Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
Wireless E911 Location Accuracy Requirements	)	PS Docket No. 07-114
	)	
E911 Requirements for IP-Enabled Service Providers	)	WC Docket No. 05-196
	)	

COMMENTS OF TRUEPOSITION, INC.

True Position, Inc., submits these Comments to the Commissions' *Further Notice of Proposed Rulemaking and Notice of Inquiry* addressing wireless location accuracy requirements.[1] TruePosition is a leading provider of wireless location solutions and technology. Its Uplink Time Difference of Arrival ("U-TDOA") system is the principal network based location technology deployed in the United States.

Summary

The Commission has been steadfast in supporting communications technologies, policies and rules to improve public safety. A modernization of the wireless location accuracy rules will significantly improve upon current abilities to locate and respond to incidents or emergency situations with greater speed, precision and reliability, at a reasonable cost. A modernization of the Commission's standards and test procedures can drive investment to deploy currently available, and much more accurate, technologies, and extend US global leadership in using modern communications to improve the quality and speed of emergency response. A regime of transparent performance standards that evaluate all technologies by objective performance

[1] In the Matter of Wireless E911 Location Accuracy Requirements, PS Docket No. 07-114 and E911 Requirements for IP-Enabled Service Providers, WC Docket No. 05-196, *Further Notice of Proposed Rulemaking and Notice of Inquiry*, FCC 10-177 (September 23, 2010).

criteria will not prescribe any specific technology but allow for continuous innovation and improvement. It will lead to the adoption of technologies to assist and improve emergency response in the broadband environment in the US and around the world, potentially giving American firms that meet the Commission's standards tangible competitive advantages.

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Further Notice of Proposed Rulemaking and Notice of Inquiry

In its September 23, 2010 *Order*,[2] *Further Notice of Proposed Rulemaking* (*FNPRM)* and *Notice of Inquiry* (*NOI*), the Commission reaffirmed its commitment to wireless location technology as integral to emergency response. Fundamental to an effective response is knowing the emergency's location; accordingly the Commission embraces forward looking technology to fulfill this core government responsibility. While recognizing progress, the Commission notes divergence between wireline and wireless location accuracy and citizen expectations for improvement.

In its *Order*, the Commission strengthens location standards. Carriers must now provide automatic location information (ALI) to the 911 Center around the County/Public Safety Answering Point (PSAP) metric. In pursuing improvements, the *FNPRM* recognizes the link between more specific automatic location information (ALI) and testing its performance indoors and outdoors. The Commission seeks a technically based record of current location capabilities and a path for improvement. Emergency response ability to rely on an accurate ALI transmitted in each call resonates throughout the Commission's work.

The *FNPRM* presents a path for immediate improvement. Recognizing that wireless use is now prominent, the Commission proposes to improve location accuracy, establish testing criteria for indoor and outdoor environments, ensure that location information accompanies devices roaming across networks and meet consumer expectation that wireless calls to 911 be located. The *NOI* charts a strategic course with its Next Generation 9-1-1 (NG911) proceeding[3]

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[2] In the Matter of Wireless E911 Location Accuracy Requirements, *Second Report and Order*, PS Docket No. 07-114, FCC 10-176 (September 23, 2010).

[3] In the Matter of Framework for Next Generation 911 Deployment, *Notice of Inquiry*, PS Docket No. 10-255 (December 21, 2010).

so all devices can communicate with the 911 Center and be located. TruePosition commends the Commission for its continued leadership and supports its proposals.

In this *Comment*, TruePosition presents data and analysis based on actual calls made to PSAPs and scenarios replicating the PSAP. The data encompasses the several environments from which most calls are placed and shows how calls made from several common environments remain outliers. The analysis indicates how current technologies perform and their challenges. Based on this data and analysis, TruePosition proposes a path to improve accuracy and reliability by combining the positive elements of current technology.

TruePosition endorses the Commission's direction. It presents how wireless location accuracy and reliability can be enhanced, including implementing testing demonstrating compliance. TruePosition believes substantial improvements in locating an emergency are achievable in scenarios where ALI is currently challenged. The Commission should move expeditiously: Improvements to emergency response are inextricably linked to Commission action and investment directed to improvements stems from Commission decisions but is stifled by inaction.

Wireless Use is Now Prominent

Wireless' prominence over wireline is no longer a trend; it is reality. The transition from wireline to wireless is emphatic. The Commission's analysis reflects that 22.7% of households, more than one out of every five, are wireless only, a trend that continues to grow. It recognizes the convergence of wireless with wireline technology.[4] Average residential wireline toll minutes continue to decrease dramatically; wireless end user rose to 49.7% of total industry revenue in

[4] *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services, Fourteenth Report*, ¶s 4, 343-344, FCC 10-81 (May 20, 2010).

2008.[5] States report that wireless calls range from 52% to 72% of all calls to PSAPs.[6] J D Power indicates that 52% of all wireless calls are made indoors.[7] Wireless carriers promote indoor use by marketing aggressively infrastructure enhancements assisting indoor use.[8]

Carrier financial reports indicate continued loss of wireline revenue and expansion of wireless use and investment.[9] Wireless demographics reveal even more profound changes. For those whose use of wireless devices commenced at an early age, there is no intention to use wireline. This demographic instead relies solely on a mobile device at home, work and travel.[10] And the geography of this demographic is overwhelmingly urban and suburban where the vast majority of emergency calls nationwide are made. The challenge is to align the ability to locate emergency calls accurately in these environments.

The mobile broadband service expansion demonstrates further the vibrant wireless market and its importance to emergency response. The Commission's National Broadband Plan (NBP) presents a core objective in addressing emergency services. It envisions an environment

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[5] *Trends in Telephone Service*, at Table 14.2 and Chart 15.1, Industry Analysis and Technology Division, Wireline Competition Bureau, Federal Communications Commission (September 2010).

