Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Wireless E911 Location Accuracy Requirements	)	PS Docket No. 07-114
	)	
Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems	)	CC Docket No. 94-102
	)	
Association of Public-Safety Communications Officials-International, Inc. Request for Declaratory Ruling	)	
	)	
911 Requirements for IP-Enabled Service Providers	)	WC Docket No. 05-196

COMMENTS OF POLARIS WIRELESS, INC.

Polaris Wireless, Inc. ("Polaris"), through its attorneys, hereby submits its Comments in response to the Federal Communications Commission's Public Notice seeking comments on proposals regarding rules for wireless Enhanced 911 Phase II Location Accuracy and Reliability in the above-captioned proceeding.[1] With great interest, Polaris has reviewed the *ex parte* letters submitted by NENA, APCO, Verizon Wireless, Sprint Nextel Corporation, and AT&T submitted to the Commission and attached as Appendix A to the *Public Notice*.

Polaris strongly supports the efforts of the Commission, public safety groups and wireless carriers to improve the accuracy and reliability of E911 Phase II systems. These new proposals clearly signal that continued progress is possible despite the deadlock that previously existed.

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[1] *See Comment Sought on Proposals Regarding Service Rules for Wireless Enhanced 911 Phase II Location Accuracy and Reliability*, PS Docket No. 07-114, Public Notice, DA 08-2129 (rel. Sept. 22, 2008) ("*Public Notice*").

***About Polaris*.** Founded in 1999, Polaris is a privately held company that has developed and commercialized a wireless location software technology for the delivery of location services, including E911 Phase II public safety applications. Polaris's software products have been deployed extensively since 2003 in twenty-two GSM and IS-136 networks covering thirty-nine states to meet E911 Phase II emergency call location requirements and enhance their customers' safety. Currently, Polaris's software-only location systems provide E911 Phase II services to about 1000 PSAPs nationwide and process more than 10,000 emergency call locates daily.

Polaris's Wireless Location Signatures ("WLS") technology has several key advantages over alternative technologies: (1) no modifications are required in the handset, as opposed to GPS/A-GPS technologies; and (2) the location algorithms are implemented on a standard computer server, which requires no hardware additions to the base stations, as opposed to other network-based technologies such as U-TDOA (uplink time-difference-of-arrival) or AOA (angle-of-arrival) that require a new radio hardware overlay. In addition, the WLS system achieves high accuracy and reliability results due to its reliance on measurements that are made as a part of normal wireless network operations.

Because the WLS system uses serving and neighbor cell measurement information to estimate location, it is most accurate in high cell density environments where many measurements are often reported, such as dense urban and many indoor settings. Unlike other technologies, such as TDOA and AOA, WLS does not rely on line-of-sight paths between the base stations and handset, so performance can actually be improved in heavily cluttered, multipath environments. Moreover, due to the system's ability to leverage existing infrastructure, the initial investment to deploy an E911 solution with WLS is a fraction of the cost of alternate technologies, and deployment times are significantly faster than what is necessary to install a new radio network overlay or to replace the installed base of wireless handsets in the marketplace.

The Polaris WLS technology is based on the observation that the radio environment varies from location to location due to features such as terrain, buildings, foliage, and cellular signal coverage. If enough elements of the radio environment can be measured with sufficient accuracy, each set of measured values provides a radio signature that uniquely identifies a particular location. In typical cellular networks, handsets measure the signal strengths (or signal-to-interference ratios) of serving and neighbor sector broadcast control channels for normal handover operations. These measurements form the basis of the radio signatures used to locate the handsets.

WLS is well-suited to provide high accuracy in urban and indoor situations because of its unique ability to take advantage of shadowing conditions that can degrade other approaches that rely on line-of-sight circumstances, such as TDOA, AOA and GPS. First, urban areas typically contain extremely high cell densities because of the large concentrations of wireless users; therefore, many neighboring cell site measurements are reported in the signatures, enabling especially accurate location estimation. Second, through use of radio propagation modeling and geographical information system data and measurements, the Predicted Signature Database ("PSD") contains information about local shadow fading conditions. This is particularly critical in urban areas, where non-line-of-sight conditions are predominant due to extensive building obstructions and clutter. Third, the PSD contains information about predicted radio signal penetration into local buildings that can be used for indoor location estimation. Finally, Polaris is actively working to further improve location accuracy by incorporating additional measurement information into the signatures. While some of this additional information will require standards changes, it demonstrates the ability to improve accuracy in the future.

Although the E911 proposals are a welcome sign of progress, they fail to address key location accuracy challenges in urban and indoor environments. Throughout this proceeding, Polaris has maintained a consistent viewpoint that hybrid systems should play a significant role in improving the accuracy and reliability of the nation's vital E911 Phase II system. Hybrid approaches have the potential to deliver more consistent accuracy performance across the wide range of environments in which E911 calls are made because of the diversity benefit achieved from combining network-based technologies, which typically work best in high cell density environments (*e.g.*, dense urban), with handset-based technologies that tend to work best in open sky environments. A hybrid approach represents the best of both worlds.

