EXHIBIT 1

Declaration of John F. Pottle, Ryan N. Jensen, and Daniel H. Wilson

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

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

DECLARATION OF
JOHN F. POTTLE, RYAN N. JENSEN AND DANIEL H. WILSON

Declarants hereby state as follows, under penalty of perjury:

1. My name is John F. Pottle. I am the Director of National Systems Engineering, Engineering Services, for T-Mobile USA, Inc. ("T-Mobile"). I have been employed at T-Mobile for 20 years. I have 34 years of experience as an electrical engineer and manager in the wireless industry, the last 16 of which have been involved in the development and deployment of location technologies and E911 systems. I manage several functional areas within T-Mobile including the teams responsible for deployment and maintenance of E911 services, compliance with mandated Public Safety Answering Point ("PSAP") request timelines, assurance of Phase II location accuracy performance, and providing PSAP technical support. I also assist in formulating T-Mobile's technology roadmap for E911 services and ongoing assurance that T-Mobile systems and networks continue to meet requirements for E911 as the network grows and as new technologies are introduced. In this capacity, I have direct and personal knowledge regarding T-Mobile's E911 location technology and deployments, and of the accuracy issues presented in this proceeding.

2. My name is Ryan N. Jensen. I am a Member of the Technical Staff and Director of Technology and Compliance, National Systems Engineering, for T-Mobile. I have been employed at T-Mobile for 24 years, with 16 of those years spent in the research, development, deployment, and analysis of the performance of various location technologies for mobile phones. I have 31 years of experience as an electrical engineer, hold a Masters of Science in Electrical Engineering, and have been issued 25 U.S. Patents. I am responsible for investigating potential new location technologies for T-Mobile, and for E911 performance and accuracy compliance methodology and testing within T-Mobile. I have participated extensively in the Emergency Services Interconnection Forum ("ESIF") since its inception, including working on the development of ESIF's Technical Reports on accuracy testing, maintenance testing, and functional/end-to-end testing for wireless E911, and currently serve as a member of the ESIF Advisory Group. I have also been a member of the Commission's Communications Security, Reliability, and Interoperability Council ("CSRIC"), and participated in the CSRIC III Working Group 3 Indoor Location Test Bed conducted in 2013. I recently helped develop the CSRIC IV Working Group 1 reports on establishing a permanent indoor location accuracy test bed, and investigating location improvements for interim SMS (Text) to 9-1-1. I am currently supporting the CSRIC IV Working Group 1 efforts involving location accuracy and testing for Voice-over-LTE ("VoLTE") networks. In this capacity, I have direct and personal knowledge regarding T-Mobile's E911 location technology and deployments, and of the accuracy issues presented in this proceeding.

3. My name is Daniel H. Wilson. I am the Location Technology Manager, National Systems Engineering for T-Mobile. I have been employed at T-Mobile for 14 years. I have 15 years of experience as an electrical engineer in the telecommunications industry. I have

managed location technology development for the last two years including the architecture of T-Mobile's location technology platform as well as technology roadmaps, network design, testing and performance optimization. In my role, I am responsible for validation of location technology platforms in the lab environment, as well as accuracy compliance performance in the field. In this capacity, I have direct and personal knowledge of T-Mobile's E911 location technology and deployments, and of the accuracy issues presented in this proceeding.

4. This declaration is intended to support the Reply Comments filed by T-Mobile in the Commission's proceeding in PS Docket No. 07-114, with respect to the Third Further Notice of Proposed Rulemaking ("FNPRM") issued by the Commission on February 21, 2014. We are familiar with the technical aspects of the comments filed in this docket, the Commission's proposed new indoor location accuracy benchmarks, the candidate technologies on which the Commission has relied in developing its proposals, including the technologies offered by NextNav, TruePosition, and Polaris Wireless, and the testing that was conducted by CSRIC III Working Group 3, as well as the reports of test results that technology vendors have made publicly available.

5. At this time, in our view, there is no location technology that can meet the Commission's initial proposed indoor location accuracy benchmark of 50 meters for 67% of calls, either alone or in combination with Assisted Global Navigation Satellite System ("A-GNSS") location technologies such as Assisted Global Positioning System ("A-GPS"), and Assisted-GLONASS (GLONASS is the Russian global navigation satellite system, similar to GPS). We also believe that there is, as yet, no basis for projecting that location technologies will have evolved such that carriers would be able to deploy a location technology that reaches 50 meters for 67% of indoor calls within two, or even three, years. Moreover, as we explain further

below, simply because a location technology is available for licensing from a vendor does not mean that it can immediately be deployed. Network-based technologies must be installed throughout a carrier's network. Handset-based technologies require a change-out of customer handsets, and may also require network modifications. These deployment steps themselves will take several years and—with the exception of Observed Time Difference of Arrival ("OTDOA") which does not require installation of an overlay network, and GLONASS, both of which already have been incorporated into at least some VoLTE handsets—do not merit beginning deployment until it has been proven that the technology can produce benchmark-compliant location estimates. Otherwise, carriers will be required to make costly investments (such as, for example, installing Location Measurement Units ("LMUs") or paying for the creation of an overlay beacon network) in technologies that may not actually work, when other alternatives may become available that do not require or utilize those same investments.

