BINGHAM

March 8, 2012

Moslem Sawez
Wireless Telecommunications Bureau
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: Nextivity, Inc. Response to Request for Information -- WT Docket No. 10-4

Dear Mr. Sawez:

Nextivity, Inc. ("Nextivity"), by its undersigned counsel, is pleased to respond to your specific questions regarding the potential impact of the Nextivity signal booster on 911 emergency assistance calling services.

Nextivity is a leading developer of indoor coverage technology which optimizes the experience of wireless subscribers and increases wireless network capacity for mobile operators. Nextivity's high capacity, ultra-low latency indoor technology offer end users and carriers a reliable solution to even the most challenging indoor environments. As such, Nextivity supports Commission rules that would facilitate well-designed signal boosters that allow carriers to meet soaring demand for improved wireless service coverage in difficult to serve areas including indoor environments. To assist in implementing rules that facilitate the use of signal boosters, Nextivity, together with T-Mobile, has offered a proposal for the design, operation and, where necessary, the installation of signal boosters that will achieve greater wireless coverage while protecting carrier networks from harm.[1]

Mobile network signal boosters offer many important public interest benefits to end users, the carriers that serve them, as well as to the first responder community. As a threshold matter, Nextivity points out that greater signal booster use will improve the availability and delivery of emergency services to end users.[2] In this letter, Nextivity addresses whether and to what extent its signal booster technology affects E-911 calling

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1 *See* Letter from Steve Sharkey, Chief, Engineering and Technology Policy, T-Mobile, USA to Marlene Dortch, Secretary, FCC, WT Docket No. 10-4 (Feb. 17, 2012.)

2 *See Amendment of Parts 1, 2, 22, 24, 27, 90 and 95 of the Commission's Rules to Improve Wireless Coverage Through the Use of Signal Boosters,* WT Docket No. 10-4, Notice of Proposed Rulemaking, rel. Apr. 6, 2011, at para 12 (where signals are deficient, boosters enable public to connect to 911 in emergencies.)

and location accuracy. Nextivity specifically provides detailed information on the design and operation of signal boosters that will enable the Commission to accurately assess any concerns raised about signal booster impact on E911 systems. Nextivity also recommends several simple operational protocols that will help ensure location accuracy is maintained.

At the outset, it is important to recognize the relatively minimal number of calls that potentially could be affected by signal boosters:

- Nextivity estimates that signal boosters will affect <2% of E-911 calls placed with 3G terminals as 3G terminal by default rely on A-GPS technology for E-911 location.

- Further, the fraction of E-911 calls affected is decreasing over time due to advances in and greater use of A-GPS receivers.

Signal boosters also affirmatively provide certain important advantages for E911 calling services:

- Boosters improve indoor A-GPS accuracy as GPS assistance information is made available.

- When A-GPS fails, round trip time ("RTT") measurements can be used to locate a subscriber.

1. What is the duration of the signal delay introduced by currently manufactured signal boosters?

Nextivity's product currently shipping in the North American market has a delay of 13.6 μs (microseconds) Nextivity's next generation product will have a delay of 7.2 μs or 13.6 μs (software selectable).

2. Is the delay taken into consideration in the design phase of the signal booster?

Yes, Nextivity tries to minimize the delay whenever possible. It is one of the Company's key design parameters.

3. If so, are there specific goals for minimum delay and maximum delay?

For maximum delay, Nextivity specifies that the delay should be less than 14 μs. This allows 6 μs of multipath delay spread to be added to the received signal and still be

within the 20 μs delay spread window that all WCDMA systems are tested against per 3GPP TS 25.101.[3]

Nextivity does not specify a minimum delay. The minimum achievable delay is a consequence of the filtering and signal processing algorithms implemented in the booster.

4. What specifically causes the delay?

The main sources of delay within the Nextivity product are:

(a) Delay through cellular radiofrequency ("RF') front end and transceivers,

(b) Delay introduced by digital filtering algorithms used to achieve

- Band select behavior
- Channel equalization
- Interference cancellation, and

(c) Delay through the interconnect between the Window Unit and Coverage Unit.

To provide a sense of the delay introduced by a digital filter, consider that 128 tap FIR filter operating at a sampling rate of 38.4 MHz (both typical numbers for a digital channel select filter) will have a nominal group delay of 1.6 μs. In order to build a complete system with high gain and consequently good indoor coverage, good signal quality, and unconditional stability, a number of filters and channel equalizers are required, very quickly adding up to the approximately 7 μs delay.