While the new E911 rule proposals provide benchmarks toward compliance over smaller county-level geographical areas, they also propose relaxed accuracy thresholds and exclude many counties. Regrettably, Polaris believes that this proposed framework will not drive the adoption of the best E911 Phase II technologies available today, such as hybrid systems, nor will it achieve the greatest or fastest possible outcome for the American public. On the contrary, the new proposals will bring about two much less effective outcomes: (1) for handset-based carriers, it will maintain the status quo; and (2) for network-based operators, it will spark a migration to predominantly handset-based technologies. In the end, after the eight-year benchmarks have expired, the nation will be left with handset-based technologies, which often revert back to crude network-based fallback approaches when satellite fixes are not available in indoor and dense urban areas. Given the predominance of indoor wireless usage and the rapidly growing trend of wireline replacement, imagining a world eight years into our future, this is a far less than satisfactory outcome and in some ways represents a stagnation of E911 technology. In addition, the proposals fail to address important deficiencies with A-GPS technologies regarding location performance in dense urban areas. Absent timely progress on urban and indoor performance, the United States is likely to fall behind other countries with respect to public safety and emergency location technology.

Solutions exist today to improve indoor location performance, and those solutions have been tested in challenging urban environments. Polaris has conducted a number of field tests to assess the potential performance improvements of hybrid systems, compared to existing handset-based systems. These tests have been conducted predominantly in dense urban, urban, and indoor areas, where satellite-based systems may experience challenges with obstructions. The overall results from several of these trials were summarized in Polaris's prior comments.[2] For indoor testing in urban areas—where A-GPS alone often cannot obtain a location fix—Polaris's test results indicate that WLS accuracy performance is at or close to the handset-based accuracy thresholds. As part of these tests of hybrid methods, some field trials were conducted using blind test protocols in which only the wireless service provider that conducted the tests knew the ground truth locations of the test calls. Even under this type of rigorous test protocol, the field test results indicate that accuracy compliance measured at the county level is achievable in urban scenarios using hybrid methods.

As an example of field trial results relevant to indoor location performance, Figure 1 shows the trial area for testing conducted in Tokyo, Japan. The left side of the figure shows an aerial photograph of the urban trial area with green line border, depicting a mix of tall and medium height high-rise buildings near the Shinjuku train station in Tokyo. The right side of the figure shows the outdoor test call locations in blue and indoor test points in red. In this trial, a total of 379 outdoor and 281 indoor call locations were tested, so that about 43% of the total calls were indoor. The call locations were designed to uniformly and densely (approximately every 40 meters) sample the trial area.

The field trial was conducted over a widely deployed commercial 3G Universal Mobile Telecommunications System (UMTS) Wideband Code Division Multiple Access (WCDMA) network. The wireless carrier conducting the trial also has a commercial A-GPS system and a commercial Enhanced Cell Global Identity (ECGI, also called Enhanced Cell-ID) system. The objective of the trial was to assess the performance of hybrid systems combining Polaris's WLS

2 *See* Comments of Polaris Wireless, Inc., PS Docket No. 07-114, at 13-14 (filed Aug. 20, 2007).

with A-GPS technology. The measurements compared the location accuracy versus time-to-fix for Polaris's WLS, A-GPS and ECID location systems.

