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

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In the Matter of	)	
	)	
Revision of the Commission's Rules	)	
to Ensure Compatibility with	)	CC Docket No. 94-102
Enhanced 911 Emergency Calling Systems	)	
	)	

To: The Commission

PETITION FOR RECONSIDERATION OF FOCUSYSTEMS, INC.

FocuSystems, Inc. ("FocuSystems"), by its attorneys and pursuant to Section 1.429 of the Rules of the Federal Communications Commission ("FCC" or "Commission"), respectfully requests reconsideration of the *Fourth Memorandum Opinion and Order* in the above-captioned docket[1], insofar as it compels wireless carriers to declare what type of technology they plan to use to meet the Phase II Automatic Location Identification ("ALI") requirements set forth in wireless enhanced 9-1-1 ("E-911") rules, before a feasible and affordable technology solution is available. While FocuSystems supports the Commission's seven-month deferral of the date for initial distribution of ALI-capable handsets, the interim benchmarks for activating new ALI-capable handsets will force many carriers that select a handset-based approach to make substantial investments in equipment and switch upgrades long before any PSAP in their operating territory is prepared to utilize the ALI data. As a result of such investments, these carriers will have a significant disincentive to considering newer handset-based technologies that are currently under development and which are likely to provide superior performance and other benefits that are in the public interest.

[1] In the Matter of Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling System, CC Docket No. 94-102, *Fourth Memorandum Opinion and Order*, FCC 00-326, 65 Fed. Reg. 58657 (October 2, 2000).

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STATEMENT OF INTEREST

FocuSystems is a privately-owned corporation with offices in Rockport, MA, Scottsdale, AZ, and Newark, CA, that is in the business of designing and operating systems that facilitate the location and tracking of personnel and property, as well as providing a wide variety of location-based services using wireless handsets (*e.g.*, cell phones) as a source of information. A recent white paper discussing the Company's technology is attached.[2]

While the recent elimination of selective availability for GPS has significantly improved the accuracy of that data, this improvement does not impact the unavailability of GPS in certain environments -- such as indoors or where the GPS signal is obscured by tall buildings or trees. To solve this problem, FocuSystems has developed a land-based technology that is capable of locating a receiver within 10 feet, 90% of the time. The FocuSystems technology has the added benefit of working indoors, and its designers say that their system can also provide the United States with a backup system for many GPS applications, such as timing for the nation's telecommunications and electric utility grids. The new patent pending technology has been termed Ground Locator System (or "GLS").

The GLS system would also result in lower equipment investment by wireless carriers considering a network-based solution (the elimination of a per-tower investment of $20,000 or more) and the accomplishment of the public safety goals articulated in the Communications Act of 1934, as amended (the "Act")[3], and by the FCC in CC Docket No. 94-102. It is a handset solution that makes use of a terrestrial network to be constructed on an aggressive schedule by FocuSystems.

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[2] *See* October 30, 2000 White Paper, "Precise Time of Day and Navigation-Location Technology" by Leonard Thomas, Vice President Advanced Development, FocuSystems, Inc. ("White Paper") at Attachment A.

[3] One of the Commission's statutory mandates under the Act is "promoting safety of life and property

FocuSystems is an interested party in this proceeding because the interim benchmarks adopted by the FCC for wireless carriers to begin selling ALI-compliant handsets will effectively prevent such carriers from considering newer handset-based technologies that are currently under development and which are likely to provide superior performance and other benefits that are public interest.

