

**BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of

Wireless E911 Location Accuracy
Requirements

PS Docket No. 07-114

**T-MOBILE USA, INC. COMMENTS ON
THIRD FNPRM ON LOCATION ACCURACY**

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May 12, 2014

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I. INTRODUCTION AND SUMMARY

T-Mobile USA, Inc.¹ (“T-Mobile”) believes that continued work regarding Enhanced 911 (“E911”) capabilities is critical to ensuring that wireless customers continue to have access to the best possible location technology in the event of an emergency. And T-Mobile stands second to none in its commitment to the safety of our customers. Just as we have aggressively thought outside the box to remove consumer pain points for wireless service, we have also worked with and are ready to continue to work with the Commission, other carriers, public safety, and other important stakeholders—including local governments, premises owners, technology developers, and manufacturers—to think creatively about the challenges associated with generating location estimates indoors. A creative and inclusive approach is important for all improvements to location accuracy, but it is particularly critical with respect to the Commission’s stated goal of ensuring that public safety is provided with a truly “actionable location” for wireless 911 calls placed from inside large multiunit and multistory buildings.² That type of creative solution is not yet on the table.

The plain fact is that, while wireless carriers can continue to make incremental improvements, they cannot by themselves deliver fully “actionable” horizontal and vertical indoor location estimates; when limited to technologies that wireless carriers can incorporate in their networks or handsets, a wireless carrier can only generate estimated center coordinates for a two- or, in some instances, three-dimensional probabilistic search radius. Put more simply, regardless of whether the proposed new accuracy standards are adopted, if the Commission and public safety rely solely on wireless carriers to provide location information, it will always be

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

² *Wireless E911 Location Accuracy Requirements*, Third Further Notice of Proposed Rulemaking, FCC 14-13, 29 FCC Rcd. 2374 (2014) (“*Third FNPRM*”).

possible that the caller is on some other floor or in a different building. To attain truly actionable indoor locations requires buy-in and development from all stakeholders—not just wireless carriers, but also public safety, handset manufacturers, location technology vendors, mobile operating system providers, state and local governments who regulate building codes, and, perhaps most critically, premises owners. “Smart buildings” should be more than just wired—they should also be capable of providing actionable locations to any mobile device (including Wi-Fi-only devices).

In the nearer term, T-Mobile understands that public safety continues to be concerned about the provision of more accurate indoor (and outdoor) location estimate information—as is T-Mobile. T-Mobile is working both on its own and as part of the FCC’s Communications, Security, Reliability and Interoperability Council (“CSRIC”) and the Alliance for Telecommunications Industry Solutions’ (“ATIS”) Emergency Services Interconnection Forum (“ESIF”) to explore new technological solutions that promise to narrow the search radius that T-Mobile reports. This includes moving to integrate into handsets additional satellite constellations (*i.e.*, GLONASS, another Global Navigation Satellite System (“GNSS”)) to complement the Global Positioning System (“GPS”) constellation, and Observed Time Difference of Arrival (“OTDOA”) to improve location accuracy when GNSS systems cannot provide a high accuracy location estimate on their own. Other technologies of interest are maturing to the point of nearing readiness for consideration, such as Wi-Fi-based location methods, currently used exclusively for commercial location-based services (“cLBS”). Furthermore, when T-Mobile implements voice-over-Long Term Evolution (“VoLTE”), it will gain the ability to run multiple location technologies simultaneously, rather than sequentially, improving its ability to deliver highly accurate location estimates within a given latency limit.

When implemented, these measures will improve what is already a high level of performance. Wireless 911 and E911 are working well to enable people to place millions of 911 calls every year. Today, T-Mobile is able to provide a Phase II location estimate for at least 90 percent of wireless 911 calls made on its network—including calls made from indoors. If three-quarters of wireless 911 calls are made from indoors, as some have speculated, and T-Mobile is able to provide an Assisted GPS (“A-GPS”) fix for 77 percent of E911 calls from its subscribers, it follows that at least two-thirds of all of T-Mobile’s indoor wireless 911 calls of more than 30 seconds in length are getting position fixes based on A-GPS.³ And T-Mobile’s A-GPS yield and accuracy performance continues to improve over time. Moreover, T-Mobile delivers uncertainty estimates at a 90 percent confidence level—the level public safety requested through ESIF best-practice recommendations—to any Public Safety Answering Point (“PSAP”) that wants it. That uncertainty and confidence information allows a PSAP to ascertain—irrespective of underlying location technology—whether it is getting an estimate that is likely to be highly accurate, or one with a broader potential range of error.

