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

In the Matter of	)	
	)	
Wireless Telecommunications Bureau seeks	)	
comment on petitions regarding the use of signal	)	WT Docket No. 10-4
boosters and other signal amplification techniques	)	Released Jan 6, 2010
used with wireless services	)	
	)	
_____	)	

NOTICE OF EXPARTE COMMUNICATION
MILLARD/RAINES PARTNERSHIP
("SMART BOOSTER")

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Intelligent Signal Boosters and the Future of Wireless Communications

Michael Millard and Jeremy K. Raines, Ph.D., P.E., inventors of the Smart Booster, are pleased to submit the following ExParte Communication to WT Docket 10-4.

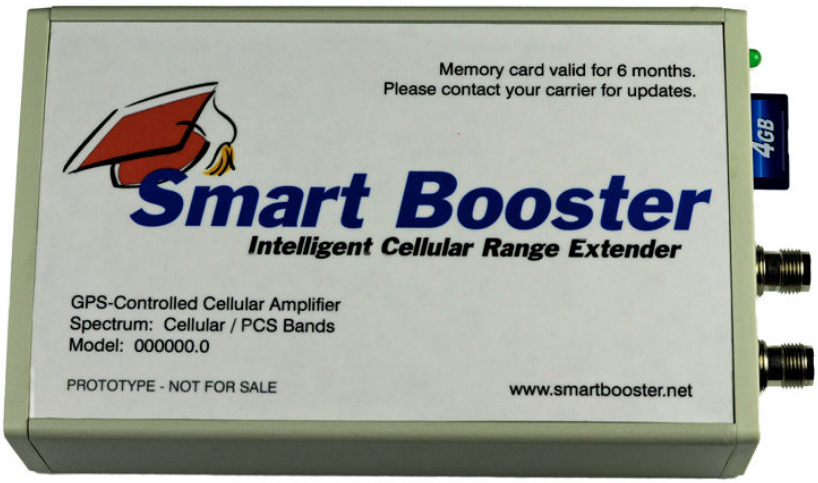

Figure 1 – Smart Booster Prototype Device featuring removable, updateable memory as seen at upper right.

Introduction

In January, 2010, the FCC invited comments concerning signal boosters and cellular communication networks. In February and March, 2010, the Commission invited follow up or reply comments.[1] The purpose of this document is to respectfully submit further remarks on that subject, with the benefit of the perspective and reflection that elapsed time inevitably provides.

The original purpose for inviting comments was clear and remains clear. That is, there is a conflict between cellular and PCS network providers and the users, suppliers, and manufacturers of signal boosters. Some boosters cause substantial interference to the networks in well documented cases. On the other hand, at locations where cellular or PCS

[1] See: ECFS WT Docket 10-4.

service is marginal or completely unusable, boosters have made wireless communication possible, including on occasion, in life threatening situations.

Our initial comments in February, and our reply comments in March, proposed the intelligent booster as the clear and obvious solution to the conflict. We continue to advocate intelligent boosters, and in particular our version called the Smart Booster, as shown in Figure 1. The reasons are more compelling than ever.

Intelligent Boosters Must Be an Integral Part of Future Wireless Networks

The traditional base station does not provide coverage for much of the USA, and there are practically no prospects that it ever will. Base stations are too expensive to construct and maintain if they serve only a sparsely populated area. There is no financial incentive to install them.

The signal booster overcomes this obstacle. Small, inexpensive, and portable boosters extend the range of traditional base stations and fill the gaps in coverage.

Signal boosters will not only be in demand for the future. They are in demand now, as evidenced by the robust sales from over a dozen manufacturers. Unfortunately, these boosters cause interference problems because they are not intelligent. That is, they do not know when to deactivate themselves at locations where they are not necessary. They contribute significantly to ambient noise levels, and they overwhelm base stations with over amplified signals that exceed network design assumptions. Only an intelligent booster has the capability to avoid these problems.

Present Boosters Are Not Sufficiently Intelligent to Avoid Causing Interference to Cellular Networks

Boosters are presently available from many manufacturers, and the features they offer to avoid interference range from absolutely none to patented anti-oscillation circuitry and an adaptive procedure called "forward link sensing". None of these are sufficient to protect base stations from interference, for the many reasons discussed in this section.

For example, Wilson Electronics[2] offers "forward link sensing" in some models. Forward link sensing is synonymous with continuously monitoring the downlink signal from all nearby carriers' cell site towers or base stations. When the downlink signal is sufficiently strong, the Wilson booster proposes to reduce or eliminate its gain in an attempt to minimize interference to those cell towers or base stations.