[6] *See* Comments of Intrado, Inc. and Intrado Communications on National Broadband Plan Public Notice #8, GN Docket No. 09-47, at 4 (Nov. 12, 2009) (noting that the States of Alabama, Texas, Virginia, Washington, Massachusetts, Delaware, and Michigan report that the percentage of wireless calls in those states ranges from 52% to 72% of all calls received by PSAPs).

[7] *The J.D. Power and Associates 2009 Wireless Call Quality Study℠—Volume*, http://www.jdpower.com/telecom/articles/2009-Wireless-Call-Quality-Volume-1

[8] *FNPRM* and *NOI* at paragraph 40. Mossberg, Walter S., *Cell Towers for the Home Work Best in Worst Sites*, Wall Street Journal (August 26, 2010), Murphy, Kate, *Cellphone Carriers Try to Control Signal Boosters*, New York Times (November 18, 2010).

[9] Form 10-K, Verizon Communications Inc., Management's Discussion and Analysis of Financial Conditions and Results of Operations (February 26, 2010). http://investor.verizon.com/sec frame.aspx?FilingID=7081932.

[10] Wireless Substitution: Early Release of Estimates From the Nation Health Interview Survey, January-June 2009, Center for Disease Control and Prevention (December 16, 2009). http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless200912.htm#telephone_status.

in which emergency responders receive vital information, regardless of how it is transmitted. It states that broadband makes it possible for PSAPs to push and pull video, images and medical information to those able to act on it. The NBP relates that it is critical that the NG 911 system develop to ensure that all Americans can access 911 systems anytime and anyplace.[11] The enormous expansion of advanced mobile services must be accompanied by similar benefits accruing to emergency response. Wireless location accuracy is critical to meeting the NBP's goals.

The Commission's recognition of this fundamental change in how consumers communicate and their need for emergency services is crucial. Consumer use is not static and changes with advances in technology; a device's ability to communicate must be accompanied by ability to be located. The record is clear that adequate and reliable wireless location information is not transmitted in several common environments where large numbers of 911 calls are made. These common environments include areas where the view of the sky is significantly obstructed, such as inside buildings constructed of concrete, steel and glass, and in urban tall building settings. It is here where Commission decisions are critical.

Existing and Prospective Location Technologies

The Commission seeks information on the state of wireless location technology since it examined the issue in 2007. It asks how location determination can be improved. It requests quantitative analysis addressing current technologies and the potential to incorporate newer technologies into wireless networks and their relative performance capabilities and commercial

[11] Federal Communications Commission, Connecting America National Broadband Plan, Public Safety, at pages 313, 323-326. http://download.broadband.gov/plan/national-broadband- plan-table-of-contents-exhibits-preface.pdf.

feasibility. It inquires whether certain technologies are better suited for particular environments.[12]

Two technologies currently provide location accuracy, Uplink-Time-Difference of Arrival (U-TDOA) and Assisted Global Positioning System (A-GPS). U-TDOA is able to provide accurate location estimates for calls placed within buildings and calls placed out of doors in urban and suburban locations. It is challenged in rural areas. A-GPS performs well where there is an unobstructed view of satellites and in some indoor areas such as wood frame houses. It does not perform reliably where the view of the sky is significantly obstructed, such as in dense urban areas, or in areas inside buildings made of concrete, steel and glass.

A-GPS and U-TDOA

U-TDOA and A-GPS are each based on geolocation--determining a mobile devices' location by measuring its distance to three or more points of known location. Properties of radio waves allow us to know the velocity of radio wave propagation. With velocity known, distance from the known points to the mobile device is determined by measuring the time it takes the radio wave to travel between points.[13]

GPS relies on a low earth orbit satellite system. Each satellite possesses a time clock synchronized with the time clocks in the others. Each satellite transmits at least one civilian signal with its own signature, the time of transmission and location. Mobile devices containing GPS receivers can be located through geolocation, provided they have an unobstructed and uniform view to several satellites. GPS is challenged by the nature of the radio signal and the materials it must penetrate.

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[12] *FNPRM* at para 15

[13] *Ex parte* communication of TruePosition, PS Docket 07-114 (June 4, 2010)..

Radio waves emanate spherically to their destination, a property permitting multiple receivers at many different locations to receive a signal. The consequence is that the radio wave's power diminishes as it gets further from its source. With noise always present, a device can get so far away from a transmitter that the signal cannot be received reliably because its power is too low with respect to the noise level. The distance between GPS satellites and GPS receivers is approximately 26,560 kilometers; the power of GPS signals is fairly low. This factor, combined with the circumstance where a device has less than an unobstructed view of the GPS satellites, limits location accuracy.

The materials a GPS signal must penetrate to reach a device located indoors further limits location accuracy. When a radio wave impinges upon building material a portion of its power is reflected; the remaining portion refracts into the building material. Reflection and refraction of radio waves results in further attenuation with an even lower power signal arriving at the mobile device. A-GPS enhances the signal's integrity by providing additional information about the signal and allows information to be recovered. A-GPS provides significant enhancement to indoor environments such as residential structures constructed primarily of wood. The attenuation of signals by buildings constructed of metal, concrete and metal tinted glass is too great to permit indoor reception in these types of buildings, even with A-GPS.

U-TDOA is currently used in GSM networks to locate all handsets. Like GPS, it is a geolocation technique measuring the time radio waves travel. The location of the mobile device is determined by the period it takes the radio wave to travel from the handset to Location Measurement Units (LMUs). LMUs are collocated with the network's base stations and are synchronized with each other. The radio wave LMUs measure is the same signal the handset

uses for signaling and communications on the network. A minimum of three LMUs must receive a handset's signal to determine its location.