6. Furthermore, it is highly unlikely that anything other than location technologies based on small area cells or low power beacons (whether femtocells, WiFi, Bluetooth low energy ("BLE"), or other very small coverage area technologies) will reliably yield dispatchable indoor location estimates, particularly in multi-unit, multi-floor buildings. Even an indoor location estimate that is accurate to within 50 meters could easily encompass not only multiple units and floors, but also multiple buildings within the indicated search radius.[1] This is particularly true given the non-uniform "scatter" of location estimates produced by wide-area radio location

[1] *See* CSRIC III, Working Group 3, E9-1-1 Location Accuracy, *Indoor Location Test Bed Report*, 30-31 (Mar. 14, 2013), *available at* http://transition.fcc.gov/bureaus/pshs/advisory/csric3/CSRIC_III_WG3_Report_March_%202013_ILTestBedReport ("CSRIC III WG3 Indoor Test Bed Report") (noting "the unique challenge with indoor location: absolute distances (like 50 or 150m) which may have meant much in assessing outdoor performance mean less for the indoors, since emergency dispatch to the wrong building or even the wrong block could be easily encountered at 50 or 150 m").

methods caused by substantial multipath reflections inherent indoors, especially in challenging urban and dense urban settings. As was clearly demonstrated by the CSRIC III Working Group 3 testing in dense urban and urban environments, unlike outdoor locations with fairly uniform "scatter" of location estimates, indoor location estimates frequently have a strong "bias" in a particular direction away from the actual handset location—often falling within adjacent buildings or beyond—even when the absolute error distance is on the order of 50 meters.[2] Implementing small cell/beacon location solutions will likely take several years, but unlike the wide-area radio location solutions proposed in the FNPRM and promoted by some location technology vendors, small cell/beacon solutions hold the promise of actually providing dispatchable addresses.

7. New location technology solutions can best be implemented for LTE. LTE's standards permit the use of multiple location technologies operating in parallel, rather than sequentially, as is the case with legacy 2G and 3G networks. This allows a carrier to implement a 911 location estimation system that uses multiple technologies and then submits the best available result within the budgeted time permitted, which to date has been 30 seconds. It makes little sense to attempt to add new technologies to 2G GSM networks, which at least one major nationwide carrier is proposing to turn down over the next several years.[3] Also, 2G GSM/GPRS/EDGE standards have been "frozen" by the 3rd Generation Partnership Project ("3GPP"), with the last location-related change approved in 2007. When a 3GPP specification is "frozen," only "essential corrections" are permitted and no additional functions or features may

---

[2] *Id.* at 28-31.

[3] AT&T Inc., Quarterly Report (Form 10-Q) at 21, (Aug. 3, 2012) ("We expect to fully discontinue service on our 2G networks by approximately January 1, 2017").

be added.[4] Similarly for UMTS/HSPA standards, the last location-related change was approved in 2011. Since that time, all location-related standards activities have been directed toward LTE networks. Even beyond standards issues, it would not be productive to attempt to retrofit UMTS networks, which would be extremely costly, would still require handset-change out for handset-based technologies, and would only permit one location technology to be run at a time. Because only one technology can run at a time in non-LTE networks, implementing new location technologies in those networks could also lead to reducing the percentage of high accuracy A-GNSS-based results that are returned within 30 seconds, such as where the new location technology is run first but is not as accurate as A-GNSS and reduces the amount of time available in the latency budget for a subsequent A-GNSS fix to be determined. A reduction of even a few seconds of A-GNSS satellite measurement time can have a dramatic negative impact on accuracy and yield in challenging environments.

8. We also note that there is currently no way—and there is unlikely ever to be a way—to reliably distinguish an indoor 911 call from an outdoor 911 call using wide-area radio-based technology. Tests of outdoor and indoor performance can be conducted by placing test calls, as is done with outdoor accuracy assessments today and as occurred with the CSRIC III Working Group 3 test bed. But in the context of actual real world 911 calls, it is extremely unlikely that a carrier will ever be able to reliably determine whether a caller is inside or outside a particular building using wide-area radio-based location methods.