Even when these emerging technologies are fully implemented, though, they will not enable carriers to meet the Commission’s proposed new horizontal indoor accuracy requirements of 50 meters for 67 percent of calls within two years and 50 meters for 80 percent of calls within five years. Once such solutions are market-ready—which is not presently the case—they will need to be incorporated into standards and deployed throughout the network as well as, for any handset-based solutions, into handsets. Even if these solutions were ready for commercial deployment today, unless the Commission is going to require every wireless consumer to turn in their phones and buy new ones, it will take years for consumers to exchange their old handsets

³ Letter from John T. Nakahata, Counsel to T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114 (filed Nov. 18, 2013).

for new ones with additional location capabilities.⁴ How many years this subscriber handset change-out process takes is impossible to accurately predict and is only partially influenced by wireless carriers. T-Mobile notes that the handset change-out during the initial implementation of Phase II took far longer than expected; that experience should inform any realistic evaluation of the time frame for consumer adoption of new devices.

This is also true with respect to the Commission's proposed vertical indoor location accuracy requirement of 3 meters for 67 percent of calls within three years, and 3 meters for 80 percent of calls within five years. If barometric pressure sensors turn out to be necessary for the provision of vertical location estimates, a wireless carrier would only be able to attempt to comply with such a mandate after its customers change out their current handsets for ones with barometric pressure sensors, as very few handset models currently have pressure sensor capability. But the use of barometric pressure sensors to measure altitude has only begun to be tested rigorously, and already studies indicate that it is highly unlikely that these sensors will be capable of providing accurate estimates of actual altitude, absent the placement of reference sensors in every multistory building.

The Administrative Procedure Act does not permit the Commission to take an "if we mandate it, they will invent it" approach. Technical and economic feasibility are "made necessary by the bar against arbitrary and capricious decision-making,"⁵ and "[i]mpossible

⁴ Indeed, the Commission's recent announcement of the voluntary commitment among AT&T, Sprint, T-Mobile, U.S. Cellular, and Verizon Wireless regarding handset unlocking is likely to lead to greater handset retention by consumers, potentially making the handset exchange cycle longer. See Letter from Steve Largent, President/CEO, CTIA, to Thomas E. Wheeler, Chairman, FCC, et al (Dec. 12, 2013), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-324664A1.pdf.

⁵ *Nuvio Corp. v. FCC*, 473 F.3d 302, 303 (D.C. Cir. 2006).

requirements imposed by an agency are perforce unreasonable.”⁶ Congress has not given the Commission the authority to promulgate rules that force carriers to develop and adopt technologies that are not proven to be feasible, and for which there is no record evidence of that feasibility.⁷ The Commission should, in the near term, call for the establishment of an expedited test bed to explore location technologies of high interest, such as OTDOA, the use of additional satellite constellations, and even Wi-Fi-based location technologies, following the model that CSRIC III used. In the longer term, the Commission should also support the creation of a permanent indoor test bed to test new and emerging location technologies. This will allow both a common evaluation of proposed technologies as well as a feasible means for ascertaining compliance.

No matter what, it will take many years—more than the five contemplated in the Commission’s proposed rules—to develop and implement enhanced indoor location technologies in consumers’ handsets. And even with the Commission’s proposed new requirements, at the end of that process public safety will still not have an actionable address, including floor level, for dense urban environments. Rather than just trying to shrink the location estimate circle by a number of meters, it would be much better to end this multiyear transition with an indoor location solution that really meets public safety’s needs and delivers actionable dispatch information. But this can only be accomplished by forging a more creative and effective multi-stakeholder approach, one that looks not only to carriers, technology vendors, mobile operating

⁶ *Alliance for Cannabis Therapeutics v. Drug Enforcement Admin.*, 930 F.2d 936, 940 (D.C. Cir. 1991).

⁷ *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 timetables established by Congress does not mean that courts are at liberty to ignore them, however burdensome the resulting enforcement.”). Congress has enacted no such legislation here.

systems providers, and public safety, but also to state and local governments as well as premises owners.

II. LOCATION ACCURACY IS BEST IMPROVED THROUGH SUPPORT OF INDUSTRY EFFORTS AND MULTI-STAKEHOLDER TESTING.

A. Current and Near-Term Technologies Will Continue to Improve Location Estimates for Wireless 911 Calls.

Wireless E911 continues to improve as carriers and PSAPs work to ensure that wireless calls to 911 are accompanied by the most accurate information possible. This is borne out by reality—for the vast majority of 911 calls, the caller is able to summon the help he or she needs.

Much of the ongoing improvement in wireless location accuracy and yield is due to carrier efforts. As T-Mobile described in 2011, some of these efforts include improving network and handset algorithms and handset GPS receiver sensitivities. As T-Mobile has implemented improvements in its network and handsets, it has seen its A-GPS yield steadily increase—for instance, from 2012 to 2013, it increased from 74 to 77 percent. T-Mobile expects to see continued improvement from ongoing updates to its existing A-GPS deployment.