I. THE INTERIM BENCHMARKS FOR ACTIVATION OF ALI-CAPABLE HANDSETS ARE UNDULY BURDENSOME AND SHOULD NOT APPLY TO WIRELESS CARRIERS THAT HAVE NOT RECEIVED A VALID PSAP REQUEST FOR PHASE II SERVICE

In adopting the *Fourth MO&O*, the FCC modified its Phase II rules with respect to carriers that choose handset-based ALI technologies by extending from March 1, 2001, to October 1, 2001, the date for carriers to begin selling and activating ALI-capable handsets. FocuSystems supports this reasonable extension because it recognizes marketplace realities, but believes the extension should be longer. In particular, there is still no guarantee that handset manufacturers will be able to produce ALI-capable handsets in sufficient quantity to allow all carriers to meet the October 1, 2001, deadline, and delays in the Commission's issuance of guidance regarding ALI accuracy testing and verification have contributed to the delayed development of ALI-capable handsets.[4] It would be unfair to impose such an obligation upon wireless carriers (with the potential for Commission sanctions for non-compliance) when all but the largest companies are unable to control or otherwise influence the decisions of equipment manufacturers. However, the Commission's revised rules impose further handset activation benchmarks as follows:

- December 31, 2001: at least 25 percent of all new handsets activated are to be ALI-capable;
- June 30, 2002: 50 percent of all new handsets activated are to be ALI-capable;

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through the use of wire and radio communication." *See*, 47 U.S.C. § 151.

[4] *Fourth MO&O* at ¶ 12 (*citing* Reply Comments of Nokia and Motorola).

- December 31, 2002 and thereafter: 100 percent of all new digital handsets activated are to be ALI-capable.

FocuSystems strongly supports the Commission's goal of meeting public safety needs "as quickly as reasonably possible."[5] However, FocuSystems respectfully submits that these ALI-capable handset activation deadlines are unworkable for many carriers, especially those providing service in rural markets. In particular, many carriers have not yet received a request for Phase I service, let alone more advanced (and more expensive) Phase II services. In rural markets, carriers believe they are unlikely to receive a PSAP request for quite some time. In light of the new ALI-capable handset activation deadlines, carriers that are not likely to receive valid PSAP requests for several years will be forced to adopt and to begin deploying handset-based technologies that are not yet perfected or that may be ill-suited for the geographic, topographic, or other environmental realities (*e.g.*, indoors, inside parking garages or tunnels, under cover of trees or near tall buildings) which exist throughout their networks.

To avoid these problems associated with deployment of a handset-based solution, wireless carriers may be forced into considering a network-based solution instead; but they are understandably hesitant to make a public declaration of their technology choice (even if they may change their selection in good faith) when network solution manufacturers have not proffered detailed price and availability information to allow a reasoned decision by the carrier, and because network solutions are ill suited for certain situations (*e.g.*, in rural networks or remote areas served by a single cell site). In recognition of this, the Commission should therefore modify its rules or otherwise clarify that it will grant waivers of its handset activation benchmarks to carriers not yet subject to a valid PSAP request for Phase II service.

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[5] *Id.* at ¶ 17.

II. THE COMMISSION SHOULD REMOVE ANY DISINCENTIVES FOR CARRIERS TO ADOPT NEWER HANDSET-BASED TECHNOLOGIES WHICH ARE LIKELY TO PROVIDE SUPERIOR PERFORMANCE AND OTHER BENEFITS THAT ARE PUBLIC INTEREST

Because carriers that select a handset-based approach are required by the Commission's rules to make substantial investments in equipment and switch upgrades long before any PSAP in their operating territory is prepared to utilize the ALI data, these carriers will have a significant disincentive to considering newer handset-based technologies that are currently under development and which are likely to provide superior performance and other benefits that are in the public interest. In this regard, FocuSystems and others believe it is possible for the wireless industry, in conjunction with the public safety community, to create a nationwide E-911 location technology safety net that is as ubiquitous as 9-1-1 service itself. However, efforts to create such a solution will be hamstrung if carriers are forced to select their E-911 technology prematurely, or if carriers that select handset-based ALI solutions are required to begin selling and activating ALI-capable handsets as early as October 1st of next year.

