that they be able to summon help, even when they may not be able effectively to communicate their location. Thus, since the start of wireless E911, T-Mobile has worked vigorously to implement an effective wireless E911 system. With available technology, T-Mobile strives to provide the most-effective wireless E911 service that it can, with accuracy levels that meet or exceed the Commission's requirements. We also work daily with our partners in wireless E911, the Public Safety Answering Points ("PSAPs"), to deliver wireless E911 locations, to enhance the accuracy of the information provided, and to troubleshoot our systems. And we have been and are active participants in the CSRIC, the Network Reliability and Interoperability Council ("NRIC"), the Emergency Services Interconnection Forum ("ESIF") within the Alliance for Telecommunications Industry Solutions ("ATIS"), the Association of Public Safety Communications Officials ("APCO") Project Locate and APCO's many other efforts, and the National Emergency Numbering Association's ("NENA") numerous standards and best practice development processes.

The public should understand that there is no wireless E911 crisis: wireless 911 and E911 are working well to enable people to place millions of 911 calls every year. In the vast majority of those calls, the caller is able to provide public safety with his or her location and summon the assistance he or she needs. In those limited situations in which the caller is unable

to provide a location to the PSAP, T-Mobile's wireless E911 systems provide high accuracy location estimates, consistent with the Commission's rules and NENA and APCO guidelines, that enable public safety to narrow the area in which first responders must search for wireless 911 callers. T-Mobile, moreover, continues to meet the required location accuracy benchmarks on a county-by-county level, as phased in under the current rules.[3] The fact is that carriers are able to provide accurate Phase II location information for a vast majority of the E911 calls that are processed on their networks.

A. Imprecise Terminology Can Create a False Sense of Crisis.

In some cases, T-Mobile believes that confusion over the state of wireless 911 location technologies may stem from imprecise use of key terminology. In that respect, the Commission must ensure that all stakeholders understand and are correctly using those terms, in order to avoid misunderstanding. For instance, T-Mobile has noticed that some commenters use the terms "accuracy," "yield," and "uncertainty" loosely or interchangeably, making it difficult to know what problem they are trying to solve.[4] Dialog on all of these issues will be most productive if all parties are assured that the following terminology is being used uniformly:

- ***Accuracy*** refers to the distance of a location estimate to its ground-truth. The Commission's rules specify a statistical methodology to establish compliance. Importantly, compliance with accuracy requirements is not determined on a per call basis.

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[3] *See* 47 C.F.R. § 20.18(e).

[4] *See* Letter from James Arden Barnett, Jr., Venable LLP, to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114 (Sept. 16, 2013) (encouraging the Commission to explore whether certain Phase II location estimates are "no more accurate" than Phase I location estimates would be, though this request appears to refer to the need for uncertainty information for those location estimates); Letter from Danita L. Crombach, ENP, CalNENA, to Mignon Clyburn, Chairwoman, FCC, PS Docket No. 07-114, at 3-4 (Aug. 12, 2013) ("CalNENA Filing") (describing an apparent problem of yield—*i.e.*, the lack of delivered Phase II information—as a "location accuracy problem" and a "decline in the delivery of accurate location data").

- ***Phase II Yield*** refers to how often a particular technology (or carrier's system of technologies) produces a Phase II location estimate, *regardless of how accurate or uncertain that location estimate is*. Phase II yield is not a measure of how often the PSAP pulls Phase II location data from the ALI database/Gateway Mobile Location Center/Mobile Positioning Center, but rather is how often a Phase II location estimate is available to the PSAP via the ALI database.
- ***Uncertainty*** refers to an estimate of how accurate or inaccurate any given location fix is. This is not a direct measure of how many meters "off" that estimate is, but is rather, like accuracy, a statistical measure of the likelihood that the actual location is within some range of the estimated location at a given level of confidence (*e.g.*, 90 percent confidence). Uncertainty provides a quality indicator, one that is imperfect at best, and is often misinterpreted.
- ***Latency*** refers to the length of time necessary to produce a location estimate.

Imprecise use of terminology can lead to misimpressions, as illustrated by a recent filing by the California Chapter of NENA ("CalNENA").[5] To the extent CalNENA's filing could be read to suggest a decline in location information available for E911 calls, *i.e.*, Phase II yield, or accuracy, that filing's conclusions are misleading and inaccurate. T-Mobile's data shows that, for the five California PSAPs studied, it makes E911 location data available for 90 percent of calls that last 30 seconds or more, and 86 percent of calls that last longer than five seconds—in

[5] *See* CalNENA Filing at 3-4 (describing an apparent problem of yield—*i.e.*, the lack of delivered Phase II information—as a "location accuracy problem" and a "decline in the delivery of accurate location data").

other words, its Phase II yields are much higher than suggested by CalNENA's data.[6] Nothing in CalNENA's filing actually evaluates the accuracy of the wireless Phase II location estimates that were provided or available to the PSAP. T-Mobile and other carriers[7] found that the five PSAPs studied were not requesting updated location information, which is contrary to recommended best practices, including recommendations made by APCO's Project LOCATE, and further skewing the apparent Phase II yield.[8] With respect to CalNENA's filing, it is clear that either these PSAPs did not need wireless Phase II location information for the vast majority of their 911 calls (those for which they did not "rebid" for updated information in the ALI database), or they were not following PSAP Best Practices to obtain caller location.

B. With No Optimal Solution, Stakeholders Must Set Priorities, Employ Common Hard Test Data, and Recognize that E911 Location Cannot Be Sustained by a Weak Ecosystem.

It is, of course, important to ensure that callers can place 911 calls and that PSAPs have the information that they need to respond when they need it. All stakeholders can agree that it would be optimal if carriers could provide—and PSAPs had the systems to utilize—a pinpoint horizontal (x,y) and vertical (z) location that could tell first responders "what door to kick in," with such a location able to be delivered at or shortly after the start of a 911 call (*i.e.*, with little or no latency), with 100 percent yield from indoor and outdoor locations, without draining the

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6 Letter from John Nakahata, Wiltshire & Grannis LLP, to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114, at 2 (Sept. 5, 2013) ("T-Mobile Ex Parte Response to CalNENA Filing").

7 Letter from Jamie M. Tan, AT&T, to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114, at 1 (Sept. 9, 2013) ("AT&T Ex Parte Response to CalNENA Filing"); Letter from Nneka Chiazor, Verizon, to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114, at 3 (Sept. 11, 2013) ("Verizon Ex Parte Response to CalNENA Filing").