Improvements in the effectiveness of wireless location information have also resulted from changes in the way PSAPs process 911 calls. For instance, after CalNENA submitted information to the Commission last summer suggesting a marked drop-off in Phase II information,⁸ it became clear that the relevant PSAPs—and many other PSAPs nationwide—were not following the Association of Public Safety Communications Officials International (“APCO”) best practices and rebidding for updated location information.⁹ Those PSAPs that

⁸ See Letter from Danita L. Crombach, ENP, CalNENA, to Mignon Clyburn, Chairwoman, FCC, PS Docket No. 07-114, at 3-4 (filed Aug. 12, 2013).

⁹ 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; Letter from Steve

have adopted policies calling for rebidding at appropriate intervals—or that follow recommended processes for automatic rebidding—see higher Phase II yields at the PSAP¹⁰ and a subsequent increase in perceived location accuracy.¹¹

Additional improvement to wireless location is on the horizon, as well. New satellite constellations (*i.e.*, GLONASS) are being integrated into carrier networks, and carriers are working to ensure that their handsets can communicate with those satellites, which will allow them to provide more accurate and higher yield satellite-based location fixes. Other technologies, like OTDOA, are coming to market and will be deployed soon. Indeed, T-Mobile has committed financial and personnel resources to implementation of OTDOA throughout its network and is currently actively working to deploy it, even without a mandate. And carriers continue to explore the possibility of leveraging commercial location services that are already available on many handsets. Each of these emerging location technologies hold promise to further improve automatic location information, including indoors—but each needs careful evaluation and testing through the CSRIC test bed methodology before specific performance standards are established.

Largent, President/CEO, CTIA, to Tom Wheeler, Chairman, FCC, PS Docket No. 07-114 (filed Dec. 5, 2013) (“Dec. 5, 2013 CTIA Letter”).

¹⁰ See Dec. 5, 2013 CTIA Letter; Letter from Marlys Davis, King County E-9-1-1 Program Office, to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114 (filed Sept. 25, 2013); Letter from Stan Heffernan, Chief Operations Officer, Greater Harris County Emergency Network, to David Siehl, Public Safety and Homeland Security Bureau, FCC (Sept. 16, 2013), *available at* <http://transition.fcc.gov/bureaus/pshs/911/Phase%202/TX/Greater%20Harris%20Co%20TX%20FCC%20WPH2%20Letter%20091613.pdf>.

¹¹ T-Mobile reiterates that it develops Phase II location information for the vast majority of calls of sufficient duration to allow a location fix to be calculated. The PSAP must request that location fix, however, and if it does not, the PSAP may perceive a lower Phase II yield than is actually available. Current signaling standards do not allow a wireless carrier to “push” location information to the PSAP.

B. The Commission Should Move to Establish a Permanent Indoor Test Bed and Rely on CSRIC’s Recommendations Regarding New and Emerging Location Technologies.

T-Mobile and other stakeholders have repeatedly called for the establishment of a permanent indoor test bed that will allow for investigation of new and emerging location technologies.¹² It is critical that all stakeholders have the opportunity to evaluate technologies that have the potential to improve wireless E911 location accuracy in a common, standardized, independently-run environment. In other words, the use of a single test bed to which all location vendors submit their technologies for evaluation will provide a real apples-to-apples comparison in regards to truly viable solutions. T-Mobile is willing to shoulder its share of supporting the expedited creation and operation of such a test bed, provided that other national carriers and relevant stakeholders do likewise.

In the near term, T-Mobile also supports expediting the establishment of a targeted test bed to evaluate technologies of current high interest—specifically, those technologies that were not available for testing in the CSRIC III test bed.¹³ Those technologies include emerging LTE technologies like OTDOA, which holds a great deal of promise, as well as the newly available GLONASS satellite constellation that, when integrated into handsets, is expected to complement A-GPS, thus improving location accuracy and yield. These important technological advancements are already standardized and committed for deployment by national carriers but—

¹² Comments of T-Mobile USA, Inc., PS Docket No. 07-114, at 27-28 (Sept. 25, 2013) (“T-Mobile Comments on Location Accuracy Workshop”).

¹³ See The Communications Security, Reliability, and Interoperability Council III, Working Group 3, Indoor Location Test Bed Report at 55 (2013) (“CSRIC III WG3 Report”) (noting four technologies that expressed interest but did not participate in the Stage 1 test bed, and three additional technologies that were not available in the Stage 1 timeframe but that are good candidates for the next stage).

very importantly—have yet to be evaluated in a common test bed to determine real-world performance in a variety of indoor environments.

