

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Wireless E911 Location Accuracy)	PS Docket No. 07-114
Requirements)	
)	

COMMENTS OF VERIZON AND VERIZON WIRELESS

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SUMMARY

Verizon's history reflects a longstanding commitment to improving location accuracy and public safety for its customers. Industry developments, especially the transition to IP-enabled VoLTE services, have potential to improve E911 location accuracy to a degree not possible with legacy wireless networks by using GLONASS data and Observed Time Difference of Arrival ("O-TDOA") technology. Other parties in the wireless ecosystem, however, play an increasingly critical role independent of wireless service providers. Going forward, the Commission's policy framework should: (1) rely on the technical judgments of collaborative multi-stakeholder efforts, such as the initial 1996 consensus agreement between industry and public safety; (2) account for technical feasibility from the outset to avoid the need for the type of mid-course corrections that characterized E911 Phase II deployment; and (3) facilitate the wireless industry's transition to IP-enabled services and networks in a diverse ecosystem so that consumers and public safety benefit the most from rapidly evolving location technologies.

Achieving multi-stakeholder consensus on the issues raised in this proceeding is an appropriate goal for all stakeholders. Parties will need to objectively evaluate the complex technical RF and network engineering challenges presented indoors and balance competing policy objectives. Voluntary efforts can facilitate that in a relatively non-adversarial manner. And participation by industry stakeholders other than wireless service providers will be necessary to achieve the Commission's public safety objectives here.

Delivery of dispatchable address information to PSAPs through technically feasible standards-based solutions is an important long-term objective. Policies that leverage developments already occurring in the broader wireless marketplace could increase the likelihood of providing a dispatchable address to PSAPs and first responders, and give wireless providers and other industry stakeholders incentives to deploy those technologies. The Commission should encourage development and standardization of feasible solutions that provide PSAPs with more actionable information than delivery of latitude/longitude coordinate estimates.

With respect to horizontal and vertical location accuracy standards, the proposed rules would require a fundamentally different technology approach to indoor location accuracy that cannot be implemented within the proposed deadlines.

Experience with A-GPS and planning for O-TDOA indicates that the horizontal standard in the proposed rule is not technically feasible. The CSRIC test bed results did not show how GLONASS and O-TDOA would perform for VoLTE, and the *FNPRM* erroneously presumes that those technologies can be applied to the legacy CDMA network. And using the aggregate A-GPS CSRIC indoor test bed data as a baseline, the proposal would require improvement in highly challenging indoor environments of approximately 80% in just two years, far more rapidly than was feasible for outdoor calls. For these and other reasons, "the current pace of technological developments" does not support the proposed deployment schedule. The *FNPRM*'s use of service providers' Phase II yield data and Census Bureau housing demographic data also does not indicate that the proposed standards are feasible.

While deployment of the VoLTE network is expected to improve indoor location accuracy principally through O-TDOA, it will not offset the limitations of A-GPS on its CDMA network sufficient to meet the proposed aggressive standards. And finally, given the pace of standards efforts and other handset upgrade, network architecture deployment, network integration measures, and PSAP-level upgrades, necessary to make emerging metropolitan beacon system (MBS) technology commercially available to service providers and usable for consumers and PSAPs, those solutions will not enable service providers to meet the proposed standards for either horizontal or vertical accuracy, or the respective two- and three-year proposed deadlines.

To avoid the pitfalls of earlier E911 efforts the Commission instead should modify its traditional E911 framework away from today's carrier-focused approach that treats other parties in the wireless ecosystem as secondary factors in its E911 regime. This framework should include the following components:

- Use of a test bed as a threshold to determine whether multiple solutions are available that meet any new standard, which would then trigger the start of any implementation timelines. This approach gives vendors and service providers appropriate incentives to timely develop and deploy standards-based solutions.
- A standards-based test bed that uses an independent administrator and representative environments, and that focuses on the accuracy of the location fixes. Data for other performance attributes such as yield and latency (time-to-first-fix) may be appropriate for information-gathering reasons, but should not be incorporated into implementation benchmarks, and actual results should be measured solely using performance of next generation wireless networks (e.g. LTE).
- As both horizontal and vertical accuracy solutions will require deployment of new network-level components, population-based benchmarks that also reflect the timing of handset availability are appropriate. This policy will reward providers for focusing initial deployments on the areas where indoor accuracy concerns are highest.
- PSAP readiness is a necessary condition for any vertical location standard, as it requires additional capabilities at the PSAP level beyond what is currently needed for wireless E911. And given the substantially higher network-level costs for wireless service providers, any implementation deadlines should reflect PSAP readiness at a minimum wide region area level covering a significant number of PSAPs across a provider's coverage area.
- Any indoor standard should not apply at a county- or PSAP-level. This would defeat the purpose and advantages of a test bed in the first place. The Commission should instead ensure that the test bed environments and vendors' products are representative of service providers' real world experience.

New or modified E911 delivery performance requirements are not warranted. First, the Commission should not incorporate the 30-second time limit into the accuracy parameters.

Latency often is a function of the local RF environment, not the effectiveness of the solution. PSAPs and service providers should resolve those matters on an individual PSAP basis as they arise, but if delivery timing monitoring is required it should apply independently of the location accuracy requirements. Second, there may be value in PSAPs using a uniform confidence level. But the transmission of confidence/uncertainty data are appropriately left to standards or best practices, as PSAPs need to uniformly determine what information is most useful for them. Third, the manner in which wireless providers deliver information to the PSAP regarding the Phase II technology used for a 911 call is also appropriate subject for standards or best practices as between service providers and public safety stakeholders. But any rules must be consistent across service providers. And, a uniform standard is appropriate for outdoor 911 calls, but it is premature to consider a uniform standard as between outdoor and indoor calls.

Finally, burdensome new reporting and disclosure standards are unnecessary, as compliance issues that arise with individual PSAPs are most effectively worked out on an informal case-by-case basis rather than through informal complaints. First, the test bed approach described above obviates any need for a burdensome, intrusive testing and complaint process for indoor accuracy, and best practices already address maintaining 911 functionalities when significant network changes occur. A PSAP that believes it is experiencing degraded performance in its area should bring its concerns to the service provider before lodging an informal complaint. With respect to outdoor accuracy, any data should be limited to the aggregate summary test results for a particular county or PSAP, with any outdoor testing every 2-3 years. Disclosure of accuracy data should be limited to PSAPs pursuant to a protective order or similar arrangement, as public disclosure creates a significant risk of customer confusion. Finally, 911 call delivery data reporting and recordkeeping obligations are unnecessary. Service providers and public safety stakeholders should determine collaboratively how best to use that data.

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COMMENTS OF VERIZON AND VERIZON WIRELESS¹

Verizon supports the Commission’s public interest and public safety objectives in this proceeding. Verizon has long been an industry leader in wireless enhanced 911 (“E911”) technology and implementation, and agrees that developments in technology and consumer uses of wireless services warrant a fresh look at the Commission’s wireless E911 policy framework. To that end, the Commission should draw upon its nearly 20 years of experience with 911/E911 and apply those lessons here.

INTRODUCTION AND BACKGROUND

Verizon’s practices reflect a longstanding, demonstrated commitment to improving location accuracy and public safety for its customers. In the early days of E911 Phase II implementation, Verizon decided to switch from a less accurate network-based solution to the more accurate assisted-GPS (“A-GPS”) solution when A-GPS’s superior accuracy – particularly in rural and other areas with lower cell site density – became apparent. Verizon sold 55 million A-GPS handsets in the first four years of the E911 Phase II mandate, and has sold hundreds of

¹ In addition to Verizon Wireless, the Verizon companies participating in this filing are the regulated, wholly owned subsidiaries of Verizon Communications Inc. (collectively, “Verizon”).

millions since then. As Verizon has explained, it has continually worked to improve the accuracy and speed of its E911 Phase II service.²

Verizon agrees that developments in commercial networks, location technology and consumer uses of wireless services warrant a reassessment of wireless E911 services. Moreover, the transition to IP-enabled Voice over LTE (“VoLTE”) services has the potential to improve E911 location accuracy to a degree not possible via legacy CDMA and GSM wireless networks. To that end, Verizon has been working closely with its infrastructure, handset and solution vendors to ensure that E911 accuracy performance is not merely preserved but improved when VoLTE service becomes available and its subscribers increasingly use that IP-enabled network for voice 911 calls.³ These improvements will include supplementing GPS satellite location data with GLONASS satellite data (“A-GNSS” technology) to increase the number of satellites and the quality of the available satellite-based location information. This, in turn, will increase the likelihood of a pure and highly accurate “satellite-based” location fix, including in certain indoor environments.

Further, 911 calls from VoLTE handsets will utilize Observed Time Difference of Arrival (“O-TDOA”) instead of Advanced Forward Link Trilateration (“AFLT”) as the network-based fallback location technique for VoLTE. O-TDOA is designed to outperform AFLT due to higher LTE bandwidth, improved hearability (*i.e.*, the handset’s ability to obtain distance measurements from multiple base stations), and more advanced processing. O-TDOA should continue to

² See Comments of Verizon and Verizon Wireless, PS Docket No. 07-114, at 6 (Sept. 25, 2013) (“Verizon Workshop Comments”).

³ *Id.* at 6-7; Qualcomm E911 Location Accuracy Workshop Presentation at 4-7 (Nov. 18, 2013), http://transition.fcc.gov/bureaus/pshs/911/Phase%202/Workshop_11_2013/QCOM%20FCC%20Meeting%20on%20Indoor%20Location%20Accuracy.pdf (“Qualcomm Workshop Presentation”); *see also infra* Section III.A.3.

improve as Verizon deploys additional LTE cell sites for capacity and vendors continue to enable further refinements of O-TDOA performance over time.