8 APCO Project LOCATE, Wireless 9-1-1 Deployment and Management Effective Practices Guide, Effective Practice 380743 (2007), *available at* https://dps.mn.gov/divisions/ecn/programs/911/Documents/APCO_LOCATE_Effective_Practices.pdf ("Project LOCATE Effective Practices").

handset's battery or dramatically increasing handset or operational costs, and with a robust ecosystem of location technology providers. But even setting aside costs and real-world considerations such as battery life and the state of competition for solutions that would meet whatever requirements the Commission developed, no such optimal location technology solutions exist today. Indeed, based on the recent CSRIC III Working Group 3 indoor accuracy tests, any such solutions are many years away from deployment. As the Public Safety representatives on CSRIC III Working Group 3 stated, "While the location positioning platforms tested provided a relatively high level of yield, as well as improved accuracy performance, the results clearly indicate additional development is required to ensure the positional coordinates provided on an emergency caller sheltered indoors result in an 'actionable location' for emergency response, especially in urban and dense urban environments."[9] Even the most accurate of the three location methods tested by CSRIC resulted in only about a third of the fixes falling inside the target building across all morphologies tested.[10] The CSRIC report observed that "even the best location technologies tested have not proven the ability to consistently identify the specific building and floor, which represents the required performance to meet Public Safety's expressed needs. This is not likely to change over the next 12-24 months."[11] This means that the focus for the Commission and for all stakeholders has to be on prioritizing competing considerations of accuracy, yield, and latency, in addition to operational factors, costs and the supporting location technology industry ecosystem.

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[9] The Communications Security, Reliability and Interoperability Council III, Working Group 3, Indoor Location Test Bed Report at 8 (2013) ("CSRIC III WG3 Report").

[10] CSRIC III WG3 Report at 39.

[11] *Id.* at 54-55.

One essential component to this will be developing a better understanding of PSAPs' priorities as they relate to accuracy, yield, latency, and PSAP cost or operational complexity. For example, if—as is the case—the available location technologies present a tradeoff between latency and accuracy, with technologies with a faster time-to-first-fix being less accurate than ones with a longer time-to-first-fix (but still determined within 30 seconds), which do PSAPs value more, speed of the estimate (*i.e.*, low latency) or the accuracy of the estimate? What if "z" axis locations could be made available, but doing so requires an extremely costly overhaul of PSAP systems, including the underlying maps used to aid dispatch; is this something PSAPs want to pursue and are going to be able to implement? To put these priorities in context, it is also important to know what percentage of calls to 911 actually result in dispatch of emergency assistance, as opposed to being misdials, fraud, pranks or non-emergency calls; how often a caller provides the information necessary to dispatch; and how long the calls that result in dispatches actually last.

The Commission must, moreover, continue to gather hard data on how competing location technology solutions actually perform in apples-to-apples tests. The CSRIC Working Group 3 Indoor Accuracy Test Bed was a significant step forward, allowing three location technology solutions to be examined side-by-side with respect to their indoor performance.[12] However, as CSRIC Working Group 3 itself concluded, further standardized testing is necessary.[13] This should especially include technologies that either withdrew from the Working Group 3 test or were not yet available. The Commission, public safety, and wireless carriers cannot be in a position to determine what further improvements are feasible without good data. And there is absolutely no reason why the Commission, public safety or wireless carriers should

[12] *Id.*at 24-25.

[13] *See id.*at 55.

be left to try to sort out claims by competing vendors with tests that each designed and conducted in environments and methodologies favorable to their respective technologies. Indeed, a comparison of the CSRIC Working Group 3 report and TruePosition Inc.'s ("TruePosition") Wilmington, Delaware tests[14] shows the problems inherent when a common test bed and reporting are not used. CSRIC IV Working Group 1 is the logical vehicle to organize and carry out such further testing.[15]

Finally, the Commission must ensure that any new location technologies under consideration are able to be implemented in a real-world production environment. A technology that provides a highly accurate solution, but that drains the handset's battery, for example, could be counterproductive if it means that more consumers would be unable to place a 911 call because their device had extremely low battery life: a 911 call cannot be made and, therefore, highly accurate location technology does no good if the handset has a dead battery. Similarly, if a specific location technology would raise handset costs dramatically, it could result in fewer consumers having wireless phones capable of accessing the most up-to-date location technologies during wireless 911 calls. Furthermore, a good technology with a lone provider raises questions both as to whether the provider will be able to service the market and whether innovation and service will continue to improve in the future.

All of this must be taken into account by the Commission to the extent that it is considering making changes to its location accuracy rules. And as with all issues that fall under its authority, the Commission's touchstone for any changes must be feasibility. Any mandate that is not both technically and economically feasible is arbitrary and capricious, and thus

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[14] Comments of TruePosition, Inc., GN Docket No. 11-117, PS Docket No. 07-114, WC Docket No, 05-196, Attachment 3 at 93 (Aug. 6, 2013) ("TruePosition Wilmington Test Report").

[15] *See* discussion below at pp. 27-29.

violates the Administrative Procedure Act.[16] Technical and economic feasibility are "made necessary by the bar against arbitrary and capricious decision-making,"[17] and "[i]mpossible requirements imposed by an agency are perforce unreasonable."[18] The Commission does not have jurisdiction to promulgate rules that force carriers to adopt technologies that are not proven to be feasible, and for which there is no record evidence of that feasibility.[19] Moreover, candidate location technologies must demonstrate their feasibility in real-world deployments as well as provide information showing how they will be integrated into handsets, how they will interact with other phone functions, how expensive they are, and how they will be supported commercially. A mandate to implement technologies that have not been tested under real-world conditions, that have not been tested in parallel with competing technologies, or that are offered only by a single vendor would fail to meet the arbitrary and capricious standard's feasibility requirements as articulated in *Nuvio* and *Alliance for Cannabis Therapeutics.*

C. The Commission and Other Parties Must Acknowledge Key Realities as to the State of E911 Phase II Location Accuracy as It Is Implemented Today.

In terms of assessing the status quo, several things are important to understand:

1. Even with the growth of "cut-the-cord" consumers and indoor use of wireless phones, wireless Phase II location estimates are available for approximately 90 percent of T-Mobile calls over 30 seconds. In other words, yields remain high. This same conclusion was reached in testing existing location methods in the CSRIC indoor test

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[16] *Nuvio Corp. v. FCC*, 473 F.3d 302, 303 (D.C. Cir. 2006), *Alliance for Cannabis Therapeutics v. DEA*, 930 F.2d 936, 940 (D.C. Cir. 1991).

[17] *Nuvio*, 473 F.3d at 303.

[18] *Alliance for Cannabis Therapeutics*, 930 F.2d at 940.

[19] *Cf. Edison Elec. Inst. v. EPA*, 996 F.2d 326, 337 (D.C. Cir. 1993) ("[T]he fact that technology may not be able to keep up with time-tables established by Congress does not mean that courts are at liberty to ignore them, however burdensome the resulting enforcement.").

bed, where Phase II yield for the A-GPS/AFLT hybrid method varied by morphology between 85 percent in Dense Urban environments to 99 percent in Rural areas.[20]

2. There is no location "push" to the PSAPs, and there never has been. All wireless E911 location systems (as well as nomadic VoIP location systems) operate on the basis of the PSAP "pulling" data from an E911 database populated by the provider. This has been part of standards,[21] Commission orders,[22] NENA guidelines[23] and APCO best practices.[24] It has been well-established that PSAPs must "rebid" (or re-

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[20] CSRIC III WG3 Report at 41.