The addition of Wi-Fi-based location information currently utilized for cLBS is also an important technology that carriers and other stakeholders may be able to leverage to improve E911 location accuracy. These technologies should also be tested in a common, independently run test bed, allowing stakeholders as well as the Commission to determine what truly is technically and economically feasible.

T-Mobile believes that a test bed targeted for these specific technologies of high interest could be established in an expeditious manner, with the full backing and support of the Commission, other wireless carriers, public safety, and other relevant stakeholders (including location technology vendors, mobile operating system providers, and others). The methodology that was developed and successfully implemented by CSRIC III could be followed, with oversight from a technical advisory group made up of the various stakeholders involved in the process (as was done for the CSRIC III test bed effort).

The establishment of a permanent test bed will further allow for ongoing testing of new and emerging technologies, rather than providing only a snapshot in time of available technologies. The ability to compare a new candidate technology against existing technologies in a standardized environment will allow stakeholders to develop reasonable expectations for near- and long-term location accuracy. This will enable carriers, handset manufacturers, vendors, public safety, and the Commission to make informed choices.

III. TECHNICAL AND ECONOMIC FEASIBILITY AS WELL AS PUBLIC SAFETY’S NEED FOR “TRULY ACTIONABLE” LOCATION INFORMATION MUST GUIDE THE COMMISSION’S DECISIONMAKING.

Any new rules adopted for indoor location accuracy must be firmly grounded in technical realities. T-Mobile urges the Commission, therefore, to refrain from imposing new indoor

location accuracy standards until the establishment of an indoor test bed to evaluate emerging location technologies. Only such standardized, common-environment testing can make clear what level of location accuracy performance is feasible. If the Commission chooses to move forward with new rules before the new test bed is established, it must ensure that those rules acknowledge the limitations of the available technologies that were made clear in the CSRIC III test bed.

The currently proposed 50 meter horizontal and 3 meter vertical accuracy benchmarks ignore the CSRIC III test bed results, which clearly demonstrate the difficulties of currently available technologies to meet the proposed benchmarks in challenging environments. In the face of those results, the Commission's proposed rules are simply not achievable—certainly not within the Commission's proposed time frames—particularly given that the Commission has based these benchmarks in part on the test results of a single beacon-based technology that has only been deployed in one metropolitan area and cannot be accessed by any currently or near-term available handset.

Furthermore, the Commission must not forget that, even if carriers can provide such improved location information, it will always be delivered in the form of x, y and, for vertical estimates, z coordinates. Such three-dimensional indoor location information is likely to be useless to PSAPs until they upgrade their systems and mapping data to include detailed in-building elevation and floor layout data. Without those upgrades, improved location information—and particularly vertical information—will not benefit a single 911 caller. Buildings vary in the height of their floors, and some floors (such as the first floor) may be significantly taller than others. Accordingly, a wireless carrier cannot tell the PSAP what floor a caller is on simply based on the height above mean sea level, regardless of the underlying

accuracy of the vertical location estimate. And the PSAP upgrades required to translate an estimate of height above mean sea level into an actual estimated floor number are likely to take far longer than the five years proposed by the Commission. In this, the Commission should recall the lengthy implementation period required for widespread adoption of Phase II technology in PSAPs and recognize that PSAPs will continue to be limited in their ability to quickly deploy the necessary upgrades for acceptance and use of vertical location information.

A. The Indoor Location Proposals Ignore the Results of the CSRIC Test Bed.

No technology or combination of technologies deployed by carriers can reach the Commission’s proposed new indoor location accuracy benchmarks, or provide a location so specific that first responders know “what door to kick in.”¹⁴ Though the CSRIC test bed suggests that there are candidate technologies that show promise for improved indoor location accuracy, none of the technologies tested were capable of achieving the benchmarks proposed by the Commission. The Test Bed Report expressly found that “[w]hile 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.”¹⁵ Indeed, in the CSRIC test bed, even the best-performing technologies could not reliably place calls in the right buildings, with only about a third of the fixes provided by the most accurate location technologies in the test bed falling *inside* the target buildings.¹⁶ These issues are likely

¹⁴ Wireless carriers, of course, will never be able to tell PSAPs “what door to kick in”—they can only provide geographic coordinates. PSAPs are, and continue to be, responsible for converting those coordinates to actionable addresses.

¹⁵ CSRIC III WG3 Report at 8.

¹⁶ *Id.* at 39.

to be even more pronounced where buildings are closely spaced, as in urban and dense urban environments.

