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
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	)	
Association of Public-Safety Communications Officials-International, Inc. Request for Declaratory Ruling	)	
	)	
	)	
911 Requirements for IP-Enabled Service Providers	)	WC Docket No. 05-196
	)	

REPLY COMMENTS OF POLARIS WIRELESS, INC.

Polaris Wireless, Inc. ("Polaris"), through its attorneys, hereby submits its Reply Comments in response to Section III.B of the Federal Communications Commission's Notice of Proposed Rulemaking in the above-captioned proceeding.[1] Polaris has reviewed the comments filed in response to Section III.B of the *NPRM* and desires to elaborate on several points raised by other parties.

Polaris continues to support the Commission's efforts to improve the accuracy of public safety E911 Phase II systems. Based on Polaris's experience, hybrid systems should play a significant role in improving accuracy as a step toward meeting the Commission's stated goals in the *NPRM*. Hybrid approaches have the potential of providing more consistent accuracy

[1] *See Wireless E911 Location Accuracy Requirements*, PS Docket 07-114, *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, *Association of Public-Safety Communications Officials-International, Inc. Request for Declaratory Ruling*, CC Docket No. 94-102, *911 Requirements for IP-Enabled Service Providers*, WC Docket No. 05-196, Notice of Proposed Rulemaking, 22 FCC Rcd 10609 (rel. Jun. 1, 2007) ("*NPRM*").

performance across the wide range of environments encountered with E911 calls 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.

Although hybrid systems will not solve all of the potential problems associated with location accuracy requirements measured at the PSAP level,[2] Polaris's test results – including conclusions from blind tests conducted by wireless carriers – indicate that hybrid systems can most certainly improve accuracy beyond current levels, particularly in urban areas where current handset-based approaches encounter known challenges with urban canyons and indoors.[3] Moreover, upgrading current handset-based A-GPS systems to hybrid methods could be accomplished easily and economically (now that the "heavy lifting" of penetrating A-GPS capable handsets has been achieved) because Polaris's network-based location system is a software-only technology, rather than a radio network hardware overlay. Because further testing in different environments and conditions remains necessary, however, the Commission should also facilitate stakeholder meetings to exchange test data and provide guidance on the best practices for improvements in E911 capabilities.

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 by eleven U.S. wireless carriers in sixteen TDMA IS-136 and GSM networks 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

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[2] *See* Comments of QUALCOMM Inc., PS Docket No. 07-114, at 6-7 (filed Jul. 5, 2007); Comments of Verizon Wireless, PS Docket No. 07-114, at 16-19 (filed Jul. 5, 2007) ("Verizon Wireless Comments"); Sprint Nextel Comments, PS Docket No. 07-114 at 8-12 (filed Aug. 20, 2007).

[3] *See* Verizon Wireless Comments at 16-18.

services to about 900 PSAPs nationwide and process approximately 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 neighbor 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 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 requires standards changes, they demonstrate the ability to improve accuracy in the future.

An evolution to hybrid systems could achieve compliance at the PSAP level in urban areas through a straightforward and economical upgrade path. Fundamentally, Polaris's experience indicates that the overall accuracy and consistency of E911 Phase II systems can be improved through the application of hybrid technologies, combining network-based and handset-based elements. As the record on this *NPRM* demonstrates, hybrid systems cannot solve all of the complex and varied challenges associated with achieving PSAP-level accuracy compliance. However, Polaris believes that the Commission's overarching goal of improving E911 Phase II accuracy can best be achieved by adopting hybrid approaches.

Polaris views a hybrid solution as the best long-term approach to improve location accuracy and consistency. Although there are many conceivable hybrid combinations of different technologies to improve accuracy, Polaris considers the ideal hybrid solution to be the pairing of a network-based and a handset-based technology. The foundation for improving location accuracy in a hybrid system is the introduction of measurement diversity, which reduces the detrimental impacts of errors (particularly large outliers). The best measurement diversity, in turn, is achieved when measurements are derived from systems in which errors are not correlated. For example, combining one network-based technology with another would not optimally improve location accuracy because the errors would tend to be correlated. Network-based technologies have errors that vary based on terrestrial cell site densities and geometries among other factors, so different network-based technologies may tend to experience large errors in similar locations. However, handset-based technologies have errors that vary based on satellite densities and geometries, among other factors. Thus, combining a network-based technology with a handset-based technology results in better accuracy benefits because the terrestrial cell site and satellite configurations are independent of one another (*i.e.*, not correlated).