[21] *See* ATIS/TIA, *Enhanced Wireless 9-1-1 Phase 2*, Joint Standard No. J-STD-036, at Chapter 7 (titled "Stage 3 Implementation Perspective: Emergency Services Protocol") (2002) ("ATIS Phase II Standards").

[22] *Revision of the Comm'n's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Sys.*, Report and Order and Further Notice of Proposed Rulemaking, 11 FCC Rcd. 18676 ¶ 63, n.119 (1996) (noting that delivery of E911 data to the PSAP is dependent on the PSAP's own wireline network); Letter from Thomas J. Sugrue, Chief, Wireless Telecommunications Bureau, to Marlys Davis, King County E911 Program Office, CC Docket No. 94-102, at 4 (May 7, 2001); *aff'd on recon Revision of the Comm'n's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Sys., Request of King County, Washington, Order on Reconsideration*, 17 FCC Rcd. 14789, ¶¶ 8-10 (2002) (affirming the King County Letter and applying its rationale to Phase II E911 location).

[23] NENA, *Guidelines for Minimum Response to Wireless 9-1-1 Calls*, at 8, Section 3.3.3 (Nov. 18, 2004) ("In the event Phase II information is not delivered with the initial call data, the call taker should wait "N" seconds before initiating a rebid. <<Insert the number of seconds a call taker should wait before initiating a rebid after consultation with the wireless carriers in your area.>>"), *available at* http://c.ymcdn.com/sites/www.nena.org/resource/collection/ABEAA8F5-82F4-4531-AE4A-0AC5B2774E72/NENA_56-001_Minimum_Response_Wireless_911_Calls.pdf; *see also* NENA, *Wireless Phase I & II Features & Functions, Operational Information Document*, at 10, Section 3.2.6 (Jan. 20, 2003) ("Interim or 'quick fixes' would be classified as WPH2. The call taker would need to look at the Uncertainty factor in order to determine if a rebid for more accurate location is required. Quick fixes are latitudes and longitudes that are available in 3 to 5 seconds and used to route the call. It is also the fix that is generally sent to the PSAP in response to the first ALI bid from the PSAP."), *available at* http://c.ymcdn.com/sites/www.nena.org/resource/collection/2BEE3832-DD9B-4CD6-AB89-979F2CA8F789/NENA_57-501_Wireless_911_Features-Functions.pdf.

[24] Project LOCATE Effective Practices, Effective Practice 380743.

query) in order to pull any updated location information from the E911 location database.

3. PSAPs are not rebidding for a majority of calls. Nationally, PSAPs do not "rebid" for location on 72 percent of T-Mobile calls to 911. This indicates either that an updated location is not necessary, or that changes need to be made to the PSAPs bidding practices.
4. There are a lot of short calls to 911. Nationally, nearly half (49 percent) of all T-Mobile calls to 911 are under 30 seconds long and almost one quarter (23 percent) of all T-Mobile calls to 911 are under five seconds long. To the extent that these are misdials, fraudulent calls, pranks, non-emergencies, or repetitive reports of the same event (*e.g.*, an auto accident on the highway)—as seems likely—they do not result in a dispatch of emergency assistance and can skew any analysis.
5. The Commission's existing county-level accuracy requirements have *de facto* mandated that carriers implement A-GPS. There is no other available technology solution that will allow T-Mobile to meet the county-level accuracy requirements, including the existing requirement eventually to meet the current 50m/150m handset-based accuracy standards. The migration to A-GPS has meant longer latency and, in some cases, lower yields (such as indoors when in a hard-to-penetrate structure away from the windows) compared to other technologies, although accuracy is much higher and uncertainty is lower when A-GPS produces a location estimate.[25]
6. A-GPS' ability to obtain a fix indoors has been improving over time, with technology and algorithmic advances in both the handset and network components. The

[25] Overall Phase II yields have remained high because, even in instances where A-GPS does not provide a location estimate, a location estimate is attempted using an alternative technology.

impressive yield and accuracy improvement demonstrated in the recent CSRIC indoor test bed, even in quite challenging indoor environments, highlight these advancements.

7. The growth of in-building cells will complement A-GPS in terms of accuracy even without further changes in location technology. Today, T-Mobile presents IP-based in-building cells as Phase II location estimates; as cells like these proliferate, indoor accuracy will improve.
8. The 2G and 3G standards do not permit more than one location technology to be tasked at a time. In other words, for pre-LTE radio access network technologies, any "hybrid" of location technologies must be run sequentially. This means that "fallback" technologies (with less accuracy but higher yield) run after a primary technology has been tried and failed. T-Mobile, for example, first attempts to obtain a 911 location estimate using A-GPS, a high accuracy solution. If A-GPS cannot produce an estimate, T-Mobile then attempts a location estimate using Round Trip Timing ("RTT"), a medium accuracy solution. This will change with LTE, for which the industry standards allow multiple location technologies to be run simultaneously.
9. "Hybrid" solutions—*i.e.*, solutions that utilize multiple technologies or approaches for determining a location—typically improve yield, but do not alter the accuracy of each underlying location estimation method. At best, the PSAP can be presented with the most accurate estimate the carrier was able to make from among its various technologies or approaches for each 911 call—but the time to determine which estimate is likely the most accurate will be governed by the slowest time-to-first-fix, while attempting to return a result within 30 seconds.

D. Near-Term Indoor Accuracy Deadlines are Not Feasible.

With respect to implementing any new location technologies, the Commission should recognize:

A. There is no currently available location technology that delivers accuracy that will meet the existing county-level requirements of the Commission's rules other than A-GPS. There are some technologies that show promise, but those are not yet near-term commercialized solutions, and many remain years away (if ever) from reaching that point.

B. With respect to any new handset-based technology—which would include NextNav, technologies using AM/FM/TV station transmitter locations, the use of additional satellite constellations (such as GLONASS or Iridium), and OTDOA—any implementation will require handset change-out. The Commission has previously recognized, both with the initial A-GPS deployment by CDMA carriers, and with the still-ongoing implementation of county-based accuracy standards for the carriers that initially implemented network-based technologies, that handset change-out takes many years. Contrary to NextNav's suggestion,[26] there is no way that carriers could develop, implement, and widely deploy a new handset-based location technology by January 1, 2016, even if there was such a technology commercialized and incorporated into handsets today—which is not the case.

C. The ecosystem around a location technology is important. For example, will the location technology intellectual property rights holder commit to reasonable and nondiscriminatory licensing of the technology so that there can be multiple

[26] Letter from Bruce A. Olcott, Squire Sanders, to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114, at 12 (Aug. 14, 2013).

manufacturers of a given technology? The FCC should be wary of hitching future accuracy requirements to any single technology vendor. A single provider will be slower to deliver solutions, will be more costly to implement, will have lower service quality, will be less likely to continue to innovate, and may pose a sustainability risk.