1. NextNav's Beacon Technology Is No Panacea.

The Commission cites NextNav's beacon-based technology as evidence that there are existing location technologies that can be implemented and that will allow carriers to meet the proposed indoor location accuracy benchmarks within the proposed time frame.¹⁷ But this conclusion ignores several problems with NextNav's technology.

First, NextNav does not purport to offer service on a nationwide basis. Its proposal has always been to deploy its beacon network in select markets.¹⁸ In fact, NextNav does not have the spectrum licenses needed to deploy and operate its technology outside of some quantity of the top metro areas.¹⁹ Furthermore, to date, NextNav has only deployed in one area to the density it believes is required to provide accurate location estimates—the area where the CSRIC tests were performed. Deployments in the other areas where NextNav holds licenses are just beginning.²⁰ The Commission should be wary of adopting rules based on a technology for which no nationwide deployment is planned.

Second, there is significant reason—notwithstanding the results of the CSRIC Working Group III tests—to question whether NextNav in fact has deployed, or will be able to deploy, a sufficient number of beacons to sustain highly accurate vertical location estimates. Initial studies indicate that barometric sensors—which are the foundation for the vertical estimates in

¹⁷ *Third FNPRM* at 2394, 2401-03 ¶¶ 47, 71-74.

¹⁸ Letter from Bruce A. Olcott, Counsel to Progeny LMS, LLC, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 11-49, Attachment at 13 (filed Mar. 21, 2013).

¹⁹ *Id.*

²⁰ *Id.*

NextNav’s or any similar system—will face significant challenges in reliably determining absolute vertical location in many different types of buildings and environmental conditions.

Critically, though the use of barometric pressure to track *relative* changes in altitude over short periods of time is relatively straightforward, a barometric pressure measurement by a handset alone cannot produce an accurate *absolute* altitude estimate either indoors or outdoors.²¹ Accurate absolute vertical measurements must rely on an initial pressure reference (calibration) measurement made in real-time from a sensor at a known altitude *in the same atmospheric conditions as the handset*. While it may be reasonable in some cases to assume that an outdoor calibration sensor will be in the same atmospheric conditions as a handset inside a building, in many other cases, this assumption will not be reasonable. Some challenges arise from mechanical systems common in semi-sealed, environmentally controlled buildings (which includes most modern multistory office buildings). In these buildings, fan pressurization alone can typically increase or reduce in-building pressure by as much as 50Pa (0.5hPa) relative to outdoor static air pressure.²² This impact can affect measured altitude by more than 4 meters²³—even with highly accurate, local, outdoor pressure calibration in place. Other challenges arise in older, “leaky” (high infiltration rate) buildings, where natural processes such as the “stack effect,” rapidly changing weather conditions, cold temperatures, high wind conditions, etc. can

²¹ See generally Binghao Li et al., *Using Barometers to Determine the Height for Indoor Positioning*, International Global Navigation Satellite Systems Society (July 2013), available at http://www.gmat.unsw.edu.au/snap/publications/lib_etal2013a.pdf; see also Kartik Muralidharan et al., *Barometric Phone Sensors – More Hype Than Hope!*, ACM HotMobile (Feb. 2014), available at <http://research.microsoft.com/apps/pubs/default.aspx?id=206442>.

²² Rick Quirouette, *Air Pressure and the Building Envelope*, at 6 (Nov. 2004), available at <https://www.cmhc-schl.gc.ca/en/inpr/bude/himu/coedar/upload/Air-Pressure-and-the-Building-Envelope.pdf> (“*Air Pressure and the Building Envelope*”).

²³ Using the “standard atmosphere” pressure model, pressure drops by about 0.1hPa for every 1 meter increase in altitude. Alternatively, altitude changes by about 8.7 meters for every 1hPa change in air pressure. (1hPa = 100Pa)

greatly affect internal pressure measurements relative to outdoor static air pressure. The stack effect alone in cold temperature conditions can create a pressure gradient in the building air column and a resulting indoor-to-outdoor pressure difference of approximately 90Pa (0.9hPa) on the top floor of a 20-story building, even in the absence of wind.²⁴ This pressure difference would introduce an altitude measurement error of nearly 8 meters, even with highly accurate, local outdoor pressure calibration. These indoor-to-outdoor pressure differences and resulting altitude measurement errors can be much larger for taller buildings and/or high wind conditions. While the most apparent solution would be to require the installation of barometric pressure sensors inside each building to be used as references for that building, and at various heights for tall buildings, such a requirement is outside the purview of wireless service providers, making a ubiquitous requirement for carriers to provide accurate in-building altitude measurements infeasible. And, further, if a solution involves installation of new devices in buildings, it is not at all clear that barometric pressure sensors are the best solution. Other technologies may be more effective.²⁵

In addition to the inaccuracies arising from differences between the atmospheric conditions inside and outside of buildings, there will always be errors in the barometric pressure measurement by the handset. Sensor errors fall into two categories: the relative measurement error and absolute error, or “sensor drift.” Relative measurement error for these sensors is

²⁴ *Air Pressure and the Building Envelope* at 5.