The radio waves U-TDOA measures are also reduced in power by attenuation from building materials. Yet the proximity of the device to the LMUs reduces degradation significantly so that U-TDOA can provide accurate and reliable geolocation of handsets even when indoors. Additionally, the handset's power can be varied and dynamically adjusted many times per second. When the loss between transmitter and receiver increases because of attenuation by building material, the wireless network commands the handset to increase its output power to compensate for the additional attenuation. If a handset can communicate with its wireless network from indoors, then U-TDOA can reliably and accurately locate it.

U-TDOA does not require changes to mobile handsets and can be used to locate all phones connected to the network once it is deployed. Because it is based on high power terrestrial signals and high levels of signal processing, U-TDOA can derive good location estimates, including signals which propagate through high loss paths, including those from handsets indoors and in urban environments.

U-TDOA is challenged in areas where cell site spacing is large, where terrain such as large hills or mountains predominate, or where the cell site geometry is aligned and parallels only a major roadway. In these environments, the radio waves from the device cannot effectively travel to the LMUs so that its location parameters can be calculated and defined.

Since 2007, GPS handset expansion and more pervasive use of A-GPS have made location services available to more consumers. Additionally, a hybrid technology, A-GPS + AFLT (Advanced Forward Link Trilateration) does assist in challenges experienced due to visibility of the device to the satellite. Mobile device sensitivity does improve, including

reducing the time to first fix. It contributes significantly to A-GPS in low penetration buildings but fails to perform in buildings made of concrete, steel and glass. Yet, the AFLT + A-GPS hybrid cannot reliably meet Commission requirements in urban, dense urban and indoor environments.[14] Although AFLT is based on TDOA measurements of network signals, the technology is inferior to U-TDOA. AFLT relies on the mobile handset to make these measurements. The capability of the handset to perform extensive signal processing is substantially less than U-TDOA, where dedicated receivers and signal processors are deployed solely for location purposes.[15]

With regard to U-TDOA, TruePosition has noted several paths to improve accuracy.[16] These include software filtering of probable outlier information among multiple locations allowing location estimates to be refined, and deployment of additional LMUs. TruePosition has also stressed the need for appropriate level of maintenance and adequate LMUs to enable the technology to reach its optimal level. These elements remain true today.

The Commission's record describes clearly these aspects of location accuracy technology. A-GPS provides greater accuracy than U-TDOA in rural areas with few cell sites, in areas with poor cell site geometry (*e.g.*, "strings of pearls" along rural highways), or in areas with signal-blocking terrain. A-GPS does so only as long as there is an unblocked or partially unblocked sky. A-GPS does not perform inside buildings made of concrete, steel, and glass, or in urban canyons where the view of the sky is significantly obstructed.[17] These types of

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[14] Comments of Verizon Wireless at 16-20 (July 5, 2007) Comments of Sprint Nextel at 11 (August 20, 2007) and Comments of Qualcomm at 5-6 (July 5, 2007).

[15] Comments of TruePosition (August 20, 2007).

[16] Reply Comments of TruePostion at pages 7-9 (August 20, 2007).

[17] Testimony of Dale N. Hatfield Before the Senate Committee on Commerce, Science, and Transportation Hearing on Voice over Internet Protocol (VOIP) and the Future of 9-1-1 Services, April 10, 2007, *available at*:

buildings are found not only in urban areas, but are also prominent in suburban areas in shopping malls, stores, schools, and apartments. A-GPS is severely challenged with regard to indoor performance, since the GPS signal must come from the satellite. While a subscriber making a call indoors is able to connect with the nearby cell tower, the far-travelling GPS signal is unable to penetrate the building structure and accurately locate that caller.[18] With wireless now dominant and indoor use pervasive, these environments present the greatest challenge to locating 911 calls and the greatest opportunity for improvement. TruePosition's testing and analysis, set forth below, emphasizes these circumstances and presents a path to improved performance that will provide public safety agencies better location accuracy information and reliability.

Quantitative Data of Performance Capabilities

In the 10 years since wireless locations systems were first deployed for E911 purposes, significant testing has been conducted to evaluate the accuracy and yield performance of different technologies in various environments. In this section, TruePosition provides some examples of this quantitative data and analysis to assist the Commission with its evaluation.

TruePosition believes that this information and that already in the record shows where accuracy is challenged. It also points to how improvements can be obtained. Specifically, it is a well established fact that A-GPS can provide excellent location accuracy in environments where there is a clear view of the sky. It is also well known to those who have studied the issue that A-GPS has difficulty in some environments such as indoors and urban canyons. This is borne out in the quantitative A-GPS test results provided herein. The test data also show that precisely in

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<http://commerce.senate.gov/ public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=574099ef-977f-4ca6-9dea-95a6584cc2dc&Witness_ID=1ca16256-df5d-41b1-b9f5-6a1b65abe711>.

[18] *See* Comments of Verizon Wireless, PS Docket No. 07-114, at 17-20 (July 5, 2007); Comments of Qualcomm Inc., PS Docket No. 07-114, at 5 (July 5, 2007).

these same challenging environments (indoor in all three data sets, and urban canyon in the Manhattan data set), U-TDOA provides very accurate location results. Also well known is that multilateration techniques like U-TDOA do not work well in sparse rural areas where there are few sites from which to make timing measurements. But, these are precisely the areas in which there is likely to be a clear view of the sky enabling A-GPS to provide very accurate locations.

Combining the high accuracy of A-GPS in unobstructed environments with the complementary high accuracy of U-TDOA in urban and suburban environments (including indoors) will provide a "best of both worlds" solution. This can be achieved by employing a hybrid solution where A-GPS and U-TDOA technologies operate independently to obtain range estimates. Those estimates can then be used either independently to calculate two possible results, with the better one being reported, or they can be combined into a single location calculation. Employing such a hybrid wireless location system creates an improved location solution with enhanced accuracy, yield, and performance.