D. Spectrum availability and distribution has an important role here as well. Both 911 calling ability and location yields will be better on lower-band spectrum than on higher band, because lower-band spectrum penetrates buildings better and thus improves both the consumer's ability to place an indoor call to 911 and the ability of 911 solutions that depend on uplink or downlink measurements to perform. Thus, it is important that the Commission ensure that lower band spectrum is available, especially to those carriers that currently lack lower-band spectrum, such as T-Mobile.

The most important thing the Commission can do at this point is to push CSRIC IV to continue the further development of a common indoor accuracy location test bed, and to use such a test bed to further evaluate candidate technologies. One of the most important parts of the CSRIC III Working Group 3 process was that carriers, public safety and vendors all participated in selecting the sites and morphologies for testing. It is only with actual apples-to-apples testing and validated data about what the candidate technologies can do—rather than unsubstantiated vendor claims or vendor tests in non-standardized environments—that appropriate decisions can be made, with an informed balancing of the relative priorities that maximize public safety and consumer welfare. The FCC should continue to pursue a data-driven examination of indoor E911 issues.

III. PREDICATE ISSUES TO THE CURRENT REVIEW OF LOCATION ACCURACY

T-Mobile below provides answers to many of the Commission's specific questions regarding issues raised by CalNENA and others. However, many of the Commission's questions cannot be fully examined or understood in context without first exploring several predicate issues. Indeed, without real-world context for discussion of certain Phase II location issues, the Commission cannot reasonably determine what steps, if any, it should take to improve public safety dispatch. To that end, T-Mobile asks that the Commission not only take the time to explore the issues already teed up for discussion, but also ask that stakeholders and participants in the workshop consider the following predicate questions:

- To what extent do PSAPs ask callers for their location?
- Approximately how often are callers able to adequately provide that information?
- What percentage of 911 calls result in a dispatch of emergency assistance?
- What percentage of emergency responses rely solely upon E911 auto-location information?
- What factors are used to determine whether a location rebid is performed?
- What is the average length of 911 calls that result in a dispatch of emergency assistance, and what is the distribution of these call lengths (*e.g.*, percentage of calls arrayed in 5 second increments of duration)?

Collecting answers to these questions will ensure that all parties are focused on the overriding goal of providing PSAPs with the most useful information possible, whether that information is Phase II or not. The focus in the docket and in the questions presented in the Public Notice on Phase II information rather than on actual PSAP needs and real-world outcomes

may result in changes to the rules that have a negative effect on public safety overall. The Commission must take care to avoid that possibility.

IV. RESPONSES TO SPECIFIC QUESTIONS POSED IN THE PUBLIC NOTICE

T-Mobile provides the following answers to certain questions posed by the Commission in the Public Notice:

- *Wireless usage has expanded significantly over the past few years. Americans are not only using wireless phones for a greater percentage of calls, they are increasingly using wireless phones for all calls, including calls to 911 from indoor environments. How have wireless providers and PSAPs been affected by the increase in the volume of wireless calls to 911, and how have they modified their practices to account for such changes? In addition, we seek the submission of specific data that quantifies the increase in wireless calls to 911, particularly the increase in wireless 911 calls from indoor environments.*

T-Mobile has no way to know and track when a wireless 911 call is made from an indoor location. Thus, it cannot track any increase in wireless 911 calls from indoors rather than outdoors. On the whole, however, T-Mobile adjusts to the volume of wireless 911 calls by ensuring that its trunks to the selective routers have adequate capacity, and that its location equipment, such as Gateway Mobile Location Centers ("GMLCs") and Serving Mobile Location Centers ("SMLCs"), have adequate capacity for the anticipated call volumes. T-Mobile also has been implementing network modifications that allow switch capacity to be shared among switches in a region, which can mitigate switch congestion that can accompany a sudden mass event, such as an earthquake. T-Mobile is not aware of any significant problems with 911 network congestion, other than in the case of a sudden mass event.[27] Thus, increasing volumes of wireless 911 calls itself does not appear to be presenting 911 issues.

[27] Comments of T-Mobile USA, Inc., PS Docket Nos. 11-153, 10-255, at 3-4 (Dec. 12, 2011) (noting that during the East Coast Earthquake, 911 calls from T-Mobile's network passed successfully to the PSAPs but a substantial majority could not be completed, usually due to PSAP- or LEC-specified capacity constraints).

- *How has the increase in wireless calls to 911, particularly from indoor environments, affected the ability of wireless providers to deliver Phase II location information?*

As a general matter, indoor environments tend to reduce yield (*i.e.*, how often a Phase II location estimate is generated and available for the PSAP to query). But that does not mean that location cannot be determined for a large number of indoor calls. In fact, in the CSRIC III WG3 test bed, for the A-GPS/AFLT hybrid method (which is representative of currently deployed location technologies), Phase II yield varied by morphology between 85 percent in Dense Urban environments to 99 percent in Rural areas.[28] Location estimates from indoor environments, of course, may have greater uncertainty estimates and thus lower accuracy overall, as discussed below.

In general, T-Mobile finds the factors most affecting yield to be the following:

- Available latency (how much time is allowed to take measurements and compute a position estimate);
- Length of the 911 call;
- Specific nature of the indoor environment, including the amount of RF attenuation and the level of multipath (RF reflections); and
- Specific location technology used, as all location technologies have tradeoffs between accuracy, yield, and latency.

Indoor settings also present challenges that reduce *accuracy*, such as reduced "hearability" of measured signals due to RF attenuation, as well as multipath (RF reflections). A-GPS results are typically highly *accurate*, whether indoors or outdoors, but are not available in some indoor environments. A-GPS also has high *latency*, requiring upwards of 30 seconds to produce a location estimate when signal conditions are challenging. U-TDOA, on the other

[28] CSRIC III WG3 Report at 41.

hand, can produce a medium-accuracy/medium-latency[29] result in some indoor environments in which A-GPS might not yield an estimate, but is incapable of meeting current accuracy standards (even outdoors).[30] Wireless carriers have therefore implemented "fallback" location methods to ensure that overall yields remain high, even in challenging conditions. Medium-accuracy/low-latency methods like AFLT and RTT currently provide best-available location estimates when high accuracy methods fail. As noted above, T-Mobile currently runs RTT after it has attempted to estimate location using A-GPS.

For IP-based, in-building cells, T-Mobile classifies those as wireless Phase II[31] and sends the PSAP the address of the building with the in-building cell. This increases in-building yield and also provides a location that at least gets first responders to the correct building.

- *What factors affect whether individual 911 calls include or do not include delivery of Phase II location information to the PSAP? For example:*
    - *What is the impact of 911 call duration on the ability of different technologies to provide Phase II location information to the PSAP*?