Carriers face significant expenses in selecting, testing and deploying Phase II E-911 solutions. Most carriers can only afford to make this choice one time, and will be reluctant to change their minds once a selection that imposes legal obligations has been made. The Commission should therefore modify its rules as necessary to remove this disincentive.

The Commission has modified its E-911 rules to promote competition and has sought to maintain technological and competitive neutrality in so doing.[6] However, the fact that many carriers who elect a handset-based approach will be required to purchase and activate ALI-enabled handsets before receiving a valid PSAP request acts as a significant barrier for

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[6] *Fourth MO&O* at ¶ 27.

companies that are developing new technologies and the carriers that may wish to adopt such new technologies. FocuSystems believes that a nationwide E-911 location technology safety net can be developed, and the public interest would be served, only if these handset deployment benchmarks are modified accordingly.

CONCLUSION

For the reasons stated above, FocuSystems respectfully requests reconsideration of the policies and rules adopted by the Commission in the E-911 *Fourth Memorandum Opinion and Order*.

Respectfully Submitted,

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Attachment A

October 30, 2000 White Paper
"*Precise Time of Day and Navigation-Location Technology*"
by Leonard Thomas, Vice President Advanced Development, FocuSystems, Inc.

CONTENTS OF THIS WHITE PAPER ARE COMPANY CONFIDENTIAL
AND PROPRITEARY TO FOCUSYSTEMS, INC.

WHITE PAPER

File: W_Paper1.doc
October 30, 2000
Len Thomas, VP

PRECISE TIME OF DAY
and
NAVIGATION – LOCATION TECHNOLOGY

ABSTRACT

The location of a mobile wireless device can be accomplished using one of two basic techniques. The first technique, the handset solution, involves the wireless mobile receiver recording the arrival time of radio signals from three or more known transmitter locations. The mobile receiving device, then having knowledge of the location of the transmitting device and the time of transmission, is able to calculate its approximate location based on the time differences in the radio signal transmission from each location.

Two systems currently exist that employ the handset solution. They are the LORAN-C system developed for maritime navigation by the US Coast Guard in the 1950's and the NavStar Global Positioning System (GPS) developed for the US military, intended for aerial navigation. Both systems provide excellent performance for the intended purpose, but neither system is entirely suitable for the location of wireless transceivers inside of buildings, under heavy foliage or between tall buildings.

The second technique, the network solution, involves the use of three or more receiving devices at fixed locations. These receiving devices identify a desired signal from a mobile transmitter and record the time of arrival of the particular signal at each receiving location. The time data is sent to a common site where the approximate location of the mobile unit is calculated using the same technique as employed in the handset solution.

A multitude of systems have been developed that employ the network solution. These systems have primarily been developed in response to the Federal Communications Commission (FCC) Docket No. 94-102 and subsequent amendments. These network solution systems depend on the reverse signaling channel or the reverse voice channel signal of the mobile (PCS or Cell Phone) system for the correlation of time differences.

The factors that limit the accuracy and the reliability of radio location systems include reflected radio signals (multi-path), radio signal bandwidth and signal-to-noise ratio, clock drift and error between signal transmitting or receiving devices, radio signal interference, and the geographic geometry of the location determining/measuring sites.

Since the theoretical limit of time correlation accuracy depends on the signal bandwidth, location accuracy of plus or minus 100 meters in 67% of the cases does not seem possible in an environment that includes the other limiting factors that are noted above.

The need for a GPS backup system is outlined in this paper, as is the need for a more precise and more widely available location signal. Therefore, it is the position of FocuSystems that a terrestrial network be deployed to back up the existing GPS network and that enhancements be included in that system to address various needs of the location industry, especially the need for an ultra-reliable location receiver for those applications that involve public safety and the risk of life.