Austin and Frisco, Texas PSAPs

TruePosition worked with PSAPs in Austin and Frisco, Texas to test the performance of location technologies in various environments in multiple circumstances. Over 6500 live 911 calls were placed from dozens of test points located both outdoors and indoors in suburban and light urban environments. The indoor test points consisted of a mix between suburban office buildings (typical three-story office parks familiar to suburban neighborhoods) and high-rise office buildings and hotels in light urban areas. Location accuracy was evaluated for three different technologies: U-TDOA operating on a GSM network; Hybrid A-GPS/AFLT operating on a CDMA network; A-GPS operating on a UMTS network. End-to-End accuracy performance

was evaluated by comparing the ground truth Latitude/Longitude to those reported to the PSAP for each call.

The results for the outdoor test calls are shown as a Cumulative Distribution Function (CDF) in Figure 1, and summarized in Table 1. The results show that A-GPS provides very accurate location results when there is good visibility to the sky.

Figure 1. Cumulative Distribution Function for Outdoor Test Calls

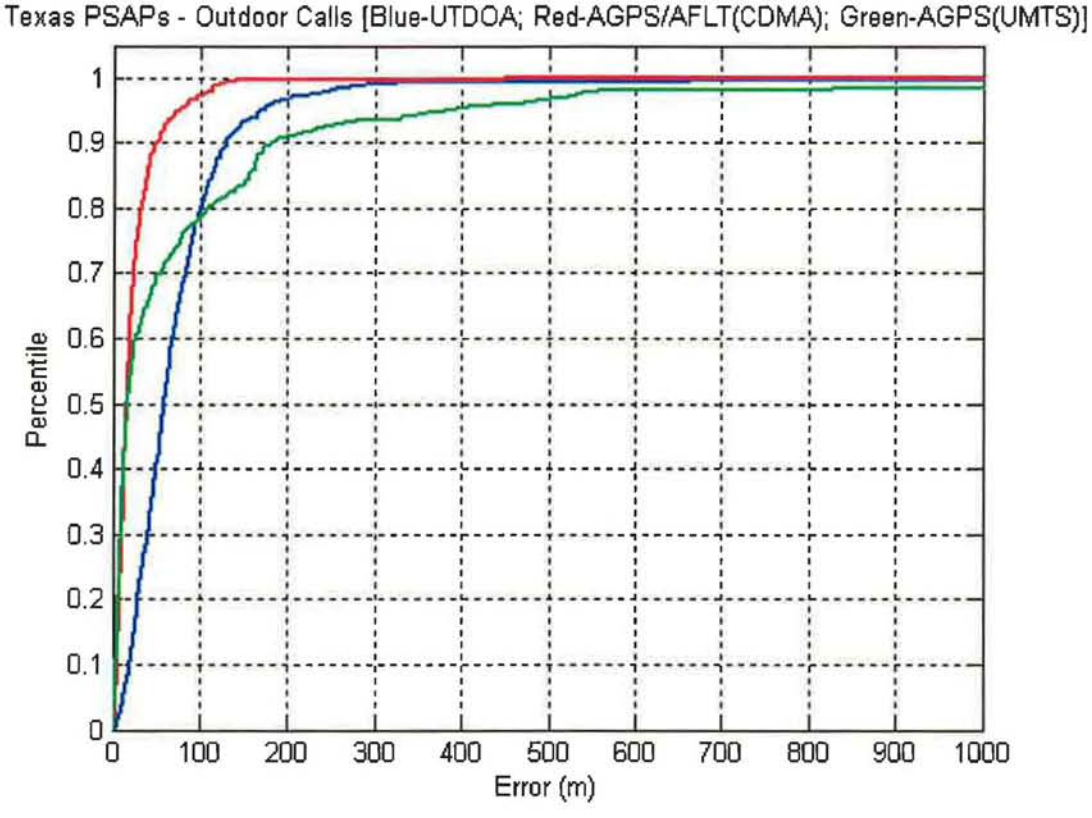

Table 1. Summary Statistics for Outdoor Test Calls

	Outdoor Test Calls		
Percentile	**U-TDOA**	**A-GPS/AFTL (CDMA)**	**A-GPS (UMTS)**
67th	78.3m	22.5m	35.6
90th	129.2m	50.7m	176.3
95th	168.6m	74.4m	390.3

The results for the indoor test calls are shown as a Cumulative Distribution Function (CDF) in Figure 2, and summarized in Table 2. It is clear that A-GPS solutions struggle in this environment. The CDMA implementation of Hybrid A-GPS/AFLT works better than the A-GPS implementation for UMTS. This is likely due to the CDMA advantages of having synchronized assistance capability as well as utilizing downlink timing measurements (AFLT) to aid the GPS solution. But, neither of the A-GPS solutions works nearly as well as U-TDOA in these indoor environments.