Call duration strongly influences the ability to generate a Phase II location estimate. Different location technologies have different latencies, but more accurate location technologies have a time-to-first-fix ("TTFF") in excess of 20 seconds: in fact, all of the location technologies

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[29] T-Mobile classifies UTDOA as "medium latency" because it falls in between low latency methods like RTT and AFLT, which provide an almost instantaneous location estimate, and A-GPS and other methods that require close to the 30 second limit to provide a location estimate. U-TDOA provides a location estimate on the edge of the typical time for an initial ALI bid—around four to five seconds—and does not routinely provide a location estimate in less than that amount of time. These differences, while not uniform, create a *de facto* three-part classification for latency as considered against the typical time for an initial ALI bid.

[30] *See* T-Mobile USA, Inc. Comments on Further Notice of Proposed Rulemaking and Notice of Inquiry on Location Accuracy, PS Docket No. 07-114, WC Docket No. 05-196, at 12 (Jan. 19, 2011).

[31] *See* ESIF Issue 38, Uniform Approach from Deriving Class of Service, Resolution Statement at 4 (2006) ("Phase 2 [sic] Definition: …Cell sites with a sufficiently limited coverage radius may also be considered Phase 2.").

evaluated in the CSRIC III WG3 indoor test bed had a TTFF of over 23 seconds on average and over 25 seconds at the 90th percentile.[32]

The Commission must also recognize that, for all technologies prior to LTE, a provider cannot run multiple Phase II location technology estimates in parallel and then select the best result. These systems were developed and standardized to utilize one location technology at a time.[33] Producing location estimates from multiple technologies requires extending the time to reach the most accurate fix, because the carrier cannot know the most accurate fix until it has generated location estimates from each of the available technologies in succession. In contrast, LTE specifications do allow simultaneous location methods. Thus, the transition to LTE promises the opportunity to select from multiple location methods, to maximize accuracy and yield, within the same overall latency budget.

Of course, latency is just one parameter, and there will continue to be tradeoffs between latency, accuracy, and yield, and there may be other tradeoffs as well (such as vertical location capability, impacts upon battery life, availability of chipsets, effect on the wireless network, diversity of supply) that are important considerations as we continue to develop and deploy E911 over time.

- *To what degree is the delivery of Phase II information to the PSAP with each call a function of automated versus manual processes?*

This is up to the PSAP, and can vary between the initial bid and subsequent bids. PSAPs determine whether they want to trigger ALI bids automatically or manually. While PSAP

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[32] CSRIC III WG3 Report at 38.

[33] *Compare* 3GPP TS 48.071, Technical Specification, at 22 (2011) (adding concurrent positioning to the LTE specification) *with* 3GPP TS 36.305, Technical Specification (2009) (describing how location is requested without noting the possibility of concurrent positioning).

equipment will normally make an automatic, immediate initial bid for location, that is not true in the case of rebids, as recommended in several industry best practices.[34]

- *What is the role of rebid procedures when Phase II information is not delivered to the PSAP with the initial 911 call?*

Under all implementations, standards, and best practices, PSAPs must bid for all location information, including at the initiation of the call, and must rebid if Phase II is not delivered as a result of the initial bid and the information is needed.[35] Under the long-established technical standards governing the interactions between a carrier and a PSAP, carriers cannot push location estimates to the PSAP;[36] the PSAP must request them. Indeed, APCO Project LOCATE Best Practice 380743 recommends rebidding whenever the PSAP is unable to get the location from the caller.[37] As the Effective Practices manual states, "[r]egardless of the reported class of service on the initial call, the simple rebid effort, at the appropriate time[,] may provide access to updated location data by the calltaker/dispatcher[.]"[38] Furthermore, the Effective Practices manual recommends a 30-second interval for rebids: "The AHJ [Authority Having Jurisdiction] should not rebid (automatically or manually) less than 30 seconds after the call is first presented to the calltaker. Any subsequent rebids should be at 30-second intervals."[39] NENA's wireless 911 best practices likewise state that "[i]n the event Phase II information is not delivered with the initial call data, the call taker should wait 'N' seconds before initiating a rebid."[40]

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[34] Project LOCATE Effective Practices, Effective Practice 380743.

[35] NENA, *Guidelines for Minimum Response to Wireless 9-1-1 Calls*, at 8, Section 3.3.3; Project LOCATE Effective Practices, Effective Practice 380743.

[36] *See* ATIS Phase II Standards at Chapter 7.

[37] Project LOCATE Effective Practices, Effective Practice 380743.

[38] *Id.*

[39] *Id.* at 380741.

[40] NENA, *Guidelines for Minimum Response to Wireless 9-1-1 Calls*, at 8, Section 3.3.3.

- *Are there other network or operational issues that can affect a carrier's ability to deliver Phase II information with each call and/or the PSAP's ability to receive the information?*

Some PSAPs are still incapable of receiving Phase II location estimates. This, in addition to the factors listed above that limit carriers' ability to generate location estimates for all wireless 911 calls (*e.g.*, misdials, fraudulent calls, calls of short duration), means that national location yields for wireless 911 calls are unlikely to ever be 100 percent.

- *What measures do PSAPs and wireless providers undertake, in terms of ongoing monitoring of Phase II performance, both on an individual call basis and an aggregated basis? What types of metrics are monitored and how are they measured?*

T-Mobile generates daily reports based upon data that comes from its GMLC. A number of these reports are reviewed and acted upon daily. For example, if there are issues seen in the reports related to individual PSAPs, T-Mobile personnel will work with the PSAP in question to investigate and to mitigate the issue. T-Mobile also has proactive tools that our engineers can use to determine if any provisioning data are missing that would lead to a call-routing failure. T-Mobile also generates other Key Performance Indicator ("KPI") reports from other systems, which look at specific E911 and location technology parameters, such as yield and uncertainty estimate trends. T-Mobile is proud of the robust data collection and review it undertakes to ensure that its 911 systems and processes work as they should and provide PSAPs and customers with the best possible service.

- *In what percentage of wireless 911 calls is Phase II location information successfully delivered to the PSAP? How does current Phase II yield (percentage of wireless 911 calls that include Phase II location information) compare to Phase II yield in the past few years?*
    - *Is there a correlation between trends in Phase II yield and an increase in the number of wireless calls originating from indoors?*
    - *Is Phase II yield affected by wireless providers' migration to new network technologies, e.g., from 2G to 3G/4G networks?*
    - *Is Phase II yield affected by the wireless provider's choice of location technology (e.g., network- versus handset-based location solution) or changes in the location technology used (e.g., migration to A-GPS)?*
    - *Are there variations in the delivery of Phase II location information based on the type of environment (e.g., urban versus rural environments, indoor versus outdoor environments)?*

The percentage of successful delivery of Phase II location information to the PSAP is largely a function of whether the PSAPs "rebid" to obtain that information from the ALI database. Using the five California PSAPs as a test sample, T-Mobile makes Wireless Phase II locations available to the ALI database for 90 percent of calls that last more than 30 seconds, and for 86 percent of calls that last more than five seconds. For T-Mobile, roughly contemporaneously with its transition to A-GPS to comply with the Commission's county-level accuracy requirements, its overall Phase II yield has declined by a small amount over the past several years—though it still remains high (90 percent for calls of at least 30 seconds duration). However, T-Mobile has also made some changes to other practices during this period that may affect overall Phase II yields.[41] Of course, as noted above, T-Mobile cannot distinguish indoor 911 calls from outdoor 911 calls and thus does not track the level of correlation between the increase in indoor wireless calls and Phase II yield.