---

[4] *See* 3GPP, TR 21.900 V11.0.1, *Technical Specification Group Working Methods*. "Essential corrections," or "category F change requests," are limited to correcting an error or ambiguity in the specification, to remedy the incorrect implementation of a previously approved change request, or to correct a misalignment between specifications.

I. EVALUATION OF WIDE AREA RADIO ACCESS NETWORK HORIZONTAL LOCATION TECHNOLOGIES PROPOSED IN THE RECORD TO DATE.

9. Of the near-term technologies the Commission points to in the FNPRM, none represent a "magic bullet" to the problem of indoor location accuracy and each requires trade-offs in key areas—such as impacts to the network, impacts to handsets, impacts to standards, costs to deploy, operate, and maintain, accuracy, yield and latency performance, and time to market. Each of these technologies—specifically, NextNav's terrestrial beacon-based technology, TruePosition's Uplink Time Difference of Arrival ("U-TDOA"), Polaris Wireless's Radio Frequency ("RF") Pattern Matching, and carrier-deployed OTDOA—have limitations that will prevent it from enabling carriers to meet the proposed benchmarks for horizontal location accuracy. Given this reality, and carefully assessing each of these key trade-offs, we believe that OTDOA and A-GNSS hold the most promise for the greatest improvement in the shortest period of time. While carriers will incur costs to deploy OTDOA, they have, by and large, already committed to do so by virtue of migrating to LTE networks into which OTDOA has been architected. That cannot be said of the other technologies.

10. The chart below sets forth a comparison of NextNav's beacon-based technology, TruePosition's U-TDOA, and OTDOA along several key metrics that illustrate the trade-offs among these three technologies.

	NextNav	U-TDOA	OTDOA
Standardization / Industry Adoption	• Not standardized for any radio access network • Proprietary, sole-sourced technology • No marketplace demand	• Version most recently proposed and tested by TruePosition is not standardized for UMTS or LTE networks • Proprietary, sole-sourced technology • No marketplace demand beyond GSM	• Standardized and committed for implementation by all major carriers in association with VoLTE • Available from multiple vendors • On-going performance enhancements currently in work in 3GPP
Coverage / Deployment	• Overlay • Beacon network in very early deployment stage • Limited geographic coverage (top metro areas) due to spectrum licenses and costs • No plans for national coverage	• Overlay • Deployed by two major carriers on GSM network • No implementations to date on UMTS or LTE networks	• Integral to LTE networks • Currently being deployed nationally in association with LTE network rollout
Network Impacts	• Independent beacon overlay network • Following standardization – requires SMLC and other network modifications for control plane implementation	• Complex LMU deployment at each cell site with multiple spectrum bands • Runs counter to goal of co-locating transceivers and downlink antennas on towers • Following standardization – requires SMLC and other network modifications for control plane implementation	• Network support inherent in LTE deployment is already in place
Handset Impacts	• Requires handset change-out • New functionality integrated into GPS chipset and minor hardware impacts to handset • One minor chipset vendor produced a functional chip – major chipset vendors have not committed to this technology	• None	• Requires handset change-out • New functionality widely integrated into GPS chipsets, adopted in VoLTE handsets beginning 2014
Cost to Deploy, Operate, and Maintain	• Very high service fees to access beacon network which scale even higher with growth of business • While costs could be shared across carriers, extreme costs to deploy/maintain the non-revenue producing independent beacon network results in a very high per-carrier cost burden	• Extreme costs for deployment (LMU at every site), network maintenance, and licensing – costs cannot reasonably be shared across carriers[5] • Economically infeasible to deploy and maintain	• Reasonable costs to deploy in handset and network • Significant initial engineering effort to calibrate timing/ synchronization

[5] While theoretically possible to share LMUs across different wireless carriers, in practice, this is not a workable option. Carriers will likely never share their network backhaul outside their own network with other carriers, due to a variety of technical, privacy, and competitive issues.

	NextNav	U-TDOA	OTDOA
Horizontal Accuracy **Yield** **Latency**	• 30-85m / 67% • > 93% • 27 sec (based on CSRIC III Indoor Test Bed results, prototype hardware implementation)	• 80-200m / 67% • 85-94% • 7-20 sec (Typical U-TDOA performance outdoors on GSM network – Valid indoor performance figures not available)	• Expected to be High • Expected to be High • Expected to be Low (CSRIC testing required for specific performance figures)
Maintenance / Support Complexity	• Independent from carrier network • Increased complexity for handset validation	• Significant operational effort to maintain network nodes: LMU performance, system capacity requirements, components reaching end of life • Ongoing effort to maintain accurate provisioning database	• Significant effort to initially calibrate system • Ongoing effort to maintain accurate provisioning database • Increased complexity for handset validation
Commercial Availability – Time to Market Estimates	• Beacon network availability is uncertain and at best – several years away • RAN network functionality for position calculation would likely take 1-2 years after standardization • No commercial handset availability – likely no significant quantity of handsets available sooner than 2018 (based on required standardization, chipset development, and handset integration)	• Likely 8 year network rollout (based on standardization, developing and testing on LTE network, integrating network equipment, and deploying LMUs) • No impact to handsets	• Release 9 OTDOA network integration started – performance testing planned for late 2014 – OTDOA activation expected early 2015 • Performance improvements committed in Release 10 • Initial handsets now available – virtually all VoLTE handsets going forward will be OTDOA capable