²⁵ One possible example would be the use of in-building Bluetooth-based location beacons. The deployment and use of this type of device could be required through building codes in much the same way that codes currently require the deployment of smoke detectors, fire extinguishers, or exit signs.

typically rated at no better than plus or minus one meter.²⁶ This error source cannot be calibrated out of the resulting altitude measurement and, under the proposed vertical benchmark, this would leave a “calibration error budget” of only *two meters* to ensure that a given measurement falls within the three meter overall accuracy requirement. “Sensor drift,” meanwhile, causes sensor measurement to drift from 60 to 105 meters over time and temperature. This error source can be calibrated out of the measurement, but only if an accurate and frequent reference measurement is available at a known altitude in the same air column environment as the handset. As discussed above, it remains unclear (if not unlikely) whether such accurate reference measurements will be available.

These challenges are mostly unexplored in the E911 context, as the CSRIC III test bed was not designed to test altitude measurements under the conditions that are most challenging for barometric pressure sensor methodology. That test bed primarily focused on evaluating horizontal location performance. T-Mobile urges the Commission to ensure that vertical location performance of this technology—or any similar technology—is thoroughly tested, evaluated, and standardized in all appropriate building and environmental conditions before adopting any new rules based on its potential capabilities. Mandating inclusion of unproven, costly technology into all handsets (and infrastructure) will, ultimately, be burdensome to consumers and may delay the development of more effective technologies in the future.

Third, NextNav’s terrestrial beacon technology did not prove capable of meeting the proposed 50 meter horizontal accuracy standard in all indoor environments in the CSRIC III test

²⁶ See, e.g., Bosch, BMP180 Digital, barometric pressure sensor, Specification Sheet, Doc. No. BST-BMP180-FL000-02, available at http://ae-bst.resource.bosch.com/media/downloads/pressure/bmp180/Flyer_BMP180_08_2013_web.pdf.

bed at either the 67th or 80th percentiles.²⁷ Specifically, both the urban and dense urban environments (precisely the areas where AGPS technology is most challenged) fell well outside the 50 meter proposed requirement.²⁸ NextNav also fell outside the proposed 3 meter vertical requirement in the suburban environment.²⁹

Fourth, setting aside these fundamental technical issues, there are no handsets on the market, and none in the pipeline, that have built-in NextNav terrestrial beacon technology. Indeed, NextNav is just beginning the process of working with standards bodies to determine how its technology can be accommodated within existing mobile technology frameworks.³⁰ For the CSRIC tests, NextNav utilized prototype hardware external to the mobile phone—a “sleeve”—which may not be representative of performance achievable in a production handset form factor. Handset integration is a key limiting factor in deploying even GPS-based location technology;³¹ it will undoubtedly be an even greater hurdle for third-party location technologies like NextNav’s, where the technology must be introduced into the mobile ecosystem—from standards to devices—from scratch.³²

²⁷ See CSRIC III WG3 Report at 27.

²⁸ In the urban setting, NextNav’s horizontal location technology demonstrated 63 meters at 67 percent and 85 meters at 80 percent. In the dense urban setting, NextNav demonstrated 57 meters at 67 percent and 73 meters at 80 percent. *Id.* at §§ 7.3.1-2.

²⁹ In the suburban setting, NextNav’s vertical location results were 4.5 meters at 67 percent and 5 meters at 80 percent. *Id.* at 37, Figure 7.5-1.

³⁰ Letter from Bruce A. Olcott, Counsel to NextNav, LLC, to Marlene H. Dortch, Secretary, FCC, PS Docket No. 07-114 (Apr. 23, 2014) (“NextNav Ex Parte”).

³¹ See 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 19 (Aug. 20, 2007) (“T-Mobile 2007 Accuracy NPRM Part B Comments”).

³² See NextNav Ex Parte (noting that NextNav is working with standards-setting bodies to, among other things, develop a standard to address air interface and control and user plane messaging, as well as working with carriers and manufacturers to incorporate NextNav technology into chipsets and devices).

2. Other Location Technologies Are Similarly Challenged.

The Commission acknowledges that the “test bed results indicate that further improvement is necessary,”³³ but nevertheless proposes adopting a 50 meter search ring in the belief that such accuracies are “attainable in the near-term.”³⁴ In support of this proposal, it cites the test bed results for NextNav’s beacon-based system—the flaws of which are discussed above—as well as technologies offered by Polaris (Radio Frequency (“RF”) Pattern Matching), Qualcomm (AGPS-Advanced Forward Link Trilateration (“AFLT”)), and TruePosition (AGPS-Uplink-Time Difference of Arrival (“U-TDOA”)). To the extent the Commission is relying on test results of any of these technologies to support the 50 meter indoor benchmark, that reliance is misplaced.