As T-Mobile has moved from U-TDOA to A-GPS/RTT, overall accuracy has improved. The A-GPS location estimates, which by 2013 were a majority of calls over 30 seconds in length,

[41] For example, T-Mobile during this period implemented a practice of not transmitting a wireless Phase II location when the uncertainty estimate exceeded the expected cell radius. This change in procedure appears to account for the small shift in Phase I versus Phase II location estimates.

had substantially lower uncertainties, on average, than did U-TDOA. Thus, as a result of the technology transition, many calls saw a significant decrease in uncertainty (meaning a likely tighter search radius for first responders). In addition, the average uncertainty for all calls over 30 seconds in length also improved from 2009 to 2013.

At the same time, it is clear that location latency increased as a result of T-Mobile's shift from U-TDOA to A-GPS. T-Mobile's data show a clear correlation between its implementation of A-GPS for its 3G network—and later implementation of A-GPS for its 2G network—with apparent shifts in Phase II yield at the time of the first location query, as depicted in the CalNENA filing. The larger sudden reductions in Phase II yield from the first ALI bid that CalNENA documents correspond generally in time with two key network events enabling A-GPS functionality for the California PSAPs. Specifically, in the first half of 2010, T-Mobile rolled out A-GPS functionality into certain 3G markets, including the five PSAPs at issue in CalNENA's filing. At that time, approximately 30 percent of T-Mobile handsets were GPS capable. By April 2011, A-GPS functionality was rolled out to T-Mobile's 2G markets, including in California, shifting callers with 3G handsets in GSM-only coverage areas to A-GPS. (Callers with non-A-GPS-capable, 2G-only handsets remained on U-TDOA.) A-GPS-capable handset penetration had reached approximately 50 percent at that time. These changes would be expected to—and in fact, did—generate noticeable shifts in the percentage of Phase II results *from the initial ALI bid.*[42]

Although CalNENA's study reflects a technology-driven change in the Phase II yields at the time of the initial ALI query (which occurs on average at 4.3 seconds into the 911 call, when

[42] In addition to these two specific discontinuities as network A-GPS functionality was enabled (which are reflected in the CalNENA data), during this same period of time, T-Mobile's subscriber base was gradually increasing in A-GPS capable handsets. These two processes together explain the overall trend.

it occurs), as T-Mobile previously explained in its September 5, 2013, ex parte letter, CalNENA's examination was incomplete.[43] CalNENA failed to account for calls for which Phase II information was available, but the PSAP did not make an update query (i.e., a rebid). CalNENA also did not account for the impact of short calls on its analysis, or calls in which there was no ALI query at all.[44]

- *According to the CalNENA filing, of the 1,589,580 wireless 911 calls received statewide in March 2013, less than half of those calls included Phase II location information. Does the data in the record support CalNENA's contention that there has been a decline in the delivery of accurate Phase II location information in the past few years?*

CalNENA has used data it collected to purport that there has been a dramatic decline in the delivery of Phase II location information; however, that is not the case. In fact, there has not been a significant decline in the availability of Phase II location information as demonstrated by the subsequent investigations of T-Mobile, AT&T, and Verizon.[45] Due to the very low rate of rebids issued by the PSAPs, CalNENA effectively only studied Phase II yield for five PSAPs at the time of the initial ALI request. This approach ignores a PSAP's responsibility to re-query, *i.e.*, rebid, the ALI database to receive Phase II location estimates. Nor does it consider the accuracy or uncertainty of the location estimates provided. In fact, the accuracy of location estimates (as predicted by the levels of uncertainty) has increased (*i.e.*, uncertainty has fallen).

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[43] *See* T-Mobile Ex Parte Response to CalNENA Filing.

[44] CalNENA also included inter-PSAP calls in its data, calls into which T-Mobile has no visibility. In those cases, one PSAP may initially receive the call and route it to a different PSAP; the second PSAP will submit the ALI request, which T-Mobile receives, but which appears in T-Mobile's logs to have come from the initial PSAP. This discrepancy may affect T-Mobile's data in comparison with CalNENA's data significantly, as a large number of wireless 911 calls in these five PSAPs likely would have been answered by California Highway Patrol ("CHP") (*e.g.*, the calls would have come from the highway) and would then have been transferred to local PSAPs while appearing in T-Mobile's logs as CHP calls.

[45] *See* T-Mobile Ex Parte Response to CalNENA Filing at 2; AT&T Ex Parte Response to CalNENA Filing at Attachment B, page 2; Verizon Ex Parte Response to CalNENA Filing at 2.

CalNENA's filing also did not factor in the impact of short 911 calls. As a result, the conclusions reached in the CalNENA filing, insofar as they claim to indicate "a serious public safety problem regarding 9-1-1 accuracy," are not based on demonstrable data.

- *In 911 calls where Phase II location information is delivered to the PSAP, has the overall quality and accuracy of the information improved, declined, or remained unchanged in comparison to the past few years? To what extent, if any, has the overall quality and accuracy of Phase II location information been affected by:*
    - *The increase in wireless calls originating from indoors?*
    - *Wireless providers' migration to new network technologies?*
    - *Changes in the location technology used by carriers?*
    - *Type of environment (e.g., urban versus rural environments, indoor versus outdoor environments)?*

Overall, T-Mobile has seen a substantial increase in accuracy over the last five years as it has transitioned to handset-based location technology. Increases in accuracy have been most pronounced in rural and suburban areas, where U-TDOA—as a terrestrial technology—generally does not perform as well. Indeed, T-Mobile would not be able to comply with the Commission's accuracy requirements in fully half of the counties it serves if it were solely to rely on U-TDOA, even when only outdoor measurements are considered and when measured against network-based accuracy standards. The Commission's orders therefore permit blending handset–and network-based technologies, and also permit a carrier to migrate entirely to a handset-based technology such as A-GPS.

The migration to new radio access network ("RAN") technologies does not, by itself, change location performance. Providers such as T-Mobile have generally deployed new location technologies as part of implementing a new RAN technology. Thus, T-Mobile used U-TDOA for its 2G GSM network (later adding A-GPS capability for A-GPS-capable handsets), and it migrated to A-GPS for its UMTS/HSPA+ network. T-Mobile is closely monitoring location technology developments for improvements that are practical and feasible as it implements LTE,

including the crucial work being carried out by the CSRIC common indoor test bed effort. It is important to note that any new technology that would be identified and implemented would be expected to improve location performance for new handsets produced with the added functionality, but would not for legacy handsets, as was also the case when T-Mobile rolled out its UMTS/HSPA+ -based services.