The Commission's rules and policies have largely treated other parties in the wireless ecosystem, such as handset and chipset manufacturers, device operating system providers, over-the-top ("OTT") providers, and location solution providers, as incidental factors. Today, however, these entities play an increasingly critical role *independent of wireless service providers*. Not only are they developing new innovative commercial location technologies, they are shaping consumers' expectations about location performance. But the current regulatory framework does not align their interests with those of public safety stakeholders, or with the wireless providers subject to the Commission's E911 regulations. Encouraging multi-stakeholder development of new technologies and practices in this new environment can minimize the need for regulatory action. To the extent that new rules are adopted, a new framework can also ensure that the Commission meets its legal obligation to do so in a technically feasible manner without imposing disparate regulatory burdens on wireless service providers.⁴

The Commission has nearly 20 years of experience in the wireless E911 arena, from which it can draw several important lessons for this proceeding. Specifically, the Commission's E911 policies have most effectively enabled industry and public safety stakeholders to achieve the Communications Act's public safety objectives when the Commission (1) relies on the technical judgments of collaborative multi-stakeholder efforts, and (2) accounts for technical feasibility. And developments in the wireless marketplace now merit a third guidepost:

⁴ See, e.g., *Nuvio Corp. v. FCC*, 473 F.3d 302, 203 (D.C. Cir. 2007) (noting technical feasibility is an inquiry "made necessary by the bar against arbitrary and capricious decision-making").

facilitating the wireless industry's transition to IP-enabled services and networks in a diverse ecosystem.

Collaborative Multi-Stakeholder Efforts. The Commission's original 1996 rules arose out of a consensus agreement among industry and public safety stakeholders.⁵ That agreement and the Commission's embrace of its staged implementation of E911, and reliance on consensus to work out most technical details,⁶ helped set the stage for the launch of Phase I service two years later and Phase II service five years later. Similarly, when technical challenges arose concerning the transmission of TTY 911 calls over digital technology, with the support of the TTY Forum consisting of industry, public safety and consumer stakeholders, the Commission accommodated the industry-led technology breakthrough in 1999-2000 that enabled the orderly implementation of digital TTY capability into wireless networks.⁷ Agreements between wireless carriers and public safety organizations also helped achieve a consensus on achieving accuracy improvements for outdoor 911 calls in 2008 – and, notably, helped break an impasse over the PSAP-level accuracy rules that were contrary to NRIC recommendations at the time.⁸ And more

⁵ *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, Report and Order and Further Notice of Proposed Rulemaking, 11 FCC Rcd 18676, ¶¶ 57-58, App. D (1996) (“*E911 First Report and Order*”); *id.* ¶ 63 (finding “that the schedule for [phase I] deployment proposed by the signatories of the Consensus Agreement is a reasonable middle ground between the positions of carriers and public safety organizations”).

⁶ *See id.* ¶¶ 73-76 (deferring “the development of detailed technical and operational standards” to stakeholders rather than promulgating rules).

⁷ *See Wireless Telecommunications Bureau Seeks Comment on New Implementation Deadline for TTY Access to Digital Wireless Systems for 911 Calls*, Public Notice, 15 FCC Rcd 8860 (WTB 2000) (describing the TTY Forum and manufacturer and service provider efforts).

⁸ *See Wireless E911 Location Accuracy Requirements; Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems; 911 Requirements for IP-Enabled Service Providers*, First Report and Order, 22 FCC Rcd 20105 (2007), *stayed Rural Cellular Ass'n v. FCC*, No. 08-1069, slip op. at 1 (D.C. Cir. Mar. 25, 2008) (per curiam), *vacated*, Order Granting Mot. Rem. (Sept. 17, 2008); *Wireless E911 Location Accuracy*

recently, the wireless industry’s agreement with public safety stakeholders to deploy text-to-911 capabilities has facilitated the early implementation of text-to-911 in dozens of markets without the need for a regulatory mandate.⁹ The complex technology and policy implications of improving E911 indoor accuracy, which are most analogous to the initial implementation of E911 in the mid-1990s, warrant a similar approach here.

Technical Feasibility. E911 implementation has been most effective where the Commission has accounted for technical and engineering realities and limitations from the outset when designing service-specific performance obligations. For wireless services, the Commission long ago recognized that mobility of the service precluded the use of a traditional wireline ALI database approach.¹⁰ Likewise, the Commission adopted the registered location approach to account for the nomadic capabilities of some interconnected VoIP services, while accounting for the technical feasibility of the applicable deadlines and accommodating implementation challenges that arose thereafter.¹¹ And rather than apply the full panoply of wireless E911

Requirements, Second Report and Order, 25 FCC Rcd 18909 (2010); Comments of Verizon Wireless, PS Docket No. 07-114, at 26-27 (July 5, 2007) (“Verizon PSAP Accuracy Comments”) (noting that the Commission declined to seek comment on relevant NRIC VII recommendations).

⁹ See *Facilitating the Deployment of Text-to-911 and Other Next Generation 911 Applications; Framework for Next Generation 911 Deployment*, Policy Statement and Second Further Notice of Proposed Rulemaking, 29 FCC Rcd 1547 (2014); Comments of Verizon and Verizon Wireless, PS Docket Nos. 11-153 & 10-255, at 2-4 (Apr. 4, 2014) (“Verizon Text-to-911 Comments”).

¹⁰ *Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, Notice of Proposed Rulemaking, 9 FCC Rcd 6170, ¶ 45 (1994).

¹¹ See 47 C.F.R. § 9.5; *IP-Enabled Services E911 Requirements for IP-Enabled Service Providers*, First Report and Order and Notice of Proposed Rulemaking, 20 FCC Rcd 10245, ¶ 46 (2005) (“recogniz[ing] that it currently is not always technologically feasible for providers of interconnected VoIP services to automatically determine the location of their end users without end users’ active cooperation”); Public Notice, *Enforcement Bureau Outlines Requirements of November 28, 2005, Interconnected Voice Over Internet Protocol 911 Compliance Letters*, 20 FCC Rcd 17949 (EB 2005).

requirements to CMRS mobile satellite services, the Commission applied a “call center” approach that accounted for those providers’ centralized core network facilities and the particularized needs of their customers.¹²

The implementation of wireless E911, though, is a more mixed story. The initial E911 Phase II deadlines and performance requirements were premised on solution vendors’ projections for products under development.¹³ The Commission, however, later modified and waived those rules in various degrees to account for feasibility issues that arose in the course of implementation.¹⁴ And the D.C. Circuit stayed the Commission’s initial 2007 decision to impose technically infeasible PSAP-level accuracy requirements.¹⁵ The need for mid-course corrections, and the corresponding diversion of resources from the pursuit of technical progress on 911 matters, is a result the Commission should seek to avoid here.

IP Transition. The clear public safety and consumer benefits of facilitating the wireless industry’s transition to IP-enabled LTE networks and services adds yet a third guidepost for any Commission action here. As explained below and recently in Verizon’s comments in the Commission’s rulemaking on new text-to-911 rules, the transition to IP-enabled VoLTE

¹² 47 C.F.R. § 25.284.

¹³ See *E911 First Report and Order* ¶ 68 (“While some wireless carriers see obstacles to implementing Phase II in five years, the equipment manufacturers believe a five-year deadline is achievable.”); *Revision of the Commission’s Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, Third Report and Order, 14 FCC Rcd 17388, ¶ 53 (1999), modified on recon. Fourth Memorandum Opinion and Order, 15 FCC Rcd 17442, ¶¶ 18-23 (2000) (“*E911 Fourth MO&O*”).

¹⁴ See, e.g., *E911 Fourth MO&O*, ¶¶ 33-35; *Revision of the Commission’s Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems Phase II Compliance Deadlines for Non-Nationwide CMRS Carriers*, Order to Stay, 17 FCC Rcd 14841 (2002); *Revision of the Commission’s Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems Request for Waiver by Verizon Wireless*, Order, 16 FCC Rcd 18364, ¶¶ 17-22 (2001).

¹⁵ See *supra* note 8; Verizon PSAP Accuracy Comments at 4-22.

technology is not just incidental, but *necessary* to future substantial improvements in E911 location accuracy and E911 capabilities.¹⁶ Consumers’ and service providers’ rapid transition to IP-based communications services and networks, the proliferation of a variety of different wireless access points in both outdoor and indoor environments, and the rapid introduction and evolution of commercial location-based services, could potentially result in a new “Phase III” of E911 location solutions with something approaching or achieving dispatchable address capability for many 911 calls – but only if the Commission’s policies align with these fast-moving marketplace developments and the diverse wireless ecosystem necessary to make them a reality.¹⁷ The Commission’s statutory public safety objectives are therefore best served by encouraging the transition to IP-enabled services and technologies, and not focusing on technologies that will become obsolete.¹⁸

For the reasons discussed below, all three of these guideposts weigh against the proposed horizontal and vertical location rules and in favor of the alternative, forward-looking framework outlined below to build upon the policies that have worked before while adapting them to today’s technologies and market players.

¹⁶ See Verizon Text-to-911 Comments at 14-16.

¹⁷ See *infra* Section II.

¹⁸ *Wireless E911 Location Accuracy Requirements*, Third Further Notice of Proposed Rulemaking, 29 FCC Rcd 2374, ¶¶ 63-64 (2014) (“*FNPRM*”) (“near-term indoor accuracy requirements should take into account long-term E911 and NG911 objectives to avoid requiring significant in technologies that could become stranded.”).