Figure 2. Cumulative Distribution Function for Indoor Test Calls

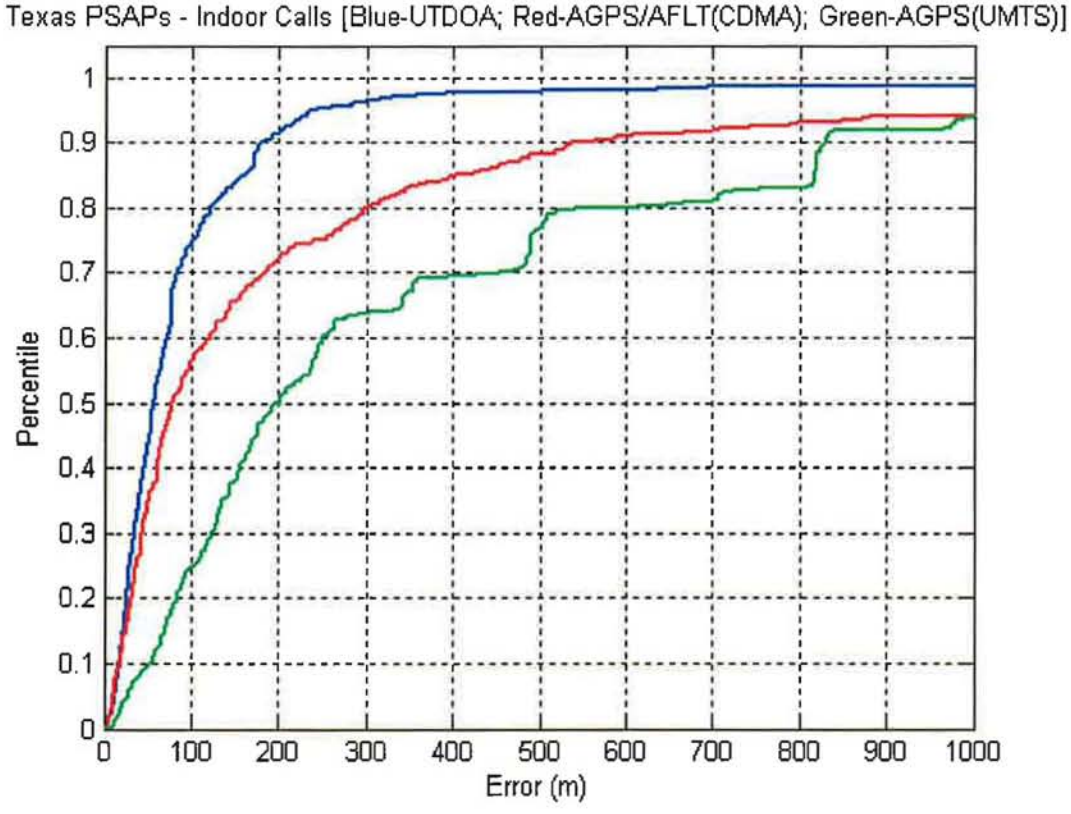

Table 2. Summary Statistics for Indoor Test Calls

	Indoor Test Calls		
Percentile	**U-TDOA**	**A-GPS/AFLT (CDMA)**	**A-GPS (UMTS)**
67th	77.5m	157.6m	357.2m
90th	178.5m	543.9m	829.6m
95th	239.4m	1088.2m	1438.6m

Wilmington, Delaware

To assess how location accuracy could be improved through the use of hybrid location technologies, TruePosition conducted testing in a light urban environment in Wilmington, Delaware. Several hundred test calls were placed from multiple test points that included a mix of indoor test points to a non PSAP facility. Locations were generated using U-TDOA and A-GPS, both on a GSM network. This particular implementation of A-GPS provided access to the satellite pseudo-range measurements, which are made by the mobile device to determine the time-of-flight of the signal from the satellite to the mobile device. This allowed TruePosition to compare the performance of three separate hybrid approaches. The Fallback approach uses the U-TDOA results only if A-GPS results are very poor. The Selection approach chooses the likely better solution from separate A-GPS and U-TDOA results. The True Hybrid approach combines measurements from both methods into a single computation. The details, and relative merits, of these approaches are discussed in the next section.

The results are summarized in Table 3. The data show that using a hybrid approach provides significantly better performance than can be achieved by either technology on its own.

The True Hybrid approach (combining measurements) provides the best accuracy, but most of the gain can be achieved by the simpler to implement Selection approach.

Table 3. Location Accuracy Statistics of Hybrid Technology

Percentile	U-TDOA	A-GPS	Fallback	Selection	True Hybrid
67th	98.7m	212.4m	95.7m	95.7m	82.6m
90th	127.2m	5977.8m	148.3m	123.5m	116.5m
95th	134.6m	6208.5m	231.9m	133.9m	128.9m

Midtown Manhattan, New York

In 2000, TruePosition conducted extensive testing with Verizon Wireless in midtown Manhattan involving CDMA mobile units. The test plan published by the CDMA Development Group sought to determine the performance of TruePosition's network-based location technology in the challenging urban canyon (10 to 25 story buildings) environment. In the trial, unmodified CDMA (IS-95) mobile phones were used to make more than 30,000 test calls in an area covered by 30 cell sites hosting time difference of arrival (TDOA) receivers- LMUs. The system demonstrated sub 100 meter location results in a variety of indoor, outdoor, pedestrian, and moving vehicle scenarios.

With a large number of test results available from different environments, accuracy performance was evaluated for several different usage profiles, with each profile representing different percentage of calls being placed in each environment. For example, Profile #1 represents the accuracy that would be achieved if 60% of calls were made by pedestrian, 35% from inside a vehicle, and 5% from inside a building. A summary of that accuracy performance evaluation is presented in Table 4.

Table 4. Accuracy Result for U-TDOA location system in various urban usage profiles.

	Profile		
Use Case Scenario	**1**	**2**	**3**
Pedestrian	60%	40%	34%
In-Vehicle	35%	40%	16%
In-Building	5%	20%	50%
67th Percentile	**88m**	**90m**	**96m**
95th Percentile	**226m**	**226m**	**204m**

This testing was performed 10 years ago. Since then, the wireless networks have grown significantly, resulting in much higher cell site densities. With Location Measurement Units installed in these new cell sites, the increased density of measurements will provide significantly better accuracy results if these tests were repeated with the wireless networks that are in place today.

The Path Forward

TruePosition believes that the current prevailing technologies are quite complementary to each other: one technology works well in environments where the other is challenged, and vice-versa. It is well established that A-GPS works very well when there is an unobstructed view of the sky and does not work very well in several common environments such as indoors and urban canyons. U-TDOA works well in suburban and urban areas, including indoors, but does not work very well in rural areas when there are few cell sites available from which to make measurements.

A combined approach can make meaningful improvements for public safety agencies locating an incident. TruePosition supports the approach being taken by major carriers that have already deployed a network-based solution. The existing network-based solution will meet the new Commission requirements in most counties, particularly where the vast majority (>90%) of people live and work. In addition, these operators are aggressively rolling out A-GPS enabled handsets to improve accuracy in places where A-GPS works reliably. The use of these two technologies can leverage the strength of two complementary solutions.