11. As is clear from the chart, NextNav and U-TDOA enjoy little to no marketplace demand. As such, they are not available from nor supported by multiple vendors.[6] Each requires a new overlay network to be deployed and, in the case of NextNav, will also require handset change out once handsets implementing its technology are actually available. While TruePosition arguably could eventually have nationwide coverage, each carrier would have to

[6] NextNav beacon technology is clearly sole-sourced as would be expected for a network of radio beacons requiring special authorization from the FCC to operate. Legacy U-TDOA for 2G GSM networks was offered by two vendors, TruePosition and Commscope. At this time, only TruePosition is offering to develop and supply U-TDOA for 3G and 4G networks.

deploy LMUs throughout their networks to achieve that coverage. NextNav, on the other hand, has made clear that its plans are to deploy only in certain metropolitan areas. Though not depicted in the chart, Polaris's RF Pattern Matching has its own implementation issues, as it relies heavily on calibration of each indoor RF environment—an extremely burdensome and expensive undertaking. Perhaps most critically, the data from the CSRIC III Working Group 3 Indoor Test Bed and other independent tests indicate that none of these technologies are currently capable of meeting the proposed horizontal accuracy benchmarks, and we do not believe that, given the implementation issues discussed above, those performance deficiencies will be rectified within the proposed timeframes. OTDOA, on the other hand, is standardized and all major carriers have committed to adopting it for location estimates for VoLTE networks. OTDOA is also expected to improve over time through continuing advancements in standardized options.

A. NextNav

12. NextNav provides location estimates by means of a network of terrestrial beacon transmitters deployed across a geographical area that can be received by specially equipped handsets. Handset measurements of the time-of-arrival of these beacon transmissions provide an estimate of the horizontal location of the handset – similar to the satellite-based GPS location method. These beacon transmissions also provide barometric pressure calibration data to supplement handset-based pressure measurements for estimating vertical location. To support ubiquitous indoor location coverage, NextNav must build out these beacon networks nationwide with sufficient density to ensure adequate building penetration. To date, NextNav has only built out its network at the density necessary to provide the level of accuracy observed in the CSRIC III test bed in a portion of a single metropolitan area—the area of the CSRIC III test bed—and its

announced deployment plans are limited to a number of the top metropolitan areas.[7] NextNav's initial deployment is limited to 47 Economic Areas ("EAs")[8] and it only holds spectrum licenses in 115 EAs (out of 176 designated by the Commission). Moreover, NextNav admits that its average population coverage "exceeds 45 percent in [the] top 40 EAs"[9]—poor coverage even in their initial deployment markets. In short, large areas of the United States will not be covered by NextNav's service.

13. NextNav's horizontal location accuracy technology is not currently integrated into any commercially available handset. Thus, during the CSRIC III test bed, NextNav's technology was tested by means of an external "sleeve"—containing a dedicated antenna used to receive the terrestrial beacon transmissions, hardware, software, and sensors—which was attached to the test handset. Even when using this configuration with a dedicated external antenna to receive the beacon signal, NextNav's technology was unable to provide location estimates within 50 meters even for the "near-term" proposed standard of 67% of indoor calls within the urban and dense urban morphologies—the very environments where the most accurate current location technology, A-GPS, is most challenged. There is a reasonable possibility that NextNav's performance will be degraded once their technology is internally integrated into real wireless handset products—especially bringing the antenna used to receive the terrestrial beacons into close proximity of other RF components and noise sources.[10]

---

[7] *See* Letter from Bruce A. Olcott, Counsel, Progeny LMS, LLC, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 11-49, Attachment at 8 (filed Mar. 21, 2013) ("NextNav/Progeny Presentation").

[8] Comments of NextNav, LLC at 10, PS Docket No. 07-114 (filed May 12, 2014) ("NextNav Comments").