The FocuSystems Position

The Global Positioning System (GPS) was developed by the military for precise aerial navigation. However, it now finds application in the provision of precise time (frequency) and precise time-of-day. The precise time signal is currently used for the synchronization of all digital telephone (voice and data) networks, the synchronization of the nation's electric power grid, and for the synchronization of digital cell phones and the Personal Communication Systems (PCS). It also provides the basis for location technology related to wireless transmitters and receivers in both the handset and the network solution as well as in sports, recreation and automobile navigation systems. Currently all of these services depend on signals provided by GPS or, on rare occasions, by the LORAN-C radio signal, an earlier maritime radio navigation system.

Certainly the military never intended the widespread use or the current national and international dependence on the GPS network. This dependence has spread to all of the developed countries in the world to the extent that no developed nation would consider deliberately disrupting the service unless they had a backup system in place. However, the potential threat posed by dissident fundamentalist groups cannot be ignored. The impact of service disruption was best described in an article published in the June 2000 issue of Discover magazine, page 52 to 57. In part, the article provided the following assessment:

"*If our public clock failed, the Internet would dissolve into an array of free-standing, no-longer-networked computers. Trade would abruptly cease on Wall Street, and money and shares would come to rest wherever they were. Air traffic would stager to a halt. Scientific labs of every description would find themselves deprived of their most fundamental measure. Even a temporary desynchronizing in the 21st century would leave turmoil in its wake. We would see in a sudden, displeasing instant how vitally our lives are shaped by agreement on the smallest measurable part of a second.*"

And that is a conservative assessment when one considers the fact that digital switches control virtually all national telecommunications services (both local and long distance), fixed location telephones and mobile (PCS and cell) phones. A network clock controls the rate at which the switches send and receive digital data. Small variations in the clock rate between switches can be accommodated with frame slips (deletion or replication of frames of 193 bits), but at the expense of increased data error rates. Larger variations can and will result in "switch crashes". While backup synchronization can be provided by the LORAN-C signal, most carriers have abandoned that system. Local atomic clocks at $50,000.00 per copy can also be used, but are only to be found in the telecommunications carrier's labs. In short, GPS is so good that we have forgotten what it was like without it. Much like we have forgotten what it was like when all long distance telephone circuits were noisy and when data transmission at 4,800 bits per second with an error rate of one part in 10^{-6} was considered wonderful. Truly, an option to return to these "good old days" is now out of the question. Considering that GPS provided all of these unexpected and unintended benefits, one must consider what level of service can be provided if a GPS backup system were designed with the intention of providing these services.

Ground Locator System (GLS) - the system design proposed by FocuSystems includes a single design for all GLS time and location transmitters and three models of GLS receivers. One receiver model would be intended for synchronization only. It would be used as a backup for systems that now use the existing GPS network for their network synchronization (precise frequency only). The second model would be used for general location much like current GPS receivers, except that it would function indoors as well as outside and with an accuracy that exceeds that of the current GPS receivers. The third model is designed to provide a very reliable and highly accurate service to be used in applications where life and public safety are the major consideration.

The design of the GLS transmitter includes the shared use of a single frequency band nation-wide, and on a time-shared basis. In that respect it is similar to the existing GPS and LORAN-C networks. The GLS transmitters will be at fixed locations and operate in a frequency band that is less susceptible to reflections than the existing GPS network or the existing cell phone networks. The transmitter power level will be dictated by the specific location and application. The GLS transmitter will transmit the necessary "time stamp" signal plus a data message that includes the transmitter identification code, its location (including elevation) and the precise time of transmission. Provisional patent applications were filed in February 2000 and the final applications are being prepared for submittal at this time. Prototype systems are currently in development and field trials are planned for January 2001. Design information will be included in the FocuSystems Web site (focusystems.com) after the patent applications are finalized and submitted to the US Patent Office. The GLS system design includes most of the features of the existing GPS and LORAN-C networks, but with a number of new and enhanced features. FocuSystems considered naming the new service LORAN-D or even GPS 2.0, but finally opted for the more conservative name of GLS to describe a ground based version of GPS.