The hybrid path avoids leaving the consumer to choose between varied carrier and device location ability. Consumers and emergency response agencies must be able to rely on devices and networks meeting defined standards. The foundation of the Commission's historic polices addressing wireline and wireless information embraces this principle.

The appropriate use of network-based U-TDOA and handset-based A-GPS technology solutions can meet the needs of public safety in all but a small minority of environments (e.g., inside steel buildings in rural areas).[19] The following presents options for implementing an effective hybrid location solution. It is supported by the quantitative data discussed previously. TruePosition believes that such a solution provides the best possible location accuracy in all environments.

The Hybrid Approach

Implementing network-based location solutions while also deploying A-GPS handsets may not harness all the benefits of both technologies if only one or the other is used for a given emergency call. To achieve optimal benefits from a hybrid solution, one of the approaches

[19] In the rural area with cell sites at a significant distance, U-TDOA is challenged because of the lack of needed LMUs to gather the information and make the calculations; A-GPS is challenged in penetrating a metal structure.

described below must be pursued to take advantage of the complementary nature of the two technologies.

Fallback - In this approach, a location computation is initiated using one technology (e.g., A-GPS). The results are evaluated to assess whether it meets a certain Quality of Service (QoS), based on Uncertainty and Confidence Level, or other similar measure of expected accuracy. If the results are deemed acceptable, they are reported to the PSAP. If the results from the initial location attempt do not meet the desired QoS, then a location computation is initiated using the other location technology (e.g., U-TDOA). The result of both methods can then be evaluated and the location result with the QoS is forwarded to the PSAP.

This approach is the simplest to implement, but increases the latency of the available location results in cases where the second technology needs to be used. This approach does not make use of all the information available based on the two technologies utilized.

Selection – In this approach, location computations are initiated on both location technologies in parallel. The results from each technology are compared and the result with better QoS is delivered to the PSAP.

This approach uses more system resources than the Fallback method, but avoids the additional latency associated with performing the two location computation in series. The resulting accuracy will be more effective than the Fallback approach since the result from the second technology might have been better even when the result from the first method met the specified QoS. This approach still does not make use of all the information available based on the two technologies utilized.

True Hybrid – In this approach, location computations are initiated on both location technologies in parallel. Each method provides the raw measurements (satellite pseudo-ranges for A-GPS, and Time Delays of U-TDOA) rather than a computed location. The measurement from both technologies are combined and used to compute a single location that will be more accurate than either technology could have provided by itself. No further QoS evaluation is required. The resulting solution is forwarded to the PSAP.

This approach is the most complex to implement, but provides better accuracy then either of the other hybrid methods.

Based on our understanding of the architectures deployed by the major carriers utilizing a Network-based location solution and now rolling out A-GPS capable handsets, TruePosition believes a Selection-based Hybrid solution could be put in place relatively easily. This would provide most of the benefits of a Hybrid approach and require modest new development and

deployment effort beyond what is currently planned. Longer term, a True Hybrid approach could be developed with cooperation between vendors and the carriers.

Testing Protocols

TruePosition believes that testing performance in locations from which most calls are made, both indoors and outdoors, is critical to assisting emergency response and improving accuracy. In this section we address some of the questions raised in the *FNPRM* around testing and validation of deployed E-911 location systems and how OET 71 should be amended. TruePosition urges that a transparent testing regime be implemented that evaluates the indoor and outdoor location accuracy information transmitted to the 911 Center.

Need for periodic testing

Previous comments[20] have argued that once a location system is deployed, its performance usually gets better and not worse with time, such that on-going testing is unnecessary. This premise is contrary to TruePosition's experience with wide-scale deployment of location systems. Over time, many factors change, some improving accuracy performance, other hampering it.

For example, the footprint of a carrier's network changes constantly, as new sites are added and others removed. At a minimum, this requires configuration changes in the wireless location system. Similarly, the environment also changes: new buildings are built, farm land is developed into a new shopping mall or condominium complex. Location system vendors also introduce new features and capabilities. These are intended to enhance system capabilities and improve performance, but must be effectively integrated into the system and environment.

To identify the impact of the numerous changes that occur over time, we believe it is necessary to characterize system performance periodically. Experience has shown that such

[20] Corr Wireless Comment at page 6 (August 14, 2007).

testing often turns up hidden problems that can usually be rectified quickly once discovered. Periodic testing also has the benefit of identifying common issues such that procedures can be put in place to address them on an on-going basis. The anticipation of validation testing also provides motivation to ensure the location network is operating properly. It is TruePosition's observation that carriers that have instituted periodic testing also appear to do a better job of maintaining their equipment and updating configurations. Due to the described benefits, staggered, periodic testing improves performance everywhere and not just in areas where testing is currently being performed. Some major carriers have purposely employed a two-year cycle of validation testing.

Testing is an important commitment supporting the Commission's core objective in its location accuracy proceeding- giving citizens access to technologically advanced emergency response structures.[21] The testing structure should be transparent to the Commission, the PSAP and the public. It should encompass those environments from which most calls are made, including indoors. Testing, like other aspects of the Commission's rules, must replicate reality. It must keep pace with consumer expectations and emergency response requirements.

Testing Parameters

When location accuracy was assessed at a network wide level, it was fairly easy to ensure that an adequate number of test calls were placed, and that a wide variety of representative environments were thoroughly tested. Now that accuracy needs to be assessed at much smaller County or PSAP boundaries, care must be taken to ensure that the testing is statistically significant and provides valid data on which to base the assessment.

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[21] *FNPRM* at paragraph 1.

OET Bulletin 71 provides some guidance on providing enough test calls for each assessment area. If the area is easily meeting the required accuracy, a small number of calls (showing sufficient accuracy margins) may be enough, but in areas that are closer to the required accuracy, a significantly larger number of calls may be needed to validate that the requirements are being met.