DISCUSSION

I. VERIZON IS WORKING WITH OTHER STAKEHOLDERS TO IMPROVE E911 LOCATION ACCURACY AND PERFORMANCE.

Verizon has followed the Commission's cues and initiated good faith discussions with public safety stakeholders to determine potential areas for consensus.¹⁹ As noted above, the Commission has made the most significant progress toward widespread E911 deployment and improvements when it has relied on the judgment of collaborative efforts such as these. These discussions are ongoing and there may well be several areas in which the parties are able to find common ground.

The Commission should encourage and enable industry and public safety stakeholders to achieve consensus that can obviate the need for prescriptive regulations. In its comments in the text-to-911 proceeding Verizon laid out a framework for how the Commission can maximize the benefits of voluntary efforts by applying voluntary commitments in lieu of new regulations as long as they substantially achieve the desired public interest benefits and, if rules become warranted, to limit them to the scope of those voluntary commitments.²⁰ The Commission should apply this approach here as well and afford stakeholders a meaningful opportunity to find areas of agreement.

Importantly, multi-stakeholder efforts can enable affected parties to evaluate the complex technical challenges and balance competing policy objectives in a candid, objective and relatively non-adversarial manner. This is particularly important here, as service providers' ability to comply with any location accuracy mandate will depend on fundamental technical and engineering realities of designing, manufacturing and deploying radiofrequency (RF) networks

¹⁹ *See id.* ¶ 26.

²⁰ *See Verizon Text-to-911 Comments* at 5.

and devices. This is true not just for commercial wireless LTE networks like Verizon's, but the network equipment and consumer devices on which third party E911 location solution providers rely. The reality is that all of the E911 technologies available today, as well as the promising nearer-term solutions under development, utilize RF-based techniques to *estimate* the 911 caller's location.²¹ Even in the best of circumstances, none of these techniques purports to enable a wireless provider to inform a PSAP of the actual address from which a 911 call originates, like a wireline ALI database lookup or a VoIP registered location.

This is not because any particular solution is inadequate. To the contrary, the capabilities that E911 location solutions enable today represent remarkable and innovative feats of engineering. Rather, it is because they are necessarily reliant on the network architecture that they deploy (or is available to them), and on a solution's ability to communicate with the 911 caller's handset via as many RF points of reference as possible.²² Today, nearly all of those reference points originate outdoors, including satellites, terrestrial beacon systems, and cell site-based methods. Each solution is therefore subject to the vagaries of RF propagation, network-based factors such as cell site (or beacon) density, and line of sight between the fixed network or satellite and the handset. And these factors are far more pronounced for indoor 911 calls than for outdoors. As discussed in the following section, these factors, combined with technology developments in the broader wireless ecosystem, counsel strongly in favor of an alternative to the E911 policy framework proposed in the *FNPRM*.

²¹ See Appendix, Declaration of Richard A. Craig, ¶ 4 (“Craig Declaration”).

²² See *id.* ¶¶ 4-5.

II. E911 POLICIES SHOULD LEVERAGE MARKETPLACE DEVELOPMENTS AND SATISFY LONG TERM PUBLIC SAFETY GOALS.

The Commission seeks comment on wireless providers' delivery of dispatchable address information to PSAPs as one of its possible "long-term accuracy objectives."²³ Verizon agrees that this is an important objective and a more appropriate use of industry, public safety and Commission resources than attempting to achieve the unworkable accuracy requirements proposed in the *FNPRM*. While improvements in location accuracy will be feasible with VoLTE-based technologies like O-TDOA, there will always be limits on the extent to which they can locate a caller indoors. (Indeed, the 67% and 80% reliability components of the proposed rules recognize this fact.)²⁴ Standards and development efforts by different stakeholders will be necessary to appropriately define "dispatchable" in particular environments and for different technologies. And delivery of an address and floor or room number²⁵ may not always identify where the emergency is occurring. Nonetheless, Verizon agrees that technologies that enable a dispatchable address or something approaching it can help meet an important public safety and consumer need in many circumstances.

Further, Verizon's experience with E911 Phase II technology indicates that stringent indoor accuracy requirements like the proposed rules risk forcing service providers into a vicious circle that has profound implications for how service providers prioritize resources for E911. Specifically, continued significant investments on a particular location accuracy solution will achieve diminishing incremental improvements. At some point, consumers' public safety

²³ *FNPRM* ¶ 117.

²⁴ *See id.*, App. C; *id.* ¶ 47 (under the first benchmark, "up to 33 percent of calls may ... have location outside the accuracy threshold").

²⁵ *See id.* ¶ 118 (describing a "dispatchable address").

interests are better served by enabling service providers to focus investment in alternative technologies. Developments in commercial LBS technology, consumer-level products and network architectures made possible by the transition to IP-enabled services point to where industry should direct that investment.

To that end, the Commission should establish policies to encourage “Phase III” of its E911 location framework by leveraging developments already occurring in the broader wireless marketplace and giving wireless providers incentives to employ new technologies.²⁶

Developments occurring in the commercial LBS market that leverage Wi-Fi access points, for example, may be more aligned with public safety’s long term goal, and the Commission should consider how to align its policies accordingly. The framework should also leverage the increasing availability of other commercial products across the wireless ecosystem, including consumer-level products and non-traditional network architectures, that increase the number of wireless access points with known fixed addresses that may be able to provide more accurate information about the location of the 911 caller. The Commission should encourage the development and standardization of feasible solutions that provide PSAPs with more actionable information than delivery of latitude/longitude coordinate estimates.

III. THE PROPOSED INDOOR LOCATION ACCURACY REQUIREMENTS ARE NOT TECHNICALLY FEASIBLE AT THIS TIME.

Verizon is working closely with vendors, public safety stakeholders, and other service providers to develop standards and test new solutions to improve indoor accuracy. The proposed rules, however, would require a fundamentally different technology approach to indoor location

²⁶ See *id.* ¶¶ 119-23.

accuracy than what the *FNPRM* presumes, and that cannot be implemented within the proposed deadlines.²⁷

A. The Proposed Benchmarks for Horizontal Indoor Location Accuracy Are Not Technically Feasible.

The Commission currently requires that Verizon meet a 50m/67% and 150m/80% benchmark, and 50m/67% and 150m/90% by January 9, 2017, measured at a county- or PSAP-level using outdoor calls.²⁸ Prior to that, a 50m/67% and 150m/95% benchmark applied, and while measurements were not *per se* limited to outdoors, only a minimal percentage of calls were expected to be attributed to indoors.²⁹ Notwithstanding the “outdoor” orientation of the rules, Verizon has incorporated many network and handset changes that have improved Phase II accuracy, with resulting improvements for some indoor environments.³⁰ Verizon’s A-GPS solution also relied on AFLT as a fallback to GPS, rather than less accurate techniques like round trip timing and cell ID, in order to provide some added support for environments where GPS signals are challenged, including indoors. Verizon’s E911 technology plan for VoLTE, particularly O-TDOA, is designed to carry those improvements forward to the IP environment and ultimately improve E911 location accuracy in all environments, both indoors and outdoors.³¹

²⁷ See *infra* Craig Declaration.

²⁸ *Applications of Cellco Partnership d/b/a Verizon Wireless and Atlantis Holdings LLC*, Memorandum Opinion and Order and Declaratory Ruling, 23 FCC Rcd 17444, ¶¶ 198-201 (2008).

²⁹ See NRIC VII Focus Group 1A, *Near Term Issues for Emergency/E911 Services*, Final Report, at 24 (Dec. 2005) (recommending that “for the near term, approximately 5% of accuracy test calls should be conducted indoors”).

³⁰ See *supra* note 3 and accompanying text.

³¹ See *infra* discussion at Section III.A.3.

This same experience with A-GPS and planning for O-TDOA, however, indicates that the standard in the proposed rule is not technically feasible.

1. *CSRIC Test Results for A-GPS Performance in Legacy Networks Do Not Support the Proposed Rule.*

The *FNPRM*'s proposed indoor accuracy requirements – 50m/67% within just 2 years of the effective date, up to 50m/80% within 5 years, exclusive of compliant location fixes obtained after 30 seconds³² – would require a fundamentally different technology than what the *FNPRM* assumes is sufficient. The *FNPRM*, however, presumes that no corresponding fundamental changes would be needed to the underlying wireless networks and solution providers' RF-based network architectures in most places.³³ That presumption is incorrect.

As a threshold matter, the *FNPRM* largely based its statements concerning the feasibility of its proposed rules on (1) how A-GPS has performed for legacy CDMA networks, including at the CSRIC test bed,³⁴ and (2) improvements over A-GPS that will be available in an LTE environment, such as GLONASS and O-TDOA.³⁵ At the CSRIC test bed Qualcomm used the A-GPS technology it provides for Verizon and other wireless providers' CDMA networks, but this is *not* the GLONASS and O-TDOA technology that wireless providers intend to use for VoLTE. And those LTE-based technologies will not be incorporated into the legacy CDMA network. Thus, the test bed results do not demonstrate how A-GNSS and O-TDOA would

³² See *FNPRM* ¶¶ 44-51.

³³ See *id.* ¶ 105.

³⁴ See *id.* ¶¶ 47-48, 104-105.