Hybrid solutions leverage the strengths of two highly complementary technologies, particularly when combining handset-based A-GPS with a network-based pattern-matching technology such as Polaris's software-only WLS approach. Polaris's WLS location information is less correlated with handset-based A-GPS than other network-based technologies, such as U-TDOA or AOA, in urban environments. Urban shadowing that leads to multipath conditions can cause location errors in A-GPS systems, as well as in U-TDOA or AOA systems; however, urban shadowing actually improves the location accuracy of Polaris's WLS.

The Polaris WLS pattern matching system achieves its best accuracy in high cell density and cluttered environments, such as urban outdoor and indoor locations. In contrast, A-GPS

achieves its best performance in open sky conditions, such as outdoor suburban and rural settings, where several satellites are visible in line-of-sight to the handset. Polaris's hybrid system uses information from both WLS and A-GPS to provide more consistent accuracy across the range of environments.

Polaris's WLS approach for hybrid systems can be deployed more rapidly and economically than hardware-based network overlay methods because WLS relies on a software-only method of determining location. For wireless carriers currently using handset-based location technologies, adding Polaris's WLS system as the network-based component of a hybrid system can be accomplished by installing computer servers and creating the prediction databases, including drive test calibration. No new radio hardware installation and no network overlay of equipment would be required. As is the case in many different industries, software-based systems generally can be deployed with lower overall costs compared to specialized, hardware-based approaches. While installing any new location system is consequential and significant, Polaris estimates that for carriers that are currently using handset-based systems for E911, this hybrid upgrade step could be accomplished well within the five-year time window adopted by the Commission.[4]

Polaris's tests indicate that hybrid methods can dramatically improve E911 accuracy, particularly in urban areas. 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

[4] *See FCC Clarifies Geographic Area Over Which Wireless Carriers Must Meet Enhanced 911 Location Accuracy Requirements*, PS Docket No. 07-114, CC Docket No. 94-102, News Release (Sept. 11, 2007).

several of these trials were summarized in Polaris's prior comments,[5] and percentage improvements in accuracy ranged from about 30% to over 65%, depending upon the type of existing network and A-GPS system. 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 within 30% of that obtained outdoors, and often times within 20%. 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 PSAP level is achievable in urban scenarios using hybrid methods.

While the expected performance improvement of hybrid systems with WLS, based on these test results, is promising and significant, further testing is required in different environments and conditions. The evolution to hybrid systems does not guarantee that PSAP-level accuracy will be achieved in each and every case, but it is critical that the industry seize the major improvements that are available. Industry stakeholder groups, such as the E911 Technical Advisory Group (ETAG) proposed by AT&T,[6] would be excellent forums to exchange test data and compare test methodologies, since different systems need to be compared on a level playing field and across a broad range of scenarios.

Conclusion. Polaris appreciates the Commission's efforts in the *NPRM* to seek public comment on these crucial E911 Phase II matters and strongly believes that a hybrid solution that combines network-based and handset-based technologies is by far the best approach to achieve the desired outcome of more consistent accuracy. Polaris's test results indicate that compliance at the PSAP level could be achieved in urban scenarios using hybrid approaches. Because Polaris's

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

6 *See* Comments of AT&T Inc., PS Docket No. 07-114, at i (filed Jul. 5, 2007).

network-based technology is a software-only solution, the upgrade path from current handset-based systems to hybrid methods could be accomplished quickly and economically compared to hardware-based alternatives.

Any rules resulting from the *NPRM* should drive the wireless industry toward the most efficient methods of implementing hybrid systems, particularly in areas where the largest benefits can be achieved, such as urban areas for carriers that are currently using handset-based approaches and rural areas for carriers using network-based approaches. Due to the extreme range and complexity of issues associated with accuracy testing and location technology evolution, the Commission should facilitate stakeholder meetings to provide guidance on the best practices to move forward.

Respectfully submitted,

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