It is important to understand that there is a difference between getting a location estimate for someone who is indoors (yield) and knowing that they are inside a particular building (accuracy). Higher indoor location yields, in other words, will not improve the ability of first responders to know which door to kick in, as reported location estimates might well be outside, on the next street over, or three blocks down. In fact, as the CSRIC test bed demonstrated, indoor location estimates typically behave differently than outdoor locations. Outdoor locations tend to produce a scatter pattern that uniformly surrounds the ground truth (the caller's actual location). By contrast, indoor location estimates—especially in challenging urban and dense urban settings where RF multipath is significant—tend to produce a scatter pattern that is offset (biased) in a particular direction away from the caller's actual location. This results in a deceivingly difficult challenge to identify the building where the caller is actually located, even after many location attempts with a high accuracy location method.

- *How is the ability of PSAPs to respond to 911 calls affected by the availability or unavailability of Phase II location information, the time required to obtain a Phase II fix (including rebids), and the quality of the Phase II information when it is provided?*

As noted above, in Section II of these comments, T-Mobile believes these questions are the most critical to forming a full and complete understanding of what needs to be done to improve E911 for consumers.

- *What efforts are stakeholders making (or can they make in the future) to improve Phase II yield and the accuracy of Phase II information?*
    - *What solutions are available to improve the delivery of Phase II information, including improving location accuracy both outdoors and indoors, and what are the costs of such solutions?*

T-Mobile and its suppliers are continually working to improve existing location technology performance over time. Examples of these improvements are A-GPS position calculation algorithm improvements in both the network and in handsets, improved GPS sensitivity in handsets, and the ability of handsets to simultaneously track and measure more satellites.

In addition, T-Mobile has an extensive handset test and validation process in place to ensure each device accepted for distribution performs optimally. These validation tests include lab testing (protocol functionality, standardized GPS conformance test cases, GPS receiver sensitivity tests), and empirical field testing (various morphologies, static tests, and drive tests).

- *What additional measures, including regulatory action, could help improve the delivery of Phase II E911 location information in the near term? In light of the expanding role of wireless technology in communicating with emergency services, are there regulatory gaps in the Commission's E911 rules? Are there public safety requirements for location accuracy that are not being met by the rules?*

Regulatory action can only be taken with respect to what is technically and economically feasible.[46] Anything else would be arbitrary and capricious. Thus, the most immediate step the Commission can take is to determine what is actually feasible, technically, operationally and economically.

In doing so, the Commission must ensure that all stakeholders—including the Commission, PSAPs, and providers—have a common set of data from which to make decisions. A key part of that is establishing a permanent working common test bed for location

[46] *See Nuvio*, 473 F.3d at 303; *Alliance for Cannabis Therapeutics*, 930 F.2d at 940.

technologies, particularly with respect to indoor environments. CSRIC IV Working Group I has such a test bed as part of its charges.[47] The Commission should also develop a type-acceptance test with respect to indoor location on the test bed.

It is critical that there also be additional common test bed tests as envisioned by CSRIC III. Vendor studies are not an adequate substitute. For example, the testing conducted in San Francisco/San Jose for the Common Indoor Test Bed not only followed the test plan and process co-developed by ATIS/ESIF and CSRIC, but also the building selection and test process itself was overseen by a CSRIC subcommittee. This group determined which areas in San Francisco and San Jose qualified as Rural, Suburban, Urban, and Dense Urban, and which specific buildings within these morphology polygons were truly representative of real-world use cases for each group—including considering the density of surrounding buildings, density of surrounding cell sites, reasonable locations to test within each building; ensuring the hardware and process used for the test was representative of real-world production devices and network architecture; making executive decisions on how to compensate if a particular building type was not available for testing, etc.

In contrast, TruePosition's recent test in Wilmington benefitted from none of this. TruePosition could not possibly replicate—nor does it appear to have attempted to do so—the cooperative planning process for the Common Indoor Test Bed. CSRIC III warned about future tests conducted outside this crucial oversight process when it noted that "[c]onducting future test bed work without benefit of a well-balanced oversight committee or group may result in only

[47] Charter of the FCC's Communications Security, Reliability, and Interoperability Council (Mar. 19, 2013), *available at* http://transition.fcc.gov/bureaus/pshs/advisory/csric4/CSRIC%20Charter%20Renewal%202013.pdf.

part of the story being told."[48] Thus, TruePosition's test results cannot be held comparable to those obtained through oversight by the CSRIC working group. One crucial aspect of the CSRIC Common Indoor Test Bed was the "common" part—namely that each location technology would be tested side-by-side in the same locations. Moving the test to Wilmington—no matter how similar TruePosition believes the building selection process was—eliminates this important aspect of the test.

Other shortcomings to TruePosition's test include the absence of a Dense Urban environment—the environment where reliance on U-TDOA would be expected to be very heavy; the lack of a Rural environment—an environment where U-TDOA tends to perform very poorly, given the low density of cell sites and resulting poor geometric dilution of precision; and a higher-than-normal density of LMUs in Wilmington. Furthermore, even the Urban environments were not similar: San Francisco included the Moscone Convention Center, much of which is underground, and the baseball stadium at AT&T Park; TruePosition's Wilmington test lacked comparable sites.

TruePosition's testing/reporting process is also misleading. TruePosition reports a hybrid combination of U-TDOA and A-GPS for its accuracy results, but only considers the U-TDOA piece for latency (time-to-first-fix). It seems TruePosition took advantage of the full 30 seconds of integration time for A-GPS measurements to help accuracy, but this is not reflected in their latency figures. Even though this inconsistency is described in their report, it is very misleading, particularly if the performance figures are reviewed out of the context of the report. Furthermore, the hybrid combination as tested by TruePosition could not be implemented in current production networks within the 30-second latency limit, as parallel location methods are

[48] CSRIC III WG3 Report at 48.

not supported by 3GPP standards for the GSM network they tested on. In short, TruePosition's A-GPS/U-TDOA implementation for the test was a non-standard, offline process of exchanging and parsing logs collected by the handset and producing a hybrid position calculation in non-real time.

Similarly, TruePosition only uses U-TDOA results for yield (which results in a high-yield figure that is less accurate), but uses a U-TDOA and A-GPS hybrid combination for the accuracy figures. This results in an apparent high-yield, medium-latency, high-accuracy solution. In reality, this is not what was tested. TruePosition took the best attributes of the two underlying technologies and presented only the most favorable in the report, even though the results were not obtained by a single standardized implementation. In practice, you would not get this combination of high-accuracy/high-yield results with medium latency. TruePosition never reports the U-TDOA-only (medium latency) accuracy performance figures.

Of course, even with these limitations and liberties in their testing, TruePosition's report reaches the same conclusion the CSRIC test report reached—"even when the location system is working well it is hard to pinpoint with confidence the building from which the emergency call was made—let alone the suite or specific room" and "[m]ore indoor-specific hybrid solutions may have to be developed and deployed to reach such a lofty goal."[49]

U-TDOA's shortcomings have always been apparent. In 2007, T-Mobile noted:

> A-GPS is not always strong where U-TDOA is weak and vice versa. Thus, a 'hybrid' solution combining these technologies is not the easy route to a unified accuracy standard that can be met at the PSAP level in all cases. As Qualcomm concluded, 'it would be inaccurate to say that the accuracy requirements can be met on a PSAP-by-PSAP basis merely by the deployment of hybrid solutions.'"[50]

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[49] *See* TruePosition Wilmington Test Report at 93.