³⁵ See *id.* ¶¶ 46, 56.

perform for a VoLTE network, and the *FNPRM* erroneously presumes that those technologies can be applied to the legacy CDMA network.³⁶

Moreover, using the very CSRIC test bed approach proposed in the *FNPRM*, today's A-GPS technology did not achieve the 50m/67% level in all of the relevant test bed environments by a significant degree.³⁷ Verizon has reviewed historical accuracy data from several of the urban counties in its coverage area where indoor location accuracy challenges would be particularly acute. Since 2008, even with its diligent efforts Verizon Wireless has been able to improve the accuracy of the GPS component of its A-GPS solution by, at most, a few (low-single digits) percentage points for outdoor calls in those areas. In contrast, using the aggregate A-GPS CSRIC indoor test bed data as a baseline, the proposal would require improvement of approximately *80% in just two years* (from 250m/67% to 50m/67%) – and then in the more challenging indoor environments where A-GPS is substantially more dependent on AFLT than in outdoor environments.³⁸ And while AFLT is largely dependent on CDMA cell site density, new cell site deployment is focused on LTE technology. Thus, the suggestion that “the current pace of technological developments” supports the proposed deployment schedule is unfounded with respect to A-GPS.³⁹

Further, using the CSRIC test bed results as a baseline again, even assuming that wireless providers, equipment manufacturers and all others concerned can continue to refine and recalibrate the GPS and AFLT components of the A-GPS solution over time, a 20%

³⁶ See Craig Declaration ¶ 10.

³⁷ See CSRIC III Working Group 3, Indoor Location Test Bed Report, at 26-36 (“Working Group 3 Report”).

³⁸ See Craig Declaration ¶ 10.

³⁹ See *FNPRM* ¶ 57.

improvement in two years – a substantial increase over previous years – would result in only a 200m/67% accuracy level (averaged across all the test bed environments), still far less accurate than the proposed rule would require. And the CSRIC results do not support the *FNPRM*'s technical feasibility suggestions in several other respects. The CSRIC results for A-GPS were far less accurate than the aggregate performance levels in urban and dense urban environments.⁴⁰ The CSRIC results also counted Phase II measurements with a time-to-first-fix of greater than 30 seconds, unlike the *FNPRM*.⁴¹ The proposed rule thus could categorically exclude location fixes that would otherwise meet the standard under the test bed. And requiring service providers to meet a standard on a per-county or per-PSAP basis, rather than through a test bed like the CSRIC's, would also make the proposed standard infeasible based on A-GPS. In addition to the simple logistical challenges of performing indoor testing in all counties, A-GPS necessarily relies more heavily on hybrid and AFLT location determinations, rather than the more accurate GPS-only technique, in the most challenging indoor environments in urban and dense urban areas.⁴² Accordingly, it would not be feasible to achieve the proposed standard in counties with demographics that are predominantly urban or dense urban. For these reasons as well, the CSRIC test bed results do not indicate that the proposed horizontal accuracy standards and deadlines are feasible.

⁴⁰ See Working Group 3 Report at 36.

⁴¹ See *id.* at 14 (“if a location fix [was] delivered after 30 seconds it was still included in successful call attempts”).

⁴² See Craig Declaration ¶ 8.

2. *The Commission Erroneously Relies on Phase II Yield and Demographic Data to Support its Feasibility Conclusions.*

The *FNPRM*'s assertion that "CMRS providers also confirm that A-GPS technology works well in most indoor locations" is based on T-Mobile's and Verizon's descriptions of their E911 *yield* performance last year in addressing issues concerning the delivery of Phase II data to PSAPs – *not* location accuracy.⁴³ Yield reflects the total percentage of 911 calls that provided the PSAP with a Phase II location determination, not the accuracy of the Phase II information itself.⁴⁴

The suggestion that service providers could meet the proposed standard on a per-county or per-PSAP level on the basis "that the majority of indoor environments are likely to be the types of structures that are suitable for A-GPS" (*i.e.* single-family detached homes) is also erroneous.⁴⁵ The same Census Bureau report on which the *FNPRM* relies found that *fewer than half* of households in several major metropolitan areas in the Northeast and Mid-Atlantic states fit this category (including New York/New Jersey, Philadelphia, Boston, Baltimore and Washington DC), as well as Miami and San Francisco-Oakland.⁴⁶ Moreover, that report did not break down other major metropolitan areas on a county-by-county basis, and while the Census Bureau did not correlate that data with the affected population, it is reasonable to expect

⁴³ See *FNPRM* ¶ 104, n.209.

⁴⁴ See, *e.g.*, Letter from Nneka Ezenwa Chiazor, Verizon, to Marlene Dortch, FCC, PS Docket No. 07-114, at 6 (Sept. 11, 2013) ("Verizon CALNENA Response"); Letter from Jamie M. (Mike) Tan, AT&T, to Marlene Dortch, FCC, PS Docket No. 07-114, Attachment A at 3 (Sept. 9, 2013) ("data and graphs purportedly raise concerns about "location yield" (*i.e.*, quantity of E911 locates), not location accuracy"); Letter from John T. Nakahata, counsel to T-Mobile, to Marlene Dortch, FCC, PS Docket No. 07-114, at 2 (Sept. 5, 2013).

⁴⁵ See *FNPRM* ¶ 104 n.210.

⁴⁶ See Christopher Mazur, U.S. Census Bureau, *Physical Characteristics of Housing: 2009-11* (Apr. 2013), at 6 <http://www.census.gov/prod/2013pubs/acsbr11-20.pdf>.

hundreds of counties serving tens of millions of Americans could fall outside of the *FNPRM*'s blanket characterization. Indeed, if anything, that Census Report would affirm that meeting the proposed indoor rule in all counties is *not* feasible via a CDMA-based A-GPS system.

Moreover, it is location accuracy challenges in urban areas that are a principal driver of this proceeding, and the very demographics of concern in the *FNPRM* – individuals living in poverty and younger Americans⁴⁷ – would be more likely to live in urban areas or apartments than others.

In addition, the proposed two-year deadline is infeasible based on technologies available today that serve as the factual basis for the *FNPRM*'s feasibility determination. Future improvements in location accuracy that the *FNPRM* envisions are premised on deployment of a different underlying LTE network and location solution architecture (e.g. A-GNSS/O-TDOA, or MBS), and the integration of those solutions into that network and end-to-end testing. The technology changes necessary to achieve these levels of accuracy require not just a software release update or refinement of existing technology, but the whole cloth implementation of new network-level technology nationwide. Thus, the presumption “that only a limited number of environments would require additional infrastructure” beyond today’s legacy A-GPS architecture is incorrect.⁴⁸

3. *LTE-Dependent Solutions Will Substantially Improve Accuracy But Still Cannot Meet the Standard in the Proposed Rule.*

Deployment of the LTE network is expected to improve indoor location accuracy, as evidenced by preliminary beta testing of Verizon’s VoLTE E911 solution in a few select markets. But the performance of the 911 solution for its VoLTE network will not offset the

⁴⁷ See *FNPRM* ¶ 28.

⁴⁸ *Id.* ¶ 105.

limitations of A-GPS on its CDMA network sufficient to enable Verizon to meet the proposed aggressive standards.⁴⁹ The proposed rule would require that measurements employ the same “technologies actually employed” in a CMRS provider’s network which, for Verizon, will include CDMA for a significant time.⁵⁰ Even if O-TDOA and A-GNSS could theoretically improve the combined average of the CDMA and VoLTE networks, it would still not approach the proposed 50m/67% level on a per-county basis.⁵¹

In any case, it is premature to conclude that indoor accuracy performance measured on the VoLTE network alone will achieve that goal. Indeed, based on discussions with vendors and experience with the legacy A-GPS system, Verizon expects that O-TDOA performance *as applied to VoLTE alone* would represent up to a 20% improvement over AFLT in similar environments in a few years – which, as noted above, would not achieve the proposed 50m/67% level within the time periods proposed in the *FNPRM*.⁵² Moreover, O-TDOA and GLONASS technologies have not been tested based on the proposed accuracy, timing and test bed criteria. Wireless service providers would also need a sufficient period after standardized commercially available solutions have been tested as compliant with any new regulations.⁵³ The proposed rules do not account for these factors.⁵⁴

⁴⁹ See Craig Declaration ¶ 11.

⁵⁰ See *FNPRM* at App. C (proposed rule section 20.18(i)(1)).

⁵¹ See *supra* Section III.A.1.

⁵² See *FNPRM* ¶ 62 (seeking comment on whether improvements in technology since the CSRIC test bed have been sufficient).

⁵³ See *id.* (seeking comment on steps necessary to implement improvements).

⁵⁴ See Craig Declaration ¶ 7.

4. *Metropolitan Beacon System Technology Will Not Enable Verizon to Meet the Proposed Standards.*

The technical basis for the proposed rule also relies heavily on the performance of NextNav's MBS technology at the CSRIC Test Bed. Like A-GPS, NextNav did not meet a 50m/67% benchmark in all four CSRIC test bed environments – much less a 50m/80% benchmark.⁵⁵ For these reasons alone, the performance of NextNav's emerging solution – which could realistically only apply to VoLTE networks and handsets given industry's transition to LTE and standards efforts under way – does not indicate that the proposed horizontal standards are feasible within two years.⁵⁶

Moreover, as the test bed and subsequent events demonstrate, important steps outside of wireless service providers' control are necessary before any solutions that meet new accuracy standards are commercially available to service providers.⁵⁷ As explained in the Test Bed Report, NextNav used a sleeve-based receiver that was attached to a handset via a USB interface.⁵⁸ Significant handset device modifications are therefore necessary. These are dependent on NextNav's ability to have chipset vendors incorporate its beacon specification, which could require significant hardware and software design changes on the handset and the Location Server. These processes alone would take close to 2 years, and it will take at least another 3-4 months for third party original equipment manufacturers ("OEMs") to test and incorporate the capability into their devices. NextNav's solution is also dependent upon its own

⁵⁵ See Working Group 3 Report at 27 (at the 90th percentile, NextNav ranged from 44.9 meters to 141 meters, Qualcomm ranged from 210 meters to 449 meters).