5. Some Location Measurement Units ("LMU") at the cell site may select the booster signal which has a built-in delay instead of the mobile handset signal, therefore causing a location inaccuracy. Can Nextivity discuss the possibilities of signal boosters with digital watermarking, i.e., signals that can be identified at the LMU as those of a signal booster, and consequently not used for location measurements?

Digital watermarking is possible. However, as discussed below, several significant technical and practical considerations apply.

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[3] *See* 3GPP Technical Specification 25.101 available at http://www.3gpp.org/ftp/Specs/html-info/25101.htm

6. Can Nextivity also discuss the pros and cons of the above-mentioned digital watermarking ?

First, digital watermarking places a fundamental limit on the signal-to-noise ("SNR") ratio that can be achieved on the uplink. For example, if a watermark signal is injected with 10 dB less power than the main signal, the SNR is limited to 10 dB, irrespective of the output power of the device. Injecting the signal at much lower levels requires the LMU to "dig" the signal out of the noise using for example spread spectrum processing gain. This would require complicated processing at the LMU and more stringent frequency accuracy requirements at the booster as noted below.

Second, the higher the amount of processing gain needed as a result of digital watermarking, the more stringent the requirement on the frequency accuracy of the booster becomes (in order to support long coherent integration lengths). The greater frequency accuracy required with digital watermarking significantly drives up the component cost of the booster as well as the testing and integration costs of consumer boosters in the operator's network. Essentially, a digital watermarking requirement will move the consumer booster from an easy to deploy consumer electronics solution to almost a network element.

In considering the utility of mandating digital watermarking, the Commission should weigh the following practical considerations (which Nextivity believes apply equally to WCDMA boosters and CDMA boosters).

(a) In the vast majority of E-911 uses, boosters are <u>not</u> a factor in E-911 positioning for 3G devices

- Approximately 15% of consumer haves indoor coverage issues.
- Based on data provided by T-Mobile, for the case of 3G phones, more than 60% of all E-911 location determinations are done using A-GPS. Furthermore, with the constant improvement in A-GPS receiver sensitivity, this percentage will continue to rise.
- If we assume that 30% of 3G phone users deploy boosters at home or in their businesses to solve their coverage problems.
- Then ***the total affected population is <2% of the overall subscriber population***. Even this conservative estimation shows that the calls potentially affected by a signal booster is exceedingly small.

(b) In what instances would error be introduced by the use of a signal booster?

- In most emergency calling situations, AGPS is used. When A-GPS is not available, Round-Trip Time ("RTT") is used in a WCDMA system to locate a subscriber.

- For cases where a subscriber is only able to see a single base station, the E-911 requirement of better than 300 meter accuracy can only be met for very small cells using the RTT method. This is due to the fact that the RTT method locates a subscriber on an arc in the sector only. In the example on Attachment A, the case is shown for a subscriber located 4 km from the base station. Without a booster present, the mean location error will be 1.53 km vs. 3.27 km with a booster with 7.2 μs delay.

The question is whether, based on these small number of cases, the potential increase in error is material in the context of emergency operations.

***7.* How can the error be minimized?**

Nextivity recommends adoption of two simple operational protocols in order to minimize the potential number of instances in which location accuracy is reduced in the presence of a signal booster.

(a) Always measure RTT based on first arriving path

- Very often the signal from the handset propagates to the base station using multiple paths. Although it is possible that the strongest signal may be through the booster, in most cases, the strongest signal will be the direct path from the handset to the base station.

- If the LMU always uses the first arriving path in time to perform location determination, any possible error that could arise in the presence of a booster will be minimized.

- Measuring the RTT based on the first arriving path is already supported by the 3GPP standard (*see* 3GPP TS 25.215 rev. 8.4).

(b) Discard obviously erroneous measurements

- If the size or approximate size of a cell is known and the booster delay is relatively large (*e.g.*, 7.2 μs or 2.16 km), then RTT measurements that yield subscriber positions outside the cell coverage area can be discarded automatically as erroneous.

Nextivity opposes a requirement that would mandate watermarking signals from boosters used in RTT measurements. Instead, to reduce any potential impact of a signal booster in the small percentage of emergency calling cases that may be affected, Nextivity proposes the following requirements for E911 systems:

- The first arriving path is always used

- Obviously erroneous measurements are discarded

Although these protocols will not completely eliminate all possible increase in error when a signal booster is in use, Nextivity believes that the above-mentioned approach will minimize any potential impact of boosters on E-911 services relevant to the small percentage (estimated <2%) of all 911 calls made in the presence of booster signals.