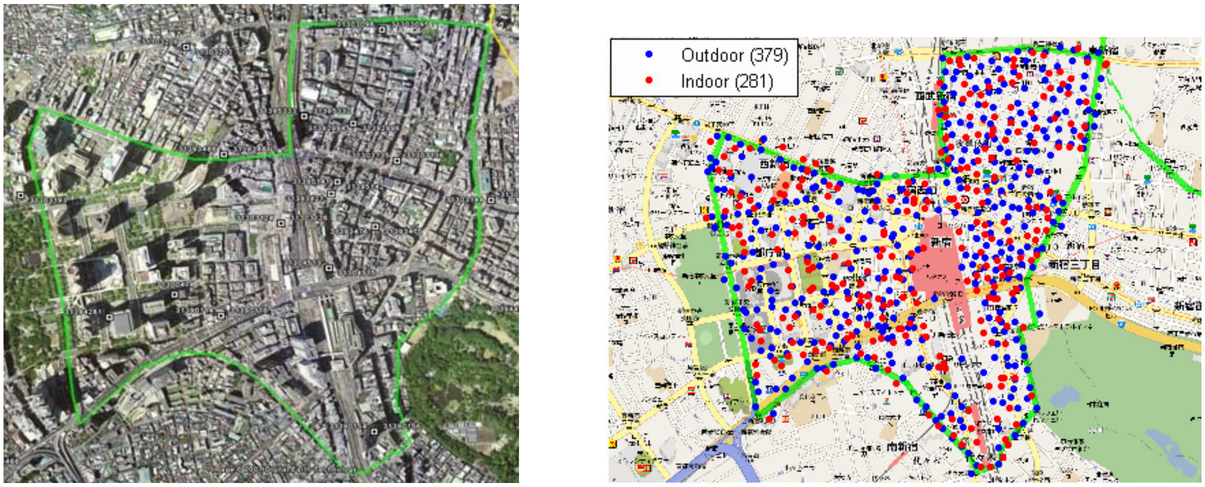

Figure 1. Tokyo urban trial satellite aerial photo (left) and test call locations (right), with outdoor calls as blue dots and indoor calls as red dots.

The Tokyo location accuracy results for the indoor test points are shown in Figure 2, which plots the 67th percentile accuracy versus the time-to-fix. The wireless carrier's existing A-GPS system (green curve) produces a location fix in 20 to 30 seconds with 67% of the calls located closer than 130 meters (presumably the A-GPS system falls back to ECGI for most of the indoor calls). The carrier's existing ECGI system (red curve) produces a fix in two seconds but with 67% of the calls located closer than 140 meters. The Polaris WLS system produces an initial fix in two seconds that has 67% performance better than 75 meters and improves to 60 meters in 10 to 15 seconds, as would be appropriate to operate within the 30 second window for location delivery under E911 Phase II requirements.

These results are for 100% indoor test calls, with WLS alone achieving 60-meter performance at the 67th percentile. In a hybrid combination with A-GPS, assuming a mix of outdoor and indoor calls as is contemplated for future E911 Phase II testing, achieving the handset-based benchmarks of 67% at 50 meters and 95% at 150 meters in urban areas is quite realistic, even at heavy mixes of indoor test calls.

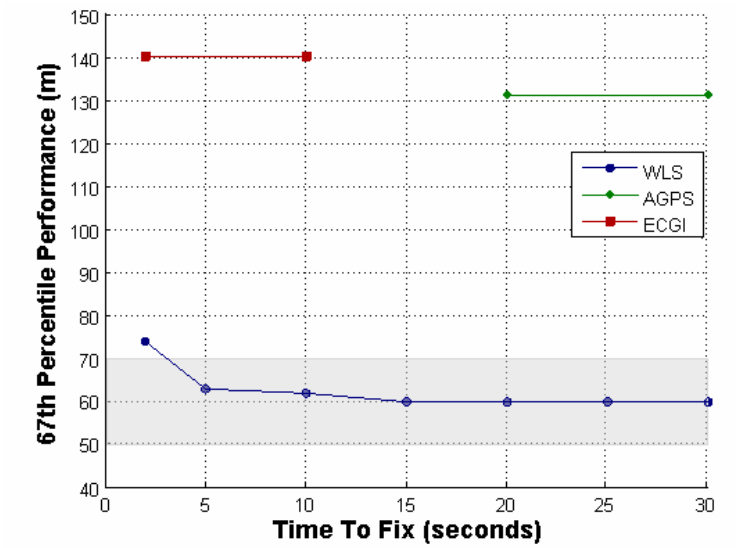

Figure 2. Tokyo urban trial indoor test call performance. Plot shows accuracy at 67th percentile (meters) versus time-to-fix (seconds) for existing commercial A-GPS system (green), existing commercial Enhanced Cell Global Identity (ECGI) (red) and Polaris Wireless Location Signatures (WLS) (blue).

Another example of indoor performance is shown in Figure 3 from testing conducted in Toronto, Canada. These results are from blind testing conducted by the wireless service provider on a widely deployed commercial UMTS WCDMA network. Figure 3 shows a Geographical Information System (GIS) diagram of the building outlines in the urban trial area. The particular building with test calls is shown in the center of the figure, with dark green circles marking a 100 meter radius around ground truth and light green marking 25 meter radius. The location estimates for the Polaris WLS system on GSM are shown as red 'x' symbols and on UMTS as magenta 'o' circles. From the figure, it is clear that many of the location estimates are within 25 meters and most all within 100 meters. Of the 40 test calls, all except two were estimated to be within the correct building. This is particularly encouraging because for indoor scenarios, many, if not most, calls would not be able to get A-GPS fixes due to obstructions of the satellite signals.