⁵⁶ See Craig Declaration ¶¶ 12-13.

⁵⁷ See Working Group 3 Report at 54; see *FNPRM* ¶ 62 (seeking comment on steps necessary to implement improvements).

⁵⁸ See Working Group 3 Report at 42.

deployment of beacon networks – a time-consuming endeavor in its own right – as well as maintenance and provision of the real time barometric pressure feed to the handsets. It is also uncertain whether handsets with the necessary hardware and software capabilities will be available concurrently with the network-level capabilities; as discussed below, any deadlines would need to reflect that factor as well. And all these capabilities require further standards development.⁵⁹

The necessary threshold 3GPP standards are not targeted for completion until December 2015. After that, vendors would need to develop and manufacture LTE-based products built to the standards and the accuracy requirements, a process which typically takes 18-24 months; at least another year will be needed for laboratory, field, IOT testing and related activity – only after which service providers could *begin* deployment in their networks. Given the tens of thousands of MBS beacons needed to achieve density levels comparable to the CSRIC test bed, *completion* of deployment nationwide throughout Verizon’s coverage area would take even longer. Finally, several significant hardware and software modifications would be necessary to the handset or chipset, as well as the barometric pressure sensor (for the vertical calculation). Moreover, there are critical handset design issues that would need to be addressed to prevent potential interference between the beacon signal and the LTE signal, and to minimize the impact on the handset’s “real estate.” It is not feasible to complete all of these steps within the two-year period proposed in the *FNPRM*.

⁵⁹ See Letter from John Kuzin, Qualcomm, to Marlene Dortch, FCC, PS Docket No. 07-114, at 1 (May 1, 2014) (describing 3GPP Study Item on terrestrial beacon systems).

B. The Proposed Benchmarks for Vertical Indoor Location Accuracy Are Not Technically Feasible.

The *FNPRM* proposes that wireless providers deliver vertical accuracy based on indoor measurements of 3m/67% within three years, and 3m/80% within five years.⁶⁰ As with horizontal accuracy, these benchmarks are not technically feasible, for largely the same reasons.⁶¹ In particular, Verizon's legacy CDMA network will not have a vertical determination solution that generates an accurate measurement at all, so any methodology that requires all technologies be incorporated will not be feasible for Verizon. Further, there are a number of additional threshold contingencies for vertical information not applicable to horizontal information that are not reflected in the flash cut three-year period of the proposed rule.

The principal basis for the proposed rule is again the Working Group 3 Report which, as noted above, did not involve commercially available technology. In addition to all of the steps described earlier that are necessary for NextNav to become commercially available with respect to horizontal accuracy, for vertical the handset requires a barometric pressure sensor and other measures to integrate its functions with the wireless service provider's network. Again, all these steps require further standards development, OEM integration and production, and network integration, with testing throughout – and given the novelty of the new capability subject to somewhat longer standardization, development and deployment timetables than described above for horizontal. And as with horizontal location, the formal standards activity for MBS technology vertical location capabilities is not targeted for completion until December 2015. It is not feasible to complete all of these steps within the proposed three-year period.

⁶⁰ See *FNPRM* ¶¶ 73-77.

⁶¹ See Craig Declaration ¶¶ 14-15.

IV. IMPROVING INDOOR LOCATION ACCURACY REQUIREMENTS WARRANTS A FUNDAMENTALLY DIFFERENT POLICY FRAMEWORK.

The *FNPRM* would largely apply the traditional E911 policy framework, which has always been carrier-focused and treated other parties in the wireless ecosystem as incidental, secondary factors in its E911 regime. The marketplace, technology, and consumers themselves have evolved beyond that construct, however, and the Commission's policies should change accordingly to avoid the pitfalls of earlier E911 efforts. The Commission should encourage stakeholders in the E911 ecosystem to work on collaborative efforts without regulatory mandates. If the Commission nonetheless continues to move toward to establishing requirements, it must account for key contingencies to reflect the technological landscape.

A. An Independent Test Bed Should Verify that Compliant Solutions Are Available Before Deadlines Are Imposed.

The *FNPRM* proposes requiring wireless service providers to participate in a test bed program to individually demonstrate compliance with the indoor accuracy rules.⁶² Verizon supports use of a test bed, but as a threshold to determine whether a solution is able to meet the standard in any rules, which, in turn, would serve as a mechanism to trigger the start of any implementation timelines in the first instance.

Specifically, the Commission should provide that any deadlines and performance requirements apply a reasonable period after multiple vendors have demonstrated that compliant products that meet any new mandated accuracy threshold(s) at all test bed points are commercially available to service providers. This framework is preferable for a number of reasons. First, it gives vendors appropriate incentives to standardize their products and work with service providers and OEMs at an early stage, rather than focusing on proprietary products

⁶² *FNPRM* ¶ 84.

that pose cost and interoperability constraints when implemented. Second, it would facilitate the efficient deployment of new solutions and be more reflective of today's diverse wireless product ecosystem. Third, it does not enable either vendors or service providers to game the Commission's regulatory processes: vendors are rewarded *not* for inflating claims of performance to the regulator, but for the quality of their products and services; whereas service providers are subject to a more equitable trade-off – a clear and independent trigger that will impose a fixed regulatory deadline, but with the business certainty that products are available that will enable them to meet any accuracy standard. Finally, by having more than one vendor demonstrate they are capable of meeting the standard in all test bed environments, a proprietary solution is avoided, and carriers can effectively make use of standardized technology.

This approach, which echoes the *FNPRM*'s suggested solution-focused approval process,⁶³ will more effectively give all stakeholders the right incentives to make new innovative E911 solutions available to consumers quickly and efficiently. As drafted, however, the proposed rule risks setting in motion the same dynamic that plagued E911 Phase II deployment: deadlines and performance requirements are adopted based on projections of technical feasibility, yet the realities of the commercial marketplace and live networks require time-consuming and adversarial midstream corrections.

Finally, while the details should be left to standards organizations, many of the preliminary criteria proposed for the test bed make sense as a general matter, such as: use of an independent administrator, similar to the Commission's equipment authorization approach as a

⁶³ *Id.* ¶ 60 (seeking comment on “initiating the compliance timeline only after the test bed administrator certifies that a technology has met the proposed accuracy standards in the test bed” and whether to “require availability of competitive technology options.”).

model (insofar as it tests technology performance against Commission requirements);⁶⁴ and the use of representative environments (including emulation of actual network deployment configurations).⁶⁵ As discussed below, however, other performance attributes may be appropriate as information-gathering criteria, such as yield and latency (time-to-first-fix), but should not be incorporated into the implementation benchmarks.⁶⁶ And consistent with the objective of “avoid[ing] required investment in technologies that could become stranded” and accommodating wireless providers’ “long-term business and technology plans,”⁶⁷ actual results should be measured based on performance for next generation wireless networks (e.g. LTE).⁶⁸

B. Deployment Timetables Should Allow Phased-In Implementation of New Indoor Solutions.

The *FNPRM* seeks comment on whether indoor accuracy requirements should apply nationwide, or in a more targeted, phased-in fashion.⁶⁹ To the extent the Commission adopts regulatory mandates, a phased-in multi-vendor approach is a must.

E911 deployment deadlines have always been premised on the readiness of PSAPs to handle the relevant data. (Indeed, providers and PSAPs are permitted to mutually agree to extend those deadlines.)⁷⁰ The Commission recognized that focusing carrier resources in this manner ensured the most “bang for the buck” in terms of the benefits for public safety and thus

⁶⁴ See *id.* ¶¶ 95-97.

⁶⁵ See *id.* ¶¶ 88, 93.

⁶⁶ See *id.* ¶ 89-91; *infra* Section V.A.

⁶⁷ See *FNPRM* ¶¶ 63-64.

⁶⁸ See *id.* ¶ 62 (seeking comment “on whether we should phase in different reliability standards in conjunction with staged implementation timeframes, or different requirements for specific types of mobile devices (e.g., only 4G-capable devices).”).

⁶⁹ See *id.* ¶¶ 104-109.

⁷⁰ See 47 C.F.R. §§ 20.18(d)-(g) and (j)(5).

drew an appropriate balance between carriers' need to spend resources efficiently and public safety.⁷¹ And it had the salutary effect of enabling service providers to deploy E911 in an orderly, systematic manner and to carry forward lessons learned from earlier deployments.

But the *FNPRM* proposes to abandon that approach, even as new solutions will require new network-level components and, for vertical, new PSAP capabilities. NextNav's MBS system, for example, requires the deployment of new beacon antennas – a capital- and labor-intensive effort under any circumstance. O-TDOA requires integration of cell site-level capabilities and, like AFLT, many of the improvements it will make possible occur over time as the system's performance is evaluated and refined. As NextNav itself acknowledges, “no reliable solution can be deployed by the wireless carriers immediately, or made available on the same timeframe in all communities.”⁷² In this important respect, the proposed rules go beyond even what vendors have suggested is feasible.

Thus, for both horizontal and vertical accuracy, population-based benchmarks are appropriate; this policy will reward providers for focusing initial deployments on the very urban areas where the CSRIC III report and public safety stakeholders indicate that indoor accuracy concerns are highest.⁷³ The availability of vertical and horizontal accuracy improvements to

⁷¹ See *Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems Petition of City of Richardson, Texas*, 16 FCC Rcd 18982, ¶ 13 (2001) (change to PSAP readiness criteria “properly balances the parties' respective obligations and ensures both that PSAPs receive timely Phase I and Phase II service and that wireless carriers are not asked to commit resources needlessly.”).