The GLS system is designed to operate in concert with the existing GPS system, but has the ability to survive in the absence of GPS, even providing equivalent services during long term unavailability of GPS. That feature alone should aid the survivability of GPS against terrorist attacks by the removal of the disruptive impact of such an attempt.

The factors that limit the accuracy and the reliability of radio location systems (and the type of system that they impact) include:

1) Reflected radio signals – multi-path (handset and network solutions),
2) Radio signal bandwidth (handset and network solutions),
3) Radio signal-to-noise ratio (handset and network solutions),
4) Clock error between signal transmitting devices (handset solution only),
5) Clock error between signal receiving devices (network solution only),
6) Receiver short term clock drift (handset solution only),
7) Radio signal interference (handset and network solutions),
8) The geometry (geographic location) of the location defining or determining elements (handset and network solution).

In addition, battery power consumption and the time to acquire a location fix are important issues that need to be addressed for application in the portable handset devices.

The following section addresses each of the above accuracy and reliability limiting factors and describes the measures that are taken in the GLS design to resolve (where possible) or reduce the impact of each of the limiting factors.

1. **Reflected radio signals**: All location and navigation systems that depend on the measurement of radio signal transmission time (propagation delay) are impacted by this factor. The lower frequencies tend to penetrate trees and buildings rather than reflect. The only way to totally resolve this issue is to assure a line-of-site radio path between all transmitting and receiving devices. In fact, this method is employed in the enhanced receiver version, but it is not practical for the general application. In the general application where more than four timing sources are available, it is possible to determine the existence of and to identify the radio path that is reflected. This data may be used to calculate the Estimated Position Error (EPE) for the more advanced receivers. The impact is reduced for the case of the standard receiver by selecting a frequency band below 300 MHz. Hardware design and testing is now in progress to determine the precise frequency band and bandwidth that are needed. Completion of this effort is expected before year-end with field verification completed in January.

2. **Radio signal bandwidth**: The theoretical limit for location accuracy is totally dependent on the bandwidth of the radio signal that is used to convey the timing information. In the case of the network solution, the bandwidth is that of the reverse control channel or the reverse signaling channel. Improved location accuracy is not possible without a complete redesign of the cell phone and PCS networks. Also, in the case of the network solution, the reverse channels occupy multiple frequency assignments. Considering the value of radio frequency spectrum, one would have to consider the alternatives to increasing the reverse channel bandwidth allocation.

   One alternative is the handset solution. Currently two handset solutions exist; they are the LORAN-C and the GPS networks. LORAN-C was designed for maritime navigation and operates on a radio carrier frequency of 100 kHz using 20 kHz of radio frequency spectrum. With that frequency and limited bandwidth, the system was able to provide a location accuracy of plus or minus 500 feet using vacuum tubes and 1950's technology. Single station signal coverage is provided in all of the fifty United States, and three or more station signal coverage (minimum requirement for location and navigation) is provided for maritime service over most of the northern hemisphere. The LORAN-C system has successfully provided the service for which it was intended for nearly 50 years. However, its basic design does not allow upgrade to meet the current requirements.

   The second available handset solution is the GPS system. Like LORAN-C, it serves its intended purpose very well, but its intended purpose was military and aerial navigation. FocuSystems has designed a handset solution whose intended purpose is terrestrial location and navigation, both indoors and out-of-doors. Prototype design is in progress and field trials are expected to be in operation, available for demonstration before the end of January 2001.

3. **Radio signal-to-noise ratio**: A major limitation of GPS is the signal-to-noise ratio whenever there is an obstruction in the line-of-site path between the satellite and the GPS receiver. Due to the great distance between the satellite and the GPS receiver, the high frequency employed, and the difficulty in gaining access to the satellites, modifying the GPS satellites does not seem to be a practical solution. An equally difficult situation exists in the network solution. Cell networks are designed with directional antenna systems and operate with the minimum radio signal level consistent with an acceptable audio signal-to-noise ratio. Only a sufficient number of cell towers are constructed to provide communications coverage and allow hand-off from tower to tower without the loss of the connection. Location and navigation applications require signals with acceptable signal-to-noise ratios from three or more signal paths (four or more if elevation data is also needed, and five or more if location accuracy quality assurance is needed).