[9] *Id.*

[10] This risk of performance degradation in moving to production hardware was also noted in the CSRIC III Working Group 3 Test Bed Report: "Technical performance of some position

14. Only recently has NextNav begun working with the relevant standards bodies on developing the necessary standards to support its terrestrial beacon system in wireless handsets and networks, including development of standards for control plane and user plane messaging between the handset, the network, and the terrestrial beacons. In addition, NextNav has begun the process of working with carriers and manufacturers to consider its technology for their chipsets and handsets. The largest chipset manufacturers have not committed to adopt this technology.[11]

15. NextNav is realistically a minimum of four years away from commercial handset availability. Before NextNav's technology can be implemented in handsets and carrier networks, new standards must be developed, a process that can be expected to take 12-24 months. The standards process ensures that the technology works and properly integrates and interoperates with the rest of the carrier network and handsets. It also ensures that various equipment and software can be provided by multiple vendors and still function properly. Only after the necessary standards have been developed could mainstream manufacturers reasonably begin integrating NextNav's technology into chipsets and, from there, into handsets. That process can be expected to take another two to three years, given the need for design, development, and implementation time, along with coordination within the global market. Finally, handset turnover will take another several years. Though handset change out occurs more rapidly today than in the past, full change out across a subscriber base is estimated to take at least five years, if

---

methods was determined in the test bed using non-production form factor hardware. Care must be exercised in applying these results to production handsets." CSRIC III WG3 Indoor Test Bed Report at 54.

[11] One minor GPS chipset manufacturer, CSR, has implemented NextNav's technology into a functional chip. Other chipset manufacturers, however, have not done so and are waiting for standards development as well as for market indicators that such chips will be in demand by handset manufacturers.

not longer. These estimates, moreover, do not account for the time needed for NextNav to deploy its beacon network overlay—a necessary step before any location estimates can be provided.

B. TruePosition (U-TDOA)

16. TruePosition's U-TDOA generates a location estimate by triangulating on time-of-arrival measurements of handset transmissions by LMUs installed at cell sites. TruePosition has offered U-TDOA for years; indeed, T-Mobile relied on U-TDOA for its early Phase II deployment on its GSM network.

17. In recent years, however, those carriers that initially used U-TDOA for Phase II on GSM have migrated away from U-TDOA and have adopted A-GPS because U-TDOA is incapable of meeting even the current outdoor accuracy benchmarks in every environment. Even implementing a hybrid solution that combines U-TDOA and A-GPS would not enable carriers to meet the proposed indoor location benchmarks in every environment. U-TDOA, even when working at its best, is generally less accurate than A-GPS. In addition, U-TDOA, like any triangulation method, works only when the handset's signal can be received by at least three cell sites. Some rural and isolated areas have only one or two cell sites, and in those areas there simply are not enough measurements to obtain any U-TDOA position estimate. In areas with three or more cell sites, it will still be impossible for U-TDOA to triangulate a location where the handset's signal is not able to be received by at least three cell sites—such as where the distance between the cell sites is too great, where terrain or building obstructions (including indoors) block the handset's signal, or when the handset is located along a coverage boundary. Finally, even where a handset's signal can be received by at least three cell sites, U-TDOA can be unable to determine an accurate location estimate where there is poor cell site geometry, such as when cell sites are arrayed along a highway or coastline in a "string of pearls" configuration. In

addition, mountains, buildings, and interior walls can reflect signals in ways that delay the receipt of the handset's transmission at the cell site, resulting in multipath issues which create uncertainty as to the proper measurement to be used for the location calculation, reducing the accuracy of the position estimate. A hybrid combination of a high accuracy location method (e.g. A-GPS) and a medium accuracy location method (e.g. U-TDOA) does not result in a higher accuracy location estimate—rather, it tends toward an accuracy level between the two constituent location methods.

18. TruePosition recently conducted yet another vendor-controlled test of their U-TDOA location technology in the Wilmington, Delaware area, during May 2014, this time hosted on a UMTS network.[12] Having reviewed their test report, we note the following issues that make their conclusions invalid. As with their testing conducted in February/March 2013, TruePosition once again conducted these tests outside of the crucial oversight of the CSRIC technical advisory group, and in the Wilmington area rather than in the San Francisco Bay test area established by CSRIC III. These differences preclude the ability to compare performance results from different location technologies in the same indoor environments—the established purpose of the "common" CSRIC III test bed. Once again, TruePosition failed to conduct any tests in dense urban settings—where U-TDOA would be expected to be relied upon most, or in rural settings—where U-TDOA is most challenged. Furthermore, the TruePosition test methodology and analysis of results are misleading as indicators of the feasibility of the proposed rules. When TruePosition states that for their tests "the yield is 100% by design,"[13] what they really mean is that yield was not measured for these tests. In fact, they only included

[12] TruePosition Indoor Test Report, Wilmington, DE (June 18, 2014), http://www.trueposition.com/assets/Uploads/TP-TestResults-2014.pdf ("TruePosition 2014 Indoor Test Report").