First, the Test Bed Report makes clear that neither Polaris’s nor Qualcomm’s technologies are currently capable of meeting a 50 meter accuracy requirement for either 67 percent or 80 percent of calls in almost any indoor environment.³⁵

Second, TruePosition’s technology has proven time and again to be incapable of providing highly accurate location estimates. U-TDOA has also proven economically infeasible to deploy and maintain in comparison to other, better performing technology alternatives. Indeed, as T-Mobile has noted on the record in this docket, carriers have migrated away from U-TDOA because of its inherent shortcomings, including poor performance in rural environments and environments such as highways, beaches, edges of service areas, and other areas with

³³ *Third FNPRM* at 2394 ¶ 47.

³⁴ *Id.* at 2393 ¶ 45.

³⁵ CSRIC III WG3 Report at § 7.3. The sole exception is that Qualcomm demonstrated 48.5m accuracy at 67% in the rural indoor environment. Other results for these two technologies in the urban and dense urban environments ranged from 117 meters to 227 meters at the 67th percentile, and 190 meters to 306 meters at the 80th percentile.

suboptimal cell geometry.³⁶ Furthermore, TruePosition chose not to participate in the CSRIC test bed—rather, it conducted its own testing, in a very different environment, without the benefit of direct comparison with other technologies, and using a very different reporting methodology.³⁷ The Commission should not rely on those results to support the 50 meter indoor benchmark; TruePosition’s U-TDOA technology needs further apples-to-apples testing in a standardized test environment.³⁸

B. The Indoor Location Proposals Establish Unrealistic Time Frames Given the Need to Test and Deploy Equipment as well as for Handset Turnover.

The Commission has stated that “the adoption of more stringent requirements for indoor location accuracy, together with a reasonable implementation timeframe, would afford CMRS providers with sufficient time and incentive to develop the necessary technology to enable compliance.”³⁹ Even assuming that technological solutions that were capable of meeting a 50 meter indoor horizontal requirement and a 3 meter vertical accuracy requirement for 67 percent of calls were available in commercial-ready prototypes today—which is not the case—the proposed timelines cannot possibly be met.

As T-Mobile has noted on the record in the past, “meeting any new accuracy requirement that is more stringent than the current requirements, or even implementing the current requirements at the PSAP level, will require installation of new technology and swapping out existing technology,” requiring an extended transition period.⁴⁰ Such transitions require years,

³⁶ See T-Mobile Comments on Location Accuracy Workshop at 29-31.

³⁷ See *id.* at 30 (citing TruePosition test bed report).

³⁸ See *id.* at 28-30.

³⁹ *Third FNPRM* at 2394 ¶ 47.

⁴⁰ T-Mobile 2007 Accuracy NPRM Part B Comments at 17.

not months, to ensure that they are incorporated into industry standards as well as into actual equipment, software, and products.⁴¹

Any new technologies must first be incorporated into industry standards, a process that takes at least 12 to 24 months in the appropriate standards bodies. This ensures that the technologies work and properly interoperate with the rest of the commercial mobile radio service (“CMRS”) world. It also helps to ensure that a given technology can be developed and offered by multiple vendors, ensuring a healthy ecosystem and continued innovation.

Only after new standards are developed can they be implemented into equipment and software; indeed, most telecommunications manufacturers will not even consider the inclusion of non-standardized technologies into their devices and network equipment. The design, development, and implementation time can take two or three years, as the U.S. market is only a part of global CMRS equipment markets and therefore must be coordinated with other product changes being implemented around the world. And deployment of new network equipment throughout networks itself takes time—at least two years, perhaps longer if tower loads are increased or additional ground space is needed.

Perhaps most critically, new technologies must be built into handsets, which must then be replaced across the subscriber base. Though handset turnover times may arguably be shorter now than they were a decade ago, it remains a lengthy process, and it is difficult to accelerate without requiring consumers to replace handsets and/or mandating that carriers shut off service to older handsets. The Commission can therefore expect handset turnover alone to take several years. And because next-generation location accuracy technologies universally will require new

⁴¹ While T-Mobile, as a carrier, is best able to speak to the transition timing for carrier and subscriber equipment, as discussed above, even if carriers can provide vertical location information, it will be useless until PSAPs upgrade their systems and mapping data to include detailed building elevation and floor layout data.

handsets, carriers will not be able to meet the proposed accuracy percentages until new handset penetration reaches a critical point, presumably at least 67 percent of subscribers for the near-term requirement and at least 80 percent for the long-term requirement.