There is also need to ensure calls are being initiated on every cell site. This will ensure proper configuration of the location system, as well as force diversity of test points.

Within a test area, County or PSAP, test calls from a specific cell site should be weighted according to the percentage of 911 calls originating on that cell site. This can be done by designing the test point in such manner, or by statistical weighting on the post-test data. This has the effect of removing some test point selection bias, as well as providing results that are more representative of actual calling patterns.

All test calls should be included in the analysis. While accuracy is the main criteria for compliance, it is meaningless unless yield is also taken into account. Each valid test call that is placed should be assessed for accuracy. If each call is not considered, results are diluted. A dropped call to 911 or one that cannot be calculated is just as devastating as one not providing adequate location information. If a position cannot be computed for a given call, then a very high error should be associated with that test call.

Indoor Testing Requirement

Various comments have previously put forth different numbers for the percentage of 911 calls that originate indoors.[22] Some conclude that no requirement should be put forth.[23] While

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[22] Verizon Wireless states that in selected markets, which it does not identify, approximately 80% of 911 calls are made from outdoors on or near highways, not indoors. *Ex parte* letter of Robert G. Morse, Esquire, Counsel to Verizon Wireless, PS Docket 07-114 (July 23, 2010).

identifying a specific percentage of indoor calls presents challenges, none are insurmountable or cost prohibitive. Absence of an indoor testing requirement would ignore the purpose of the Commission's rules and their objective: assisting emergency service in locating an incident. Disregarding calls for emergency service from indoors ignores reality and legitimate consumer expectation.

The National Emergency Number Association (NENA) notes that there are 240 million 911 calls per year and that one-third are wireless. Even at the lowest percentage advocated, 20% for indoor wireless 911 calls, such numbers equate to an average of 1,320,000 calls per month.[24] The quantity of calls and the continued dominance of wireless cannot be ignored in any serious testing protocol.

Recognizing the challenge in establishing specific percentages, particularly since it is likely to change over time, as well as the environments associated with indoor locations, TruePosition proposes that a separate accuracy standard be adopted for indoor calls. This would eliminate the need to identify a specific percentage of test calls to be placed indoors because indoor and outdoor performance would be measured separately. The outdoor requirements are already well defined. The indoor requirements could be set to a reasonably achievable level. Based on TruePosition's testing, a hybrid U-TDOA/A-GPS location system would be able to achieve 100m/300m level accuracy at the 67th and 90th percentile, respectively for indoor environments in the vast majority of urban and suburban counties/PSAPs and be consistent with established U-TDOA technology capability. A waiver process similar to the Commission's

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[23] QualComm Comments at pages 5-6 (August 20, 2007).

[24] NENA states that there are 240,000,000 911 calls per year and that the Commission's estimate that at least one third, 79,200,000, are wireless calls. http://www.nena.org/911-statistics. 20% indoor calls equal 15,800,000 annual wireless indoor calls, or 1,320,000 per month.

current policy can be used for the small minority of rural indoor areas where this metric is not achievable.

Another objection to indoor testing is difficulty and cost associated with performing such testing. These are legitimate concerns. Significant indoor testing has been performed by major carriers over the years. To alleviate these concerns, the testing requirements could be made less stringent for indoors. For example, if periodic outdoor testing is performed in an area to confirm that the overall location system is performing as expected, indoor testing could be performed on a less regular basis (e.g., every 4 years rather than of every 2 years). Similarly, the confidence level (per OET-71) of the results could be reduced so that accuracy levels could be established with a smaller number of test calls.

Compliance with the Commission's rules is vital to achieving the improvements the Commission seeks. Testing the location information a device transmits to the 911 Center is the only reasoned means to ensure that policies and rules seeking to assist public safety actually do so. A pragmatic and effective testing structure encompassing the source of calls, both indoors and outdoors, should be implemented by the Commission.

Next Generation 911

The *NOI* commences a broad inquiry addressing location accuracy obligations in the current and future mobile environment. The Commission recognizes that the range of devices, voice and data, continues to expand and are not within the CMRS regulatory model and its location accuracy standards. Yet citizens expect to summon 911 via any device and any format. The NBP recommends the Commission pursue location accuracy and ALI for all devices.[25] A

[25] NBP at page 325.

range of complex challenges are presented, including Commission and state jurisdiction, network interfaces, open standards, industry and PSAP readiness, investment and funding and transition mileposts.

TruePosition urges the Commission to be guided by NENA's principle when it defined NG911 as that encompassing all sources having access to emergency services:

> NG9-1-1 is the next evolutionary step in the development of the 9-1-1 emergency communications system known as E9-1-1 since the 1970s. NG9-1-1 is a system comprised of managed IP-based networks and elements that augment present-day E9-1-1 features and functions and add new capabilities. NG9-1-1 will eventually replace the present E9-1-1 system. NG9-1-1 is designed to provide access to emergency services from all sources, and to provide multimedia data capabilities for PSAPs and other emergency service organizations.[26]

The Commission should set an objective that all mobile devices have access to 911 and be capable of providing information allowing emergency response to locate the incident expeditiously. Commission leadership is critical. It is important to recall that the CMRS environment, only a decade ago, was unable to locate a cellular phone with any precision. Yet the Commission's emphatic embrace of the objective and its enforcement promoted investment, innovation and compliance. Any action requires a transition, yet the CMRS rules should be embraced as an obtainable near future standard, not a distant goal.

Industry Standard Setting Bodies

The importance of the Commission's objective to bring clarity to the broadband environment so that NG911 provides emergency response to all citizens parallels its inquiry regarding standard setting bodies. The *FNPRM* asks what are 4G industry standard setting bodies considering for location identification and how such activities might impact the

[26] National Emergency Number Association, Glossary – NG 9-1-1. http://www.nena.org/glossary/term/27.