[50] T-Mobile USA, Inc. Comments on Section III.B of the Wireless E911 Location Accuracy NPRM, PS Docket No. 07-114, WC Docket No. 05-196, at 9 (Aug. 20, 2007).

This remains true. Using U-TDOA, T-Mobile can only achieve the network-based 100m/300m accuracy requirement in approximately 50 percent of its counties. Nor is there any capability in U-TDOA to meet the 50m/150m accuracy requirements (as will be required after January 2019) in any significant number of counties. Indeed, T-Mobile would be unable to meet the third interim milestone relying solely on U-TDOA, or even on U-TDOA and A-GPS blending. In theory, using U-TDOA with A-GPS should result in higher (and maybe very high) yields, but the U-TDOA component will not be capable of meeting the accuracy requirements, and therefore does not further the cause of meeting long-term location performance goals.

- *Is currently available location technology able to deliver more precise location information than the Commission's current E911 rules require?*
    - *What is the potential for current technology to provide vertical location (z-axis) as well as horizontal location (x- and y-axis)?*
    - *What is the potential for future location technology to improve accuracy performance, particularly as providers deploy 4G networks and increase the use of small cells and other advanced infrastructure?*

No currently available location technologies have been proven to deliver more precise location information than the Commission's current E911 rules require. No currently available technology can provide accurate vertical location, either. Only one vendor submitted vertical results in the CSRIC III Working Group 3 tests, but that system requires creating a new network of beacons, and would require new chipsets and barometric pressure sensors in every handset, and therefore could only be implemented as consumers change out handsets. Handset changeover is a slow process, one that is still on-going for those carriers shifting from U-TDOA to A-GPS. There is absolutely no way that handset changeover could be completed in time for a January 1, 2016 implementation date for indoor accuracy standards, as NextNav proposes.

This would be true even if handsets incorporating the NextNav location method were available for consumers to purchase today. In reality, not a single handset is currently being

produced with this technology. Nor is it clear when or if handset manufacturers will incorporate this functionality into their devices. Furthermore, the NextNav technology is not yet standardized for use on any radio access network. Because the standardization process tends to be slow and methodical in nature, that further undermines the feasibility of a January 2016 implementation date.

To support ubiquitous indoor location coverage, NextNav also must build-out a nation-wide, carrier-grade beacon network. The economic feasibility and timeframe to complete this effort are not known, as NextNav was silent on these system necessities in their filing. Contrary to NextNav's claims, cost considerations for their proposed location technology are not well understood, and considering the sole-sourced nature of this service, extreme caution would be warranted. In addition, NextNav proposes that the Commission adopt indoor rules requiring accuracy that is equivalent to the current outdoor handset-based 50m/150m level—even though their technology as demonstrated in the CSRIC test bed did not meet that level of accuracy across all indoor morphologies. Specifically, NextNav's technology missed the 67th percentile requirement in both the Urban and Dense Urban morphologies—the very environments where A-GPS is most challenged.[51] Technical and cost issues aside, clearly, NextNav's own technology will not be available by January 2016, making their recommended timeframe illogical.

Polaris Wireless also demonstrated their technology in the CSRIC III WG3 indoor test bed process, but failed to move the performance needle on either accuracy or latency. Their current system has a particular weakness with accuracy on the upper floors in high-rise buildings,[52] as the RF signal characteristics above ground are very different than those at ground level where their calibration database is generated. Notably, their technology does not require

[51] CSRIC III WG3 Report at 35.

[52] CSRIC III WG3 Report at 40.

modifications to the handset—but demonstrated performance does not further the effort to improve indoor location relative to currently deployed methods.

There are some emerging location technologies that show promise, but they are not currently available. These technologies also, without exception, require modifications to equipment both in the network and in handsets. In particular, three technologies that were not available for testing during the CSRIC III common indoor test bed are noteworthy:

1. The use of the GLONASS satellite constellation to supplement the GPS satellite constellation has been on the horizon for some time.[53] GLONASS is now fully operational, and some handsets are beginning to be produced that can take advantage of the additional satellites. The expectation is that having significantly more satellites in the sky available for measurement will improve both yield and accuracy in many locations. Both the higher likelihood of a sufficient quantity of pseudo-range measurements and reduced geometric dilution of precision ("GDOP") will lead to improved location performance.

2. OTDOA was developed in conjunction with the LTE specifications, using unique attributes inherent in the standards designed to optimize location performance. Positioning Reference Signals ("PRS") designed to produce highly accurate time-of-arrival measurements by handsets can be transmitted by LTE base stations. Surrounding base stations can synchronize and coordinate the transmission of PRS signals. This eliminates the need for additional equipment to determine downlink timing and resolves the near-far interference problem normally associated with multilateration methods.

3. WiFi-based location methods use handset-collected RSSI and SSID information from the WiFi receiver in the handset, which is compared against a database of known WiFi access points and their estimated positions. This database is typically developed and maintained through a combination of scheduled drive testing and crowd sourcing. WiFi-based location is currently being used for commercial location purposes, but has not yet been offered specifically for use with E911. CSRIC III sought out vendors who would be willing to offer their WiFi-based location technology for the indoor test bed, but none were identified. It is hoped that some of the vendors currently utilizing WiFi-based methods commercially will be willing to offer an E911 solution for the next stage of the indoor test bed.

[53] *See* The National E9-1-1 Implementation Coordination Office, *A National Plan for Migrating to IP-Enabled 9-1-1 Systems*, Appendix B at B-4 (2009).

The first two of these technologies, and possibly the third, should be available for testing during the CSRIC IV test bed, and T-Mobile is eager to see each of them formally examined, and their performance in various indoor morphologies quantified through the CSRIC test bed process. Each of these three emerging location methods is already standardized for use on the LTE network. Note that CSRIC III also recommended that these three technologies be studied further in the next stage of the test bed, as a high priority.[54]

The best opportunity for implementing improved location technology is as carriers and consumers implement Voice Over LTE. Small cells will help when they are used, as there are and will continue to be cases in which the small cell location is more accurate than the estimate provided through a dedicated location technology. Because 3G and earlier networks don't allow location estimates to be run in parallel, it does not make sense to retrofit pre-LTE networks.

[54] CSRIC III WG3 Report at 55.

V. CONCLUSION

T-Mobile appreciates the opportunity to submit these comments and, if permitted to do so, to participate in the Bureau's October 2, 2013 workshop. The Commission's best approach here is to continue to be data-driven, which in this context requires further development of a common indoor test bed, with careful and consistent testing of all candidate technologies. The Commission should harness CSRIC IV to do this.

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