⁷² See Letter from Bruce Olcott, counsel to NextNav, to Marlene Dortch, FCC, PS Docket No. 07-114, at 4 (Dec. 23, 2013) (“NextNav December Letter”).

⁷³ See *FNPRM* ¶ 106 (asking “would it be more effective to phase in application of the indoor location accuracy requirements, by first focusing on areas throughout the nation with the largest volume of indoor calls?”); NextNav December Letter at 4-5 (supporting population-based benchmarks).

consumers, however, is also dependent on the availability of new handset chipset and other handset modifications. Insofar as availability of necessary handset capabilities from OEMs occurs subsequent to deadlines for service providers' implementation of the relevant capabilities at the network level, service providers should not be liable as long as they are compliant before handsets become commercially available.

C. PSAP Readiness Is Necessary for Vertical Indoor Location.

The adverse impact of excluding a PSAP readiness contingency from the proposed rules is particularly acute for vertical information. As some vendors have already explained, vertical location requires additional capabilities at the PSAP level beyond what is currently required for Phase I and Phase II, including incorporating building schematics into their mapping systems for the PSAP's area.⁷⁴ Even where a PSAP's E911 capabilities build upon one another, as was the case for the NCAS method that PSAPs used for Phase I and Phase II, a separate PSAP request was required for each.⁷⁵ The proposed rule thus reflects a marked and inappropriate departure from the Commission's traditional approach to E911 implementation, for which implementation deadlines were triggered by demonstrated PSAP readiness.⁷⁶

For vertical location, moreover, given the substantially higher network-level costs for wireless service providers any implementation deadlines should reflect PSAP readiness at a minimum wide region area level covering a significant number of PSAPs across a provider's coverage area, rather than at a PSAP-specific level.⁷⁷ This will help make vertical location implementation more efficient, and give PSAPs the further incentives to coordinate and pool

⁷⁴ See *FNPRM* ¶ 76.

⁷⁵ See 47 C.F.R. §§ (d)-(e) and (j)(1)-(2).

⁷⁶ See *id.* §§ 20.18(d)-(g).

⁷⁷ See *FNPRM* ¶ 80.

their resources in anticipation of NG911. For these reasons, in addition to a population-based deployment benchmark, any vertical location rule should include a PSAP readiness condition as well that is reflective of the higher costs of vertical location capability.

D. Per-County or Per-PSAP Measurements Are Flawed.

The proposed rule would apply the existing requirement that outdoor accuracy be measured at either a county- or PSAP-level to indoor location accuracy, even as it acknowledges that this “may be difficult to verify if testing is performed within a more geographically constrained test bed”⁷⁸ County- or PSAP-level testing and performance, however, is not feasible without different test bed parameters for each county or PSAP. The proposed rule would thus defeat the purpose and promised efficiencies of a test bed in the first place.

The use of a valid test bed approach to determine a solution’s ability to meet a new location accuracy standard obviates the need for a county- or PSAP-level testing regime. The Commission’s objective should instead be ensuring that the test bed environments are representative of service providers’ diverse topology and architectures, and that vendors’ products themselves are representative of what service providers would incorporate into their networks and handsets. CSRIC IV Working Group 1 expects to issue findings and recommendations on its test bed methodology next month, which Verizon believes will meet these criteria, and the Alliance for Telecommunications Industry Solutions Emergency Services Interconnection Forum (“ATIS/ESIF”) is separately working on a test bed standard. The Commission should encourage these consensus-driven efforts to proceed in a manner that enables stakeholders to use the test bed as Verizon recommends here.

⁷⁸ *Id.* ¶ 110.

V. E911 DELIVERY PERFORMANCE RULES ARE UNNECESSARY.

The *FNPRM* proposes several new or modified E911 performance requirements that would apply to both its existing outdoor location measurements and its proposed indoor requirements. Some of these proposals appear to stem from the record generated in response to concerns raised last year by the California Chapter of the National Emergency Number Association (“CALNENA”).⁷⁹ Many of these concerns, however, resulted from misinterpretations and misrepresentations about 911 call data and have been largely addressed.⁸⁰ Other proposals have been the subject of ongoing discussion among service providers and PSAPs. New rules in this area are thus not warranted.

A. Any Timing Delivery Standards Should Apply Separate from Location Accuracy Measurement Criteria.

Verizon agrees that timely delivery of E911 location data has important public safety benefits and, to that end, has previously demonstrated the concrete steps that it has taken to improve delivery timing standards with respect to its legacy CDMA network.⁸¹ These include improving the sensitivity of the A-GPS chipset (so it can obtain an initial GPS location fix in more challenging locations) and ensuring that the cell data used for location calculation within Verizon Wireless’s control that can influence the speed and accuracy of Phase II location information are as accurate and up-to-date as possible. This work has significantly improved the

⁷⁹ See Letter from Danita L. Crombach, CALNENA, to Chairwoman Mignon Clyburn *et al.*, PS Docket No. 07-114 (Aug. 12, 2013) (“CALNENA Report”).

⁸⁰ See Letter from Nneka Ezenwa Chiazor, Verizon, to Marlene Dortch, FCC, PS Docket No. 07-114 (Nov. 14, 2013) (“Verizon Rebuttal Letter”); and Letter from Nneka Ezenwa Chiazor, Verizon, to Marlene Dortch, FCC, PS Docket No. 07-114 (Nov. 15, 2013) (“Verizon Further Rebuttal Letter” (rebutting inaccurate and misleading claims of the Find Me 911 Coalition and TruePosition).

⁸¹ See Verizon Wireless Presentation at E911 Phase II Location Workshop, at 5 (Nov. 18, 2013) at <http://www.fcc.gov/events/workshop-e911-phase-ii-location-accuracy>.

ability to obtain a Phase II fix in most locations and decreased the time it takes to make the initial location fix available to PSAPs.

The *FNPRM* also, however, appropriately recognizes the trade-off between accuracy and latency.⁸² As with location accuracy, improving the timing of delivery of 911 calls involves many complex technical, engineering and PSAP operational considerations that are not necessarily related to the accuracy performance of a particular E911 solution. Given these complexities, service providers and PSAPs should develop practices to coordinate and better communicate concerns related to call delivery.⁸³ Moreover, conflating whether location information is provided and the time it takes for the information to be provided makes no sense from a technical perspective. Latency is more often than not a function of the RF environment in which the particular solution operates, not the effectiveness of the solution. Where a PSAP is concerned about a drop in Phase II versus Phase I fixes it receives from a service provider, it is more likely to reflect a performance issue unrelated to location accuracy, and service providers should resolve those matters on an individual PSAP basis. For these reasons, any delivery timing standards should be decoupled from location accuracy standards.

Specifically, the 30-second time limit should not be incorporated into the accuracy measurement parameters as proposed.⁸⁴ Doing so could have implications for the statements in the *FNPRM* concerning the technical feasibility of the proposed standards, which are premised largely on limited CSRIC III test bed performance that was not tied to live wireless networks.⁸⁵ If delivery timing monitoring is required, it should apply independently of the location accuracy

⁸² *FNPRM* ¶ 143.

⁸³ *See id.* ¶ 149 (seeking comment on potential voluntary measures).

⁸⁴ *See id.* ¶ 144.

⁸⁵ *See* Working Group 3 Report at 14.

requirements. Consistent with current industry practices and the CSRIC III test bed methodology, it is enough that delivery timing data be separately maintained so that PSAPs can be informed how providers' solutions perform in different environments so that they can calibrate their training and operational practices accordingly.

Should the Commission proceed with rules that combine accuracy with delivery timing, however, they must be technically feasible and afford adequate time to comply and distinguish between outdoor and indoor calls. Application of a delivery timing rule to indoor 911 calls would be counterproductive as industry, solution vendors and PSAPs should principally be focusing their efforts on improving accuracy of location information on indoor calls. Moreover, if the Commission were to proceed with timing restrictions on indoor calls, any wireless provider implementation deadlines should not be triggered until a sufficient number of solution vendors demonstrate that their commercially available products meet a delivery timing mandate.⁸⁶ Verizon also agrees that calls without a location fix that are dropped or disconnected within a minimum 10 seconds after the user hits "send" should be excluded from any timing analysis. Finally, for the reasons discussed previously in this proceeding, delivery of Phase II data should be measured based on delivery to the Mobile Positioning Center or functional equivalent, consistent with Commission precedent and industry standards.⁸⁷

B. New Standards for Confidence/Uncertainty Data Require PSAP Consensus and Are Appropriately Left to Service Provider-PSAP Arrangements.

Verizon agrees that there may be value in PSAPs using a uniform confidence level, as the *FNPRM* proposes.⁸⁸ But service providers' practices regarding the transmission of

⁸⁶ *See supra* Section IV.A.

⁸⁷ *See* Verizon CALNENA Response at 1-6.

⁸⁸ *FNPRM* ¶¶ 155-56.

confidence/uncertainty data are appropriately left to standards or best practices at this point, as the PSAP community itself needs to determine what approach makes sense from its perspective. Importantly, a high 90-95% level is not self-evidently more useful for PSAPs, as a lower confidence setting results in a *smaller* uncertainty circle around the latitude/longitude fix – thereby giving first responders a more precise area in which to work and prioritize their resources.