[13] *Id.* at 7.

in the accuracy analysis test calls that resulted in a successful U-TDOA fix, discarding calls where U-TDOA failed to return a position estimate. This approach is inconsistent with the proposed indoor rules where all calls must be included in the accuracy analysis. This consideration alone makes it impossible to apply reported accuracy figures from TruePosition's latest test effort against accuracy standards proposed by the Commission. Another fundamentally inconsistent aspect of their recent tests is that they used a special test handset configured to transmit at higher power than would normally be used for a handset making a 911 voice call over the UMTS network. Since U-TDOA depends on surrounding LMUs being able to measure the handset's uplink transmissions, this change can have a dramatic impact on U-TDOA accuracy performance. What is not stated in their report, however, is that this power-up capability for a 911 voice call is not standardized for the UMTS network, and could not be standardized and implemented within the timeframe of the FCC's proposed rules. There is no indication that such a power-up feature would ever be standardized or implemented in UMTS or LTE networks, especially considering the crucial nature of uplink power control and related interference mitigation central to wide-band CDMA communications. Interestingly, TruePosition reported U-TDOA-only accuracy and hybrid A-GPS/U-TDOA accuracy, but did not report A-GPS-only accuracy for their tests. Consistent with the point made above regarding hybrid approaches, TruePosition's report shows that A-GPS can enhance accuracy over a U-TDOA-only approach. However, today's UMTS and VoLTE networks already use A-GPS and TruePosition's report does not show that U-TDOA can enhance the accuracy over an A-GPS-only approach—nor would we expect it to. Furthermore, while TruePosition has historically touted their rapid time-to-first-fix as a benefit to their U-TDOA technology, during their recent testing, each positioning method (A-GPS and U-TDOA) was afforded 26 +/- 1 seconds to

develop a location estimate. These last two observations leave one wondering what benefit U-TDOA would add to an existing A-GPS solution. Finally, TruePosition gave no consideration to the proposed vertical accuracy requirements when they stated "[t]he outcome is a current overall performance that readily meets the FCC's proposed location performance threshold for indoor wireless E911 at the 67th percentile."[14] All these issues notwithstanding, TruePosition's own test results clearly demonstrate—most easily seen in the various "scatter plots"—the continued challenge, as with the CSRIC III tests, of identifying which building the caller is actually within, often getting the building next door in several directions, and sometimes even two or three buildings away.[15]

19. Large scale deployment of U-TDOA for the purpose of meeting the Commission's proposed indoor benchmarks also presents challenges. Such deployment would require installation of LMUs at virtually all cell sites across a network. Further, to achieve ubiquitous indoor coverage across all of the several different RF bands in use and from the three or more LMU sites required to estimate a position with U-TDOA, carriers might have to deploy LMU-only sites.[16] Such LMU-only sites are non-revenue-generating for the carrier and therefore extremely costly to build and maintain. This installation would not only be an extremely lengthy process—we estimate it would take a minimum of four years to deploy LMUs across T-Mobile's network[17]—but would also be extremely complex.

---

[14] *Id.* at 79.

[15] *Id.* § 7.1.

[16] Letter from John T. Nakahata, Counsel, T-Mobile USA, Inc., to Marlene Dortch, Secretary, FCC, Attachment 1, ¶ 11, PS Docket No. 07-114, WC Docket No. 05-196 (filed Dec. 12, 2008).

[17] When T-Mobile deployed U-TDOA across its GSM network in the early 2000s, it took one year for TruePosition to deploy the first "Service Area" (market), and an additional three years to complete all GSM markets. T-Mobile has many more cell sites now than in the

20. First, sufficient numbers of LMUs will need to be manufactured to enable carriers to undertake network-wide deployment. Currently deployed LMUs are restricted to the GSM network, and cannot function on wideband UMTS or LTE networks. TruePosition claims it can provide those LMUs within two years,[18] though we believe that estimate is optimistic. Only after the LMUs are available can installation occur. One fundamental roadblock to deploying LMUs for UMTS and LTE networks is that recent advancements in basestation radio equipment have led to many UMTS and LTE cell sites being configured and deployed with the transmitting/receiving equipment actually mounted on the tower top or roof top with the antennas, in some cases actually mounted inside the antenna, as opposed to ground-level equipment enclosures, to increase RF coverage by virtually eliminating cable losses between antennas and transceivers. This architecture does not lend itself to the introduction of an LMU, which needs to be connected to the uplink antenna. In some cases, remote radio module equipment already deployed is physically incapable of porting uplink signals to an LMU.