Commission's flexibility in determining the best solution. It asks if there are incentives for wireless carriers to exceed the Commission's baseline location accuracy requirements?[27]

TruePosition's experience in the global standard setting body addressing system-wide specifications for broadband Long Term Evolution (LTE) indicates that it has selected only a subset of location technologies available for older (2G and 3G) technologies, and these selected technologies have fallen short of meeting current location accuracy requirements. The process has not been driven by the values of location information to emergency response, but by the business interests of a few participating manufacturers. Unless rectified, LTE deployment will set back wireless location accuracy. TruePosition urges the Commission to require broadband systems to meet its E911 wireless location rules.

Standards setting bodies serve a vital role in promoting system-wide specifications for devices and equipment for particular technologies. The important precepts of open standards and competition rely on the comprehensive technical work and debate that dominate these processes. In wireless telecommunications, the process addresses radio, network and service architecture. Industry participants from across the world include carriers, manufacturers and service providers. Resolving the numerous technical matters to present a standard means that ultimately standards setting bodies serve as gatekeepers to technologies that can be used on or connected to the particular networks. If a particular technology is not specified, it is essentially precluded from access to necessary network integration. Similarly, if a vital public policy is subordinated to other interests, it will be diluted if not ignored in the equipment and systems designed to meet the standards.

[27] *FNPRM* at paragraph 18.

The 3rd Generation Partnership Project (3GPP) seeking to establish system-wide specifications for broadband LTE technology specifically excluded a proven technology that has been widely deployed to successfully meet the Commission's standard for location accuracy. A US public policy priority, in this circumstance, emergency response, does not appear at the forefront of the deliberations. US policy to assist emergency response through modern communications technology is left at risk.

TruePosition participated extensively in the 3GPP working group responsible for specification of the physical layer in LTE radio interfaces. The effort included positioning and location technology. What emerged from over a year long process, in what is referred to as Release 9 (R9), is 3GPP's embrace of technologies that have fallen short of the Commission's well established CMRS location information requirements. R9 includes Observed Time Difference of Arrival (OTDOA) and A-GPS, but excludes U-TDOA technology as an option.

It should be noted that OTDOA, which was included in the R9 specifications, is based on the same principles as E-OTD (Enhanced Observed Time Difference), a technology that failed to meet the original FCC mandate and had to be replaced with alternative technologies, U-TDOA and AGPS. EOTD failed to meet the required accuracy for reasons which include: the inability to accurately synchronize or measure the timing of the base stations, the lack of adequate receiver and signal processing resources in the mobile phone to achieve the required sensitivity, time lag between measurements of signals from different sites and inability for the solution to sufficiently mitigate interference. These issues are fundamental, and will affect the LTE implementation of OTDOA. There are no installations in the US of OTDOA or EOTD operating in support of E911, yet it was included in R9. Meanwhile, U-TDOA, which is

deployed on 85,000 base stations in the US in successful compliance of the FCC accuracy requirements, was specifically excluded from R9, thereby benefitting certain manufacturers' technologies. The Commission's tenet of competitive neutrality is at risk. On R9's present course, the critical need that LTE devices and networks locate individuals summoning emergency response within the parameters of the Commission's E911 rules will be lost.

The Commission has justifiable reticence to participate or interfere in processes such as 3GPP. Efficiency is obtained when private interests resolve matters, particularly those involving significant technical detail. There is legitimate premise that the market is the best means to pursue investment and innovation. Yet in circumstances involving core government responsibility, such as effective emergency response, where there are no market forces advocating its importance, there must be a way to uphold the Commission's policies. The Commission should provide clarity in its rules that equipment serving the US market must meet its location accuracy standards.

3GPP failed to comprehend that providing location information for each 911 call evolved from a national policy debate in the US. US wireless location accuracy rules were pursued with an understanding that the costs are not trivial but are an element of the robust growth and investment in mobile communications. The Commission determined that knowing where the location of an emergency is of such a priority that it should be an integral element of our telecommunications networks. Standard setting bodies must discern and translate such a priority into their own processes.

TruePosition recommends that the Commission make clear that locating an individual seeking emergency assistance/public safety services must pervade the technical capability of

devices and equipment in the broadband environment and that its principle of technical neutrality be upheld. Without interfering in the detail of the processes, the Commission's ample authority as to what devices and equipment can serve the US market will protect this critical requirement. To obtain equipment authorization, a demonstrated ability, through verified testing showing conformance to the Commission's location accuracy rules, must be established.

Such clarity will promote emergency response, consumer expectation and the accompanying interests of national security and law enforcement. By making clear the Commission's expectation that providers and devices in the broadband environment be able to locate an emergency, standard setting bodies can embrace the important attributes that must be present for accessing the US market.[28]

Conclusion

The Commission can make a significant improvement to public safety by strengthening its wireless location accuracy rules. TruePosition urges the Commission to address emphatically the common environments currently suffering from lack of accurate location information- inside buildings and urban settings. Reasonable investment can extend current technologies to meet

[28] The Commission inquires of the ability of devices roaming among networks and the obligation to provide location information. The reason for wireless E911 is stronger for roamers than any other category- subscribers, not in their geographic area, are more likely unable to know where the emergency is.

Also queried is the availability of technology able to discern the Z axis and assist locating individuals in high rise apartment and office buildings. TruePosition is aware of no current capability that can efficiently address this challenge. Yet, the pragmatic path the Commission has pursued in VOIP devices, supplemented by State requirements where those provisioning and using Centrex or VOIP communications establish an accessible database where devices are located, provides a parallel that transmits important information to emergency response.

this challenge. The Commission should implement a testing regime evaluating where most 911 calls are made. More expeditious and higher quality emergency response will result. It is the Commission's actions that present the path to meaningful improvements.

Respectfully submitted,

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