C. Best Practices Should Govern Standards for Identifying the Service Provider’s E911 Technology to the PSAP.

The *FNPRM* seeks comment on whether or in what manner wireless providers should deliver information to the PSAP regarding the Phase II technology that generated the call-specific location information.⁸⁹ This too is a more appropriate subject for standards or best practices as between service providers and public safety stakeholders, given rapidly evolving wireless technology. Improvements in location resulting small cells, for example, could quickly render any new regulatory obligations outdated, as a “Phase I” fix for a small cell could potentially be more accurate than even a good GPS location fix.⁹⁰

Should the Commission adopt rules, however, they must be consistent across service providers. Verizon, for example, will only identify GPS, hybrid, and AFLT as “Phase II” calls, and plans a similar approach for VoLTE. In contrast, Verizon identifies 911 calls that use less accurate techniques as “Phase I.”⁹¹ Verizon has always disclosed these facts to PSAPs, who have uniformly approved of its approach. The Commission should ensure that any requirements

⁸⁹ *Id.* ¶¶ 161-62.

⁹⁰ *See id.* ¶¶ 124-26.

⁹¹ *See* Verizon Workshop Presentation at 2; Verizon Rebuttal Letter, at 3.

concerning yield, location accuracy calculations or delivery timing do not have the effect of penalizing Verizon and other providers that take a similar approach.

D. A Unitary Outdoor Location Accuracy Standard Makes Sense.

Verizon has long supported moving to a uniform standard for outdoor 911 calls.⁹² As service providers uniformly migrate to A-GPS for legacy networks and LTE-based technologies using A-GNSS solutions (combining GPS, GLONASS), as well as O-TDOA over the next few years, this will become more feasible for outdoor location accuracy.⁹³ This policy would help fulfill longstanding Commission objectives to make its E911 rules more technology- and competitively-neutral. It is premature, however, to suggest a unitary requirement for both outdoor *and* indoor calls, given the absence of industry and public safety experience with indoor location accuracy requirements or standards.⁹⁴

VI. BURDENSOME REPORTING AND DISCLOSURE STANDARDS ARE UNNECESSARY.

The *FNPRM* seeks comment on a number of issues concerning testing and monitoring with location accuracy and 911 call delivery requirements. In Verizon's experience, performance issues that arise with individual PSAPs are most effectively resolved on an informal case-by-case basis, so new testing and reporting requirements are generally unnecessary. In any event, disclosure of carrier-specific data should be subject to strict confidentiality protections.

⁹² See Comments of Verizon and Verizon Wireless, PS Docket No. 07-114, WC Docket No. 05-196, at 1-4 (Jan. 19, 2011).

⁹³ See *FNPRM* ¶ 164.

⁹⁴ See *id.* ¶ 166.

A. Ongoing Indoor Testing Is Unnecessary Under a Test Bed Framework.

As explained above, Verizon's recommended test bed approach obviates any need for a burdensome, intrusive testing regime for indoor accuracy.⁹⁵ While the *FNPRM* posits that material upgrades to networks and handsets may warrant further testing, by definition the use of a test bed would not entail testing of the new or modified network component in question.⁹⁶ Moreover, Verizon already tests the 911 functionalities of its networks after significant changes in accordance with existing best practices,⁹⁷ and rules that micromanage those processes are unnecessary.

The better approach is to allow vendors to continue to use the test bed as they update their products so that wireless providers are aware that newly available compliant releases of the vendor's product are available for deployment. Nothing precludes PSAPs from conducting their own tests at their own expense.⁹⁸ But in order to save Commission, service provider and PSAP resources alike, a PSAP that believes it is experiencing degraded performance in its area should first bring its concerns to the service provider before lodging an informal complaint with the Commission, so that the provider has an opportunity to work in good faith to timely address it.⁹⁹ And in all cases a provider's deployment and maintenance of a test bed-approved solution that has representative topologies to those in county and PSAP jurisdictions within its coverage area, consistent with the vendor's test bed parameters, should be deemed compliant.

⁹⁵ *Id.* ¶ 100.

⁹⁶ *Id.*

⁹⁷ See ATIS/ESIF, *Maintenance Testing*, ATIS-0500010 (Feb. 2007) (requirements and testing procedures needed to perform maintenance testing for accuracy and end-to-end functionality in wireless E9-1-1 Phase 1 or Phase 2 systems).

⁹⁸ *FNPRM* ¶ 101.

⁹⁹ See *id.* ¶ 171.

B. Disclosure of Outdoor Test Data Should Be Limited to Aggregate Data.

The *FNPRM* seeks comment on what outdoor test data should be provided to the Commission and PSAPs.¹⁰⁰ The purpose of any disclosure regime should be to ensure that the E911 location system is functioning as intended and that the service provider has diligently worked to maintain that level of performance. Thus, any data should be limited to the aggregate summary test results for a particular county or PSAP sufficient to show performance consistent with the rules. If the Commission has concerns then it can always request additional data in a manner that ensures proprietary information is afforded confidential treatment. But it is unnecessary to provide more granular data to individual PSAPs.

To the extent that outdoor testing requirements are imposed, then testing every 2-3 years is adequate.¹⁰¹ A PSAP that believes it is experiencing degraded performance in the interim should always approach the carrier first with documentation of its concerns so that the provider can examine the issue and work in good faith to timely address it. PSAPs that complain to the Commission before taking these reasonable efforts should have their complaints referred to a designated point of contact with the service provider. This approach will enable PSAPs and service providers to work through these issues collaboratively in a non-adversarial manner, and help minimize the type of unnecessary misunderstandings between service providers and PSAPs that arose in the wake of the CALNENA Report.

¹⁰⁰ See *id.* ¶¶ 171-81.

¹⁰¹ See *id.* ¶ 179.

C. The Commission Should Limit Disclosure of Test/Performance Data to Itself and Individual PSAPs Subject to Confidentiality Protections.

The *FNPRM* seeks comment on the extent to which any rules should afford various types of E911 test data confidential protection.¹⁰² Under Verizon's recommended indoor location accuracy framework, PSAPs should know that an individual service provider has implemented a particular vendor's test bed-compliant solution, and how it performed in particular environments. Public disclosure of such data creates a significant risk of customer confusion, as a particular customer may reside or work in a particularly challenging RF environment, and it would be difficult (if not impossible) to meaningfully convey that fact, whether through simplified but generalized data or mountains of statistics.¹⁰³

Any carrier-specific data the Commission has gathered for monitoring purposes, moreover, should not be disclosed except subject to a protective order or similar arrangement. With respect to outdoor location data, any data subject to disclosure should be provided to the Commission subject to a Protective Order or similar arrangement to which designated PSAP personnel alone would have access, not individual consumers. Moreover, providers should have the option of disclosing the information to those designated PSAP personnel through an online portal.

D. The Commission Should Not Require that Wireless Providers Report or Disclose 911 Call Tracking Data.

The *FNPRM* asks whether wireless providers should report 911 call tracking data similar to the state- and PSAP-specific data posted online in advance of the Public Safety and Homeland

¹⁰² *See id.* ¶ 181.

¹⁰³ *See Comments of Verizon and Verizon Wireless, GN Docket No. 11-117, PS Docket No. 07-114, WC Docket No. 05-196, at 28 (Oct. 3, 2011).*

Security Bureau's November 2013 workshop.¹⁰⁴ As Verizon discussed in the record, much of this data was misinterpreted and publicly misrepresented in a number of ways.¹⁰⁵ Verizon has nonetheless engaged in discussions with public safety stakeholders in recent months to help evaluate 911 call data for a number of jurisdictions. Based on these discussions, this data can be somewhat helpful in evaluating or troubleshooting delivery issues associated with particular PSAPs, or in assessing if a location solution faces particular topology and RF challenges in a particular geographic area. But public safety stakeholders themselves are not unanimous in how PSAPs and wireless providers can use that data to improve service, or even what data is most relevant to individual PSAPs. The Commission should instead allow service providers and public safety stakeholders to determine collaboratively how best to use (and not misuse) that data. No additional recordkeeping and disclosure costs should be imposed on service providers.

Respectfully submitted,

/s/ Robert G. Morse

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May 12, 2014

¹⁰⁴ See FNPRM ¶¶ 169-70.

¹⁰⁵ See Verizon Rebuttal Letter; Verizon Further Rebuttal Letter.

APPENDIX

Declaration of Richard A. Craig

Comments of Verizon and Verizon Wireless, Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114 (May 12, 2014)

DECLARATION OF RICHARD A. CRAIG

1. I am Director – Engineering and Operations Support for Verizon Wireless, a position I have held since January of 1999. In that capacity I have oversight responsibility for the planning, design and construction of network infrastructure projects in support of Verizon Wireless national networks, including the nation’s largest 4G LTE Network and Verizon Wireless’s legacy 1X CDMA network. Prior to that, I was director of Network Engineering for Verizon Wireless, where I was responsible for network administration, design and construction of Verizon Wireless networks in the greater New York Metro area. In my 18 years with Verizon Wireless and its predecessor companies, I have held positions in network engineering and compliance.

2. My responsibilities currently include Verizon Wireless’s ongoing compliance with the Commission’s enhanced 911 (“E911”) location accuracy requirements and monitoring the performance of its E911 location technology. Together with other organizations within Verizon, my responsibilities also include the selection and deployment of future E911 location technology.

3. I have reviewed the Commission’s proposed rules for indoor horizontal and vertical accuracy as well as the attached Comments of Verizon and Verizon Wireless. Based on my experience and that of other subject matter experts within Verizon and Verizon Wireless, I agree with the Comments that compliance with the proposed performance requirements and deadlines would be technically infeasible for Verizon Wireless at this time.