21. Moreover, U-TDOA has never been adopted for networks other than GSM. Adapting the technology for use with multiple spectrum bands and multi-technology configurations at each site will take significant time, introduce operational complexity for deployment and installation, and potentially compromise the performance of the radio network. Other network equipment besides LMUs would also be required to implement a U-TDOA system—a U-TDOA Serving Mobile Location System ("SMLC"), at a minimum. As none of this equipment has yet been implemented on an LTE network, there would likely be significant

---

2003-2007 time period and does not believe it could deploy LMUs across those cell sites in any fewer than four years.

[18] Comments of TruePosition, Inc. at 15, PS Docket No. 07-114 (filed May 12, 2014) ("TruePosition Comments").

additional development, deployment, and testing required before such a system could be made operational.

22. As discussed above, TruePosition has also indicated the need for a feature to be added to current 3GPP UMTS and LTE standards where the handset would power-up its RF transmissions during a 911 call to achieve higher accuracy and yield. This standardization process would likely take considerable additional time. Taken together, we estimate it would require eight years to standardize and implement the handset power-up feature for UMTS and LTE (two years), develop and test U-TDOA functionality and performance on an LTE network (one year), integrate required U-TDOA equipment (such as a U-TDOA SMLC) into our LTE network (one year), and deploy the required LMUs nationally (four years).

23. Most importantly, however, U-TDOA has yet to demonstrate the ability to meet the FCC's proposed indoor accuracy standards, as TruePosition withdrew from the CSRIC III Working Group 3 indoor test bed process before real world indoor performance of their technology could be established. Furthermore, there is no indication, either from simulations or real-world measurements, that U-TDOA could ever be systematically more accurate than OTDOA, which is already in the plan of record for all national carriers. In fact, while OTDOA also has not yet demonstrated the ability to meet the FCC's proposed indoor accuracy standards, OTDOA has the potential to be considerably more accurate and reliable than U-TDOA, given the availability and flexibility of downlink Positioning Reference Signals ("PRS"), including the ability to implement PRS muting, in which surrounding eNodeBs coordinate downlink transmissions to allow a single downlink transmission at a time to be accurately measured by the handset, greatly reducing the classic "near-far" interference challenge of cellular systems. In

addition, time-to-first-fix would be expected to be very similar between U-TDOA and OTDOA, clearly making OTDOA the overall performance winner.

C. Polaris (RF Pattern Matching)

24. Polaris Wireless's RF Pattern Matching approach is another candidate technology. RF pattern matching, also referred to as "RF Fingerprinting", compares mobile measurements against a geo-referenced database of the wireless carrier's radio environment. This technology was tested in the CSRIC III Working Group 3 indoor test bed and was clearly shown to be unable to meet the proposed indoor accuracy benchmarks, missing even the "near-term" proposed 67th percentile accuracy standard by a factor of four in urban settings, and by a factor of 10 in rural areas.[19]

25. Additionally, RF Pattern Matching has a fundamental limitation that precludes its use to further the goal of improved indoor location accuracy in high rise settings: RF pattern matching accuracy degrades with the height above ground-level of the 911 call location. The Polaris system relies on extensive calibration of the RF environment in the field, which is normally and historically performed at ground level through drive testing. Polaris itself has acknowledged that the signal environment in the upper floors of high-rise buildings is significantly different from the signal environment at ground level because of the different obstructions in the signal path.[20] It is clear that, without empirically calibrating the system at many different elevations above ground to account for the different RF environments in upper floors, Polaris's system cannot provide accurate indoor location estimates in those locations. Such calibration, however, would be infeasibly expensive—gaining access and bringing equipment into various floors of each building, establishing accurate ground-truth for each point

---

[19] CSRIC III WG3 Indoor Test Bed Report at 27.

[20] *Id.* at 40.

of measurement, and collecting the required calibration database of surrounding basestation transmissions. In addition, radio networks are reconfigured frequently, which would require frequent recalibration. Moreover, as self-organizing networks ("SONs") become more prevalent, radio environments will change even more dynamically, making it all but impossible to maintain a calibrated system based on RF Pattern Matching. Even if one were to attempt to collect the required indoor RF Pattern Matching calibration data across various floors of each building, the data collection process alone could not be completed in time to meet the commission's proposed timelines.