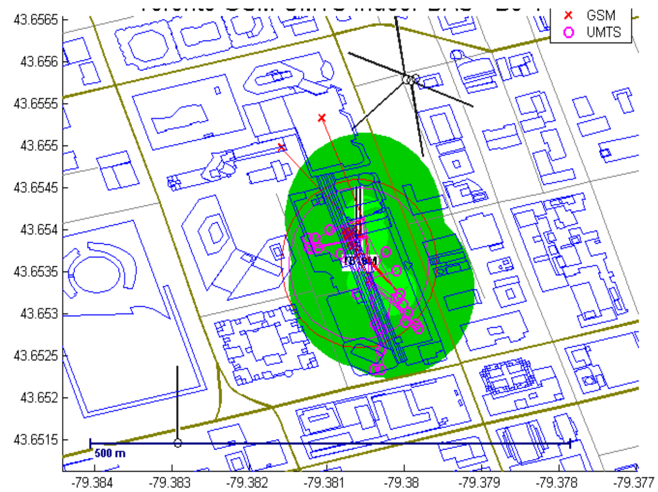

Figure 3. Toronto urban indoor location accuracy example. Dark green circles show 100 meter ring around ground truth, light green is 25 meter ring. Polaris Wireless Location Signatures (WLS) position estimates for GSM as red 'x' and for UMTS shown as magenta circles.

To demonstrate the overall performance improvement that can be achieved with hybrid systems in typical urban scenarios, results from an urban trial for a mix of indoor and outdoor test calls are shown in Figure 4. Error curves are presented for the A-GPS system alone (magenta), Polaris's WLS system alone (light blue) and the hybrid combination of WLS plus A-GPS (dark blue). The test results reflect that the 150-meter performance of the A-GPS system alone is about 79%, while the WLS alone performance is better than 91%. The hybrid combination position estimates from both WLS and A-GPS, however, achieved 150-meter performance of 98%. The hybrid performance curve is better than either the handset-based A-GPS system alone or the network-based WLS system alone. This hybrid improvement is most evident in the "tails" of the distribution (toward the right half of the figure) by the reduction in large outlier errors—an important factor in achieving the E911 Phase II consistency that the public safety community has noted is necessary.

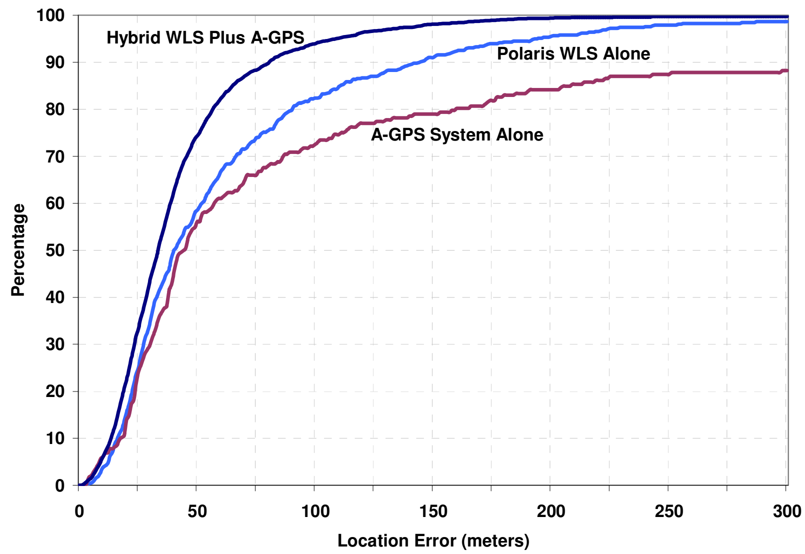

Figure 4. Plot of location accuracy in urban areas comparing A-GPS system alone (magenta), Polaris WLS alone (light blue) and hybrid combination of WLS plus A-GPS (dark blue) demonstrating hybrid improvement.

The results from these and other trials suggest that implementing a hybrid system would result in improvements in accuracy ranging from 30% to over 65%, depending upon the type of existing network and A-GPS system. These improvements represent significant performance gains, particularly for prevalent indoor and urban calling scenarios, that should be harnessed to drive accuracy and consistency improvements for E911 Phase II.

Conclusion. Polaris greatly appreciates the Commission's solicitation for public comment on these crucial E911 Phase II proposals. Polaris is also pleased that the new proposals reflect continued progress in this proceeding. However, after carefully reviewing the new proposals, Polaris observes that the proverbial "elephant in the room" is urban and indoor location performance. A hybrid solution that combines network-based and handset-based technologies is by far the best approach to achieving consistent accuracy—for emergency callers both outdoors and indoors. Yet the proposals on the table only address half the problem—creating the 50% solution. The field trial results contained herein, including blind tests conducted by major wireless carriers in multiple cities, demonstrate that urban and indoor performance can be dramatically improved beyond current levels by employing hybrid systems. With such options readily available and demonstrated in field trials, the Commission should consider raising the bar for indoor and dense urban accuracy in the near future.

Respectfully submitted,

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