IV. MANY OF THE COMMISSION’S PROPOSALS APPEAR TO CONFLICT WITH ONE ANOTHER AND CREATE INCONSISTENT OR CONFUSING OBLIGATIONS.

The Commission should clarify a number of its proposals, as described in more detail below.

First, the Commission has proposed what appear to be two conflicting compliance regimes—one based on county or PSAP level results, and one based on testing in a representative test bed that would establish nationwide compliance. T-Mobile continues to believe that the Commission must establish a permanent indoor location accuracy test bed, and that relying on test bed data for compliance is far preferable to attempting to measure compliance on a county or PSAP basis.⁴² In fact, logistics alone dictate against measuring on a county or PSAP basis, as it would take unreasonable amounts of time to negotiate building access with landlords and establish ground truth positions for each test location. Furthermore, once a technology or combination of technologies has demonstrated compliance through the test bed process, ongoing, periodic compliance testing should not be required. Carriers introducing a new location methodology should be permitted to demonstrate initial compliance via the compliance test bed process, and the passage of time alone should not require automatic re-testing.

Second, if the Commission establishes a maximum time to first fix of 30 seconds⁴³—which T-Mobile supports—then calls of less than 30 seconds’ duration (rather than calls of less

⁴² See Comments of T-Mobile USA, Inc., PS Docket No. 07-114, at 23 (Jan. 19, 2011).

⁴³ *Third FNPRM* at 2430-31 ¶ 148.

than 10 seconds⁴⁴) should be excluded. Where carriers are permitted up to 30 seconds to establish a Phase II location fix, a rule excluding from consideration only calls of less than 10 seconds will create confusion and uncertainty. The Commission should harmonize these two proposals by excluding calls of less than 30 seconds' duration.

Third, and finally, requiring carriers to provide PSAPs with the specific location technology used to generate a location estimate is unlikely to accomplish anything other than to confuse call takers. Call takers do not need to see an alphabet soup of various location technologies when answering emergency calls. They only need to know the search radius, and that information is contained in the uncertainty measurements at a given confidence level. The FNPRM correctly identifies that uncertainty information is less useful to PSAPs than it might be due to the fact that carriers currently provide uncertainty at varying confidence levels. That problem, however, could be eliminated by adopting a standardized confidence level for uncertainty measurements. T-Mobile supports the Commission's proposal to establish an industry standard confidence level of 90 percent for uncertainty estimates.⁴⁵ Doing so should obviate the need to provide PSAPs with the specific technology or technologies used to estimate a caller's location.

V. THE COMMISSION SHOULD REFRAIN FROM MODIFYING THE EXISTING LOCATION ACCURACY FRAMEWORK FOR OUTDOOR CALLS.

The outdoor location accuracy rules function well, and carriers are on a path to a unified accuracy standard. The percentage of PSAPs in which a carrier is required to meet the accuracy

⁴⁴ *Third FNPRM* at 2430 ¶ 147.

⁴⁵ T-Mobile recognizes that some carriers utilize a handset-based location architecture where the position calculation function is performed entirely in the handset, and may be unable to modify the confidence level for existing handsets. In this case, a requirement to adopt standardized confidence and uncertainty could be limited to those handsets introduced beyond a certain date.

standards continues to ratchet up.⁴⁶ This path remains very challenging, and compliance—even with today’s best performing technologies—is far from certain. Rather than accelerate the outdoor location benchmarks or adopt a unitary standard on a short time frame, the Commission should retain the existing benchmarks. As T-Mobile has said before, the move to handset-based accuracy will always be subject to the ability of carriers to roll out new handsets throughout their footprint. That process is difficult if not impossible to accelerate. Pushing the existing time frame up would impose enormous burdens on carriers, at precisely the same time that those carriers are working hard to deploy new network technologies that hold the promise of real improvements to location accuracy in all environments.

⁴⁶ See 47 C.F.R. § 20.18.

VI. CONCLUSION

T-Mobile continues to work toward improved location accuracy for wireless E911, including for indoor wireless calls. But in the face of clear evidence that no existing or near-term technology can meet the Commission's proposed indoor accuracy benchmark, it urges the Commission to refrain from adopting new rules and instead support the establishment of a permanent indoor test bed. A multi-stakeholder, collaborative approach is needed to ensure the success of any new technologies eventually adopted, as well as to enable the Commission to realize its stated goal of ensuring that PSAPs have a "truly actionable" location for all wireless E911 calls.

Respectfully submitted,



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May 12, 2014