4. Wireless location technologies used today and under development for E911 location, including the Global Positioning Satellite (“GPS”) and Advanced Forward Link Trilateration (“AFLT”) techniques used for Verizon Wireless’s assisted-GPS (“A-GPS”)

solution, the GLONASS and O-TDOA techniques it plans to use for Voice over LTE (“VoLTE”), the network-based techniques like U-TDOA and RF fingerprinting that GSM-based wireless providers initially used for E911 Phase II compliance, and the Metropolitan Beacon System (“MBS”) technologies under development by vendors, all utilize radiofrequency (“RF”) based techniques to estimate the 911 caller’s location via a latitude/longitude coordinate. They do not enable a wireless provider to inform a PSAP of the actual address from which a 911 call originates, like a wireline ALI database lookup or an updated VoIP registered location.

5. While some of these technologies derive more accurate location estimates in particular environments, *all* are dependent on a solution’s ability to communicate with the 911 caller’s handset via as many RF points of reference as possible, nearly all of which will originate outdoors. Each solution is therefore subject to the vagaries of RF propagation, network-based factors such as cell site density, geometry, and line of sight between the fixed network or satellite and the handset. And these factors are far more pronounced for indoor 911 calls than for outdoor 911 calls. For example, the ability of radio signals to penetrate in-building environments depends on the building’s materials, transmitters’ power levels, the cell site’s distance from and the user’s location within the building, and the bandwidth and frequency of the spectrum involved.

6. The Commission now proposes the same horizontal accuracy level based on indoor measurements – 50m/67% – within 2 years, up to 50m/80% within 5 years, on a per-PSAP or per-county basis, with compliance measured based on all of a wireless provider’s network technologies. I conclude that it is technically infeasible for Verizon Wireless to deploy a solution that meets 50m/67% benchmark for horizontal accuracy throughout Verizon Wireless’s coverage area and wireless networks within 2 years.

7. The minimum conditions needed to achieve a 50m/67% accuracy level indoors would require that: (1) compliance is measured exclusively using the E911 solution developed for VoLTE and based on calls over VoLTE-equipped handsets via LTE spectrum and architecture; (2) compliance is measured on a test bed environment, not a per-county or per-PSAP level; and (3) even when compliance is measured exclusively based on VoLTE, Verizon Wireless is afforded sufficient time after vendors have a commercially available standards-compliant solution that meets any Commission-mandated accuracy thresholds at all test points in a CSRIC-style test bed, to deploy the solution throughout its entire coverage area. While each is necessary (but not sufficient) for Verizon Wireless to meet the proposed standard, none are reflected in the proposed rules.

8. The performance of the A-GPS solution used for Verizon Wireless's CDMA network also does not indicate that Verizon Wireless can meet a 50m/67% accuracy level for indoor 911 calls on that network. In general, A-GPS works as follows: it first attempts to generate a pure GPS location fix using data from multiple satellites, which provides the most accurate location; if a sufficient number of GPS satellites are not in sight, it uses a combination ("hybrid") of GPS and AFLT to locate the caller; a pure AFLT fix is used as the final fallback; and if these Phase II mechanisms do not produce a location that is sufficiently accurate, Verizon Wireless will make Phase I location information available to the PSAP as the default.

9. Verizon Wireless complies with the current outdoor 50m/67% benchmark in all counties for CDMA by using this technology. To achieve compliance, Verizon Wireless has incorporated many network and handset changes that have improved Phase II accuracy for its CDMA network, such as increasing the sensitivity of the GPS chipset in the handset, which can enable a handset to "see" more GPS satellites, and thus improve the likelihood of a "pure GPS"

location fix. In addition, Verizon Wireless has established a feedback loop that analyzes actual 911 calls and produces key performance metrics that helps ensure that underlying RF data is updated timely and calibrated for peak accuracy. As a result, Verizon Wireless' outdoor 911 Phase II yield has increased by 28% over the last 14 years. These efforts also have resulted in performance improvements for indoor accuracy in certain environments that GPS signals can penetrate or where multiple cell sites can improve AFLT's functionality.

10. Using the CSRIC test bed results as a baseline, however, the indoor performance of A-GPS for CDMA networks indicates that compliance with the proposed rule would be infeasible via Verizon Wireless's CDMA network. For the reasons discussed above, improvements in indoor location accuracy will necessarily be far more dependent on the terrestrial network component of A-GPS and the successor O-TDOA technology to be used for VoLTE. The AFLT fix will not be as accurate as a GPS-only or hybrid fix. The potential improvements to indoor location accuracy resulting from O-TDOA are dependent on LTE networks, and thus will be available for 911 calls made via VoLTE rather than CDMA. Verizon Wireless has reviewed historical accuracy data from several of the urban counties in its coverage area where indoor location accuracy challenges would be particularly acute. Since 2008 Verizon Wireless has been able to improve the accuracy of the GPS component of its A-GPS solution in those counties by, at most, a few (low-single digits) percentage point for outdoor calls. Achieving a 50m/67% standard would require approximately an 80% improvement over the A-GPS's aggregate CSRIC test bed performance of approximately 250m/67%. Given Verizon Wireless's experience with A-GPS, and that improvements would be dependent on enhancements to AFLT due to challenges for GPS indoors, compliance is not technically feasible within two or five years for Verizon Wireless's CDMA network.

11. Compliance is also not feasible with respect to VoLTE alone, or when combining VoLTE and CDMA. Verizon Wireless is actively testing the performance of O-TDOA in its network, which is a principal capability that will improve indoor location accuracy performance for 911 calls made via VoLTE in the near term. Preliminary testing indicates that this technology has considerable promise, but more improvement would be needed to meet the 50m/67% level indoors across all representative indoor environments. Based on information from vendors at this time and our experience with improving A-GPS, Verizon Wireless estimates that O-TDOA could result in approximately a 20% improvement in accuracy over current AFLT performance as applied to 911 calls over VoLTE handsets and networks over a few years. The potential 20% improvement in indoor accuracy over the baseline CSRIC test bed results, however, would result in only an overall 200m/67% accuracy level. Thus, compliance with the proposed rule for VoLTE alone is technically infeasible, and the improvements over A-GPS that VoLTE will enable will not offset the performance of A-GPS sufficient to comply with the proposed rule.

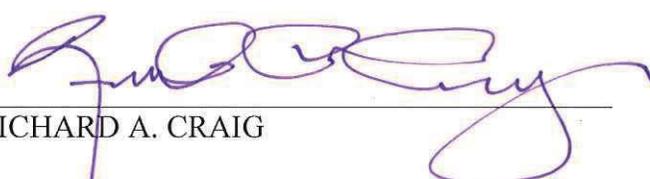
12. NextNav's solution also would not enable Verizon Wireless to achieve compliance with the proposed indoor horizontal accuracy rules. The version used at the CSRIC test bed was not commercially available; NextNav used a sleeve-based receiver that was attached to a handset via a USB interface. It requires substantial standards and product development before it can be commercially available, but the necessary 3GPP LTE standards, are not targeted for completion until December 2015. After that, vendors would need to develop and manufacture VoLTE products built to the standards and the accuracy requirements, a process which typically takes 18-24 months. At least another year will be needed for laboratory, field, IOT testing and related activity, only after which a service provider could begin deployment in

its network. Given the tens of thousands of MBS beacons needed to achieve density levels comparable to the CSRIC test bed, completion of deployment nationwide throughout Verizon Wireless' coverage area could take years. Finally, several complex modifications would be necessary to the handset and chipset, including a barometric pressure sensor (for the vertical location calculation).

13. NextNav's solution is also dependent upon its own deployment of MBS networks, which would require deployment of beacon antennas locally across Verizon Wireless's coverage area and their integration into the Verizon Wireless network. And it is uncertain whether handsets with the necessary handset capabilities will be available concurrently with the network-level capabilities. Given these contingencies, it would not be possible to deploy and initiate service using NextNav's emerging technology throughout Verizon Wireless' entire coverage area within the proposed two- and five-year periods for horizontal accuracy.

14. The Commission also proposes that wireless providers deliver vertical accuracy based on indoor measurements of 3m/67% within 3 years, and 3m/80% within 5 years. Verizon Wireless is actively evaluating further enhancements in barometric altitude sensors, but this and other solutions require further standards development, testing for public safety grade reliability, and development of new database resources of commercial LBS data and compatibility with public safety systems. These benchmarks are not technically feasible for largely the same reasons that the proposed horizontal accuracy rules are not, and feasibility would be subject to the same minimal conditions described at paragraph 7.

15. The vertical location capabilities of NextNav's emerging MBS technology were tested at the CSRIC test bed, but as noted above, that technology was not commercially available. Further, there are additional contingencies for NextNav's vertical solution that are not present for horizontal. In addition to all of the steps described above, to provide vertical location the handset requires a barometric pressure sensor and significant network integration efforts will be needed. Again, all these steps require further standards development, which has not yet begun, followed by integration and production by equipment manufacturers, and network integration, with testing throughout. And it is uncertain whether handsets with the necessary handset capabilities will be available concurrently with the network-level capabilities. Finally, vertical location requires additional capabilities at the PSAP level, including incorporating building schematics into their mapping systems for the PSAP's area. Given these contingencies and its dependence on the stand-alone terrestrial beacon infrastructure, it would not be possible to deploy NextNav's solution throughout Verizon Wireless's coverage area or begin delivering vertical location to PSAPs within the proposed three- and five-year periods.



RICHARD A. CRAIG

May 12, 2014