Coupled with appropriate disclosure to subscribers, we believe that boosters should be allowed to operate in the network as the benefits far outweigh the risks introduced to the E-911 system.

Please do not hesitate to contact the undersigned if you have any questions regarding this material.

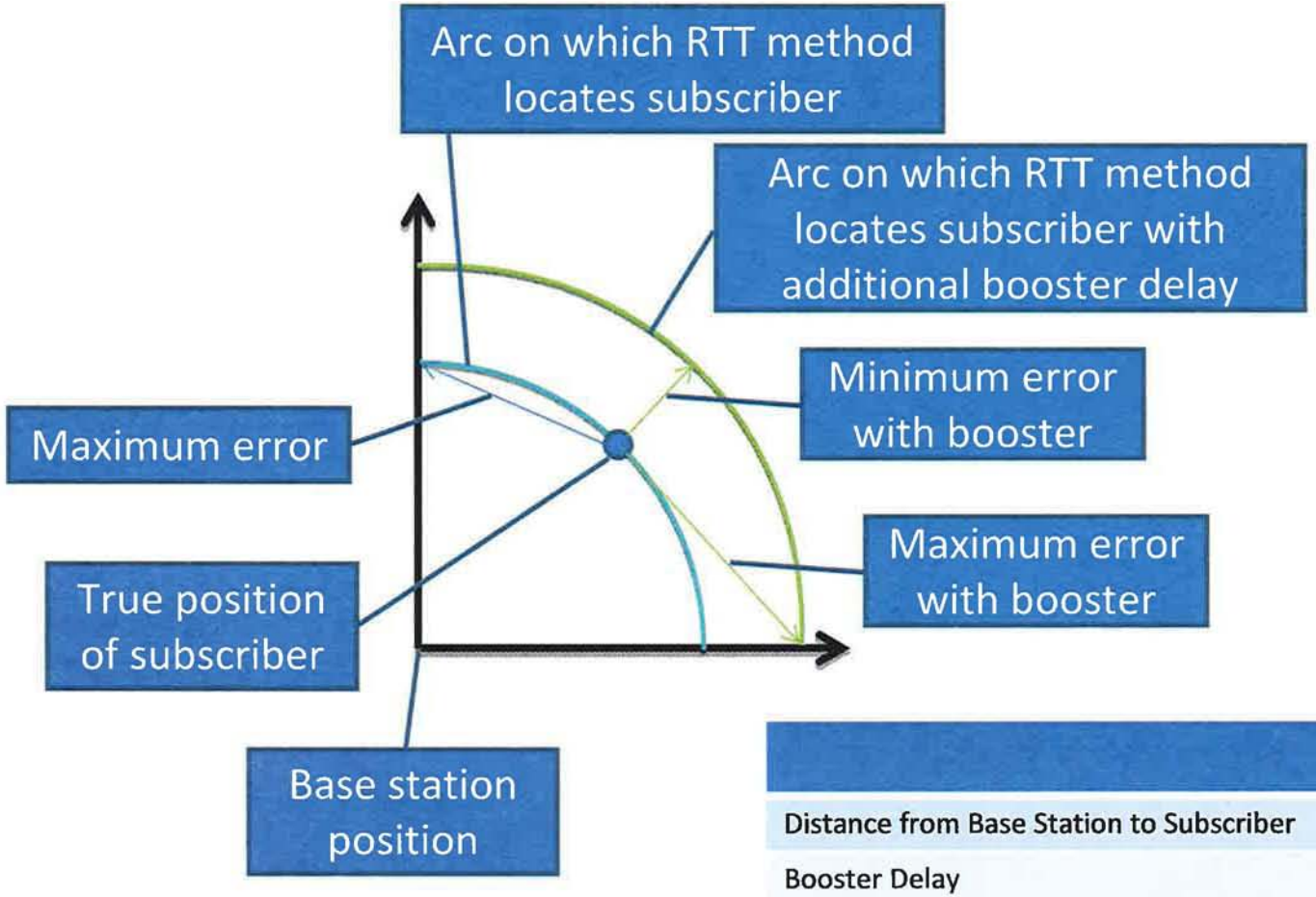
Very truly yours,

William B. Wilhelm
Catherine Wang

Attachment

cc: Michiel Lotter

E-911 accuracy and the influence of boosters



E-911 accuracy requirement not met in both cases

	No Booster	With Booster
Distance from Base Station to Subscriber	4km	4km
Booster Delay	0us	7.2us or 2.16km
Minimum error	0km	2.16km
Maximum error	3.06km	4.37km
Mean error	1.53km	3.27km