4. **Clock error in the time-of-day transmitting systems (GLS handset solution only)**: All existing navigation networks (even LORAN-C) currently depend on GPS for precision timing. LORAN-C combined with the LORAN monitoring stations can operate independent of GPS if the need should arise (provided the triple redundant cesium clocks that are located at each LORAN transmitting location have been properly maintained). The National Security Agency (NSA) and the personnel associated with National Security and Emergency Preparedness (NSEP) are responsible for addressing this issue. The GPS network also includes a very sophisticated performance-monitoring system.

   A performance monitoring system (modeled after the LORAN monitoring stations) is included in the GLS design. In the GLS network, an interface is provided for an external reference timing input at each transmitting station (from LORAN signals or from cesium atomic clocks). With the addition of the cesium clocks at key sites, the GLS network could provide the same backup capability as is currently provided by the LORAN-C system.

5. **Clock error in the signal receiving stations (network solution only)**: This is the same issue as in 4., above, except that the network solution does not provide an NSEP backup system of any kind. The timing for the location determining elements depends on GPS with no backup provisions.

6. **Receiver short-term high stability internal oscillators**: The availability and low cost of these oscillators is demonstrated in the existing GPS receivers.

7. **Radio signal interference**: The GLS network solution depends on the availability of a dedicated band of interference-free frequencies. The network solution has no protection from interfering signals, but can in fact expect them since channels are shared between cells that could be nearby, if not adjacent.

8. **The network geometry**: Navigation and location networks depend on signal overlap and a site geometry that includes signals from many wide angles. The greater the number of timing sources and the wider the angle of arrival, the better the expected accuracy. With GPS, 6 to 10 (or more) sources may be available at any given time.

A cell phone or PCS communications network is designed to provide coverage for the maximum number of customers with the minimum number of tower locations. Therefore, one may expect to find cell towers arranged in straight lines along the major transportation corridors. Conservation of valuable radio frequency spectrum in metropolitan areas requires that more and smaller cells be deployed. A key advantage to the use of GLS design and the handset solution is the possibility of using higher power GLS transmitters, but at far fewer sites. The cell phone tower location issue of "not in my neighborhood" is avoided. Low power GLS transmitters would be installed to cover the gaps in signal coverage in areas where coverage is desired, but otherwise unavailable. These units could be installed above ceilings, on the sides of buildings, or on power poles where they are available. With the network solution, more sites will be required and the selection of the location will be dictated by geometry, not by the neighborhoods.

Receiver power requirements and time to acquire a location fix: The time to acquire a location fix from the GPS network depends to a great extent on the length of time since the unit was last used and the distance traveled since its last use. Worst case may be as much as 15 minutes; typical is 15 seconds. The goal for GLS is less than one second for worst case. Provided that this design criterion is realized, it will be practical to keep the location portion of the handset turned off until it is needed. Test results are expected to confirm (or modify) this goal before the end of January 2001.

CONCLUSION

Three specific needs are identified in this paper and a single solution, FocuSystems' GLS, is offered that addresses all three of them.

- A backup system for GPS.
- A location system designed for terrestrial, commercial applications. One that functions in doors as well as outside. One that functions in concert with the existing GPS network or as a stand-alone system.
- An enhanced location system for use in critical applications where life and safety depend on precise, reliable location, such as a hospital.

This paper has addressed eight critical areas related to the current attempt to use the existing PCS and cell phone network equipment to locate these wireless devices. Based on this evaluation, one must conclude that it is highly unlikely that the wireless communications networks that exist today can ever be converted into an operationally acceptable location network.

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