D. OTDOA

26. OTDOA is a multilateration method in which the handset measures the time difference between specific downlink signals, i.e., PRS, from surrounding cell sites, and reports the time differences to an SMLC in the network. The SMLC then calculates the position of the handset based on the known locations of the cell sites and the measured time differences. OTDOA is integral to the LTE specifications, having been introduced in 3GPP release-9, and is a terrestrial beacon technology. In OTDOA, the beacons measured by the handset for OTDOA location purposes are the cell network's own base station transmissions, *i.e.*, the LTE eNodeBs,[21] rather than from a separate, overlay radio network such as NextNav's. OTDOA is standardized for LTE and has been in development with network and handset vendors for over two years. As

[21] OTDOA can be viewed as a terrestrial beacon system similar to NextNav's proposed terrestrial beacon system, but with the added benefit that the eNodeB "beacons" will be available for the handset to measure essentially anywhere the handset is capable of placing a VoLTE call, due to the nature of the RF "hearability" of the OTDOA design, and not limited to the coverage areas where NextNav chooses to deploy their dedicated overlay beacon transmitters. Another benefit is the flexibility afforded OTDOA through the wide-range of standardized PRS configuration options, allowing optimization between LTE system capacity and OTDOA location performance, depending on local terrain, morphology, LTE deployed system bandwidth, etc.

a result, OTDOA has recently become commercially available in LTE networks and handsets, and initial testing by carriers is beginning. While OTDOA was not yet available at the time of the CSRIC III Working Group 3 testing, it holds promise to make significant performance improvements over existing technologies for wireless indoor 911 calls. Further testing is needed before specific performance expectations and standards can be established, but this testing is imminent due to the fact that OTDOA has been fully developed through the standards process and vendor product design cycles. OTDOA is also expected to improve over time through continuing advancements in standardized options, such as the ability for the handset to measure eNodeB beacons on multiple LTE frequency bands—functionality inherent in 3GPP release-10.

27. OTDOA requires network upgrades as well as handset change out. However, these changes are already occurring as carriers move to VoLTE and as users upgrade to OTDOA-capable handsets. As carriers deploy OTDOA capable handsets and test and optimize LTE based network equipment, such as SMLCs, OTDOA will be enabled for 911 VoLTE calls in markets where LTE has already been deployed. This process is already underway for T-Mobile and plans to activate OTDOA are scheduled for early 2015.

II. CONCLUSIONS

28. As is clear from the above discussion, none of these candidate technologies are capable of meeting the Commission's proposed indoor horizontal location accuracy benchmarks within the proposed timeframes. Deployment of any location technology requires a healthy ecosystem in which candidate technologies are commercially available at reasonable terms and ready for deployment in both networks and handsets. Such deployment requires that the standardization process has been completed, both for integration into wireless networks as well as into handsets, followed by design and development of hardware and software by vendors, and that the equipment is actually available—*e.g.*, that LMUs are ready to be installed, that

customers can purchase updated handsets, and that any overlay networks (beacons) are deployed. But today, with the exception of OTDOA, none of the proposed candidate technologies described above is close to commercial viability and any investment in these technologies is likely to be stranded.

a) NextNav's beacon-based system is only in the very early stages of deployment, and its technology has yet to be built into any handsets. In fact, due to the required standards work and chipset/handset development, we do not believe NextNav's technology will be in commercially available handsets sooner than four years from now.

b) U-TDOA requires new standardization work, as well as integration and testing to ensure functionality and demonstrate high accuracy/yield performance on an LTE network, which has not been accomplished to date. Following this, extensive network deployment and system-level integration would be required, work which could not begin until enough LMUs were manufactured sufficient for deployment—essentially one LMU per cell site for each and every carrier in the U.S. Fundamentally, some advanced cell site remote radio module equipment already deployed is physically incapable of porting uplink signals required for an LMU. At the conclusion of such a complex and costly process, public safety would be no further ahead for indoor location performance than they will be from the rollout of OTDOA—which is already underway.

c) Polaris Wireless's RF Pattern Matching technology cannot be feasibly maintained, given its constant reliance on carefully calibrated RF

environments, environments that change frequently. In addition, Polaris Wireless's technology at its best falls far short of meeting proposed indoor accuracy requirements, and without costly and logistically challenging calibration at higher elevations will suffer marked degradation in accuracy in the upper floors of taller buildings.

d) The addition of GLONASS along with carrier-deployed OTDOA, which every national carrier is in the process of deploying, are the only commercially viable candidate wide-area radio location technologies capable of meaningful improvements for indoor 911 calls.

29. However, even OTDOA and GLONASS will not be capable of meeting the proposed benchmarks within the proposed timeframe, as the migration to LTE networks (and the necessary handset change out) is still in the early stages. Carriers have already committed to OTDOA and GLONASS, however, and the groundwork has already been laid for their deployment, putting them far ahead of any other candidate technology: OTDOA is a standardized location technology that is architected into the LTE radio access network and carriers are already rolling out the LTE networks that will use OTDOA.

30. Given the state of existing and near-term technology, we believe the Commission should refrain from adopting new location accuracy rules based on the use of wide-area radio location technologies and instead should explore the ways in which it can support deployment of small cell and low power beacon-based solutions which will allow carriers to provide public safety with provisioned, dispatchable addresses.

John F. Pottle

Ryan N. Jensen

Daniel H. Wilson

Executed on July 14, 2014