While this methodology may initially seem logical, in fact it creates at least two significant problems in real world situations. They are: (1) false positives and (2) unnecessary signal boosting in densely populated areas.

False Positives

False positives occur when a subscriber to one carrier is in proximity to a cell tower belonging to another carrier. If the downlink signal from that other carrier is sufficiently strong, then the Wilson booster will shut itself off. The undesired consequence is that, if the subscriber is located where the use of a signal booster is truly required, then that subscriber will experience dropped calls. This will occur whenever the Wilson booster passes in close proximity to a

[2] Wilson Electronics, 3301 E. Deseret Drive, St. George, UT 84790. A booster manufacturer and petitioner in these proceedings.

competitor's cell site. Where cell sites are constructed immediately adjacent to major highways, vehicle occupants may experience dropped calls every few minutes due to false positives.

In cases of fixed installations, for example inside a building, the Wilson booster will never activate if it detects a sufficiently strong downlink signal from a competitor's base station. As a result, the installation inside the building is rendered useless.

Undesirable Signal Boosting in Densely Populated Areas

False positives can be reduced; however, that reduction itself has very undesirable consequences. To reduce the false positives, the threshold for the monitored downlink signal can be raised so that the booster deactivates only in very close proximity to a tower. Unfortunately, this means that the booster will be activated practically everywhere, including locations where it is definitely not needed. For example, Wilson proposes to deactivate its booster only when the downlink signal is -45 dBm or greater.[3] This is equivalent to a radius equal to or less than 0.13 miles, or 700 feet, from a tower.[4] That is, the booster would be activated at all distances greater than 700 feet from a tower.

It is obvious that Wilson cannot have it both ways. It cannot employ forward link sensing to protect a base station while simultaneously minimizing the effects of false positives. Shrinking

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[3] Notice of ExParte. Wilson Electronics, Inc. ECFS: 05/26/2010 Supporting Documents, "Noise Floor Protection in Cell Phone Booster Amplifiers", by Richard (Riki) Kline, E.E., Patrick Cook, E.E., and Alan Van Buren, E.E., May 5, 2010, pg.1. "Wilson has been investigating [reducing booster interference] for some time and is currently setting high gain amplifiers to shut off whenever receiving a signal that is -45 dBm or stronger."

[4] Notice of ExParte. Wilson Electronics, Inc. ECFS: 05/26/2010 Supporting Documents "Wilson's Comments on Verizon's Technical Issues", pg. 4., "The Wilson booster will shut off with a -28.9 dBm forward link received signal which corresponds to a distance of 0.13 miles."

the protection radius causes boosters to operate deep into urban territory, the very places where boosters are not needed, and where their use has been shown to harm cellular networks.

In our opinion, a forward link sensing threshold of -45 dBm…

- will have practically no effect on reducing interference in urban areas.
- will not limit booster use solely to geographic areas where boosting is actually required, and consequently, will continue to frustrate carriers' engineering departments who must design their networks for non-boosted user handsets,
- will not meet Verizon's 15 Amplifier specification, discussed below
- will not comply with FCC Rules mandating use of the minimum power necessary for successful communications,[5]
- cannot be lowered to a more reasonable value and still adequately cover rural America, especially in situations where competing carriers construct facilities on opposite ends of town, and
- is no substitute for an intelligent booster that relies upon GPS positioning instead of forward link sensing.

According to Wilson's narrative, the threshold of -45 dBm was empirically determined from experiments with a single base station located in Bakersfield, California.[6] Whether or not that particular base station is, or could possibly be, representative of all base stations, now or in the future, is arguable. Further, the value of -45 dBm is excessively high compared with the FCC's Cellular Geographic Service Area contours defined by FCC Rule 22.911. For example, as shown in Figs. 2 and 3, Wilson's proposed threshold of –45 dBm would allow activation of a

[5] FCC Rule 24.232(c)
[6] Notice of ExParte. Wilson Electronics, Inc. ECFS: 05/26/2010 Supporting Documents, "Noise Floor Protection in Cell Phone Booster Amplifiers", by Richard (Riki) Kline, E.E., Patrick Cook, E.E., and Alan Van Buren, E.E., May 5, 2010, pg.1.

booster that is literally in the parking lot surrounding a cell tower. Obviously, booster activation here is completely unnecessary!

Figure 2 - Cell tower located in a typical shopping mall.
According to Wilson, its amplifier will be activated at all distances beyond the -45 dBm contour, or 0.13 miles. This is the distance from which the above photo was taken. The cell tower is clearly visible, in close proximity, and with unobstructed line of sight. It is clearly unnecessary for the Wilson amplifier to be activated under these conditions.

The photo in Figure 2 shows a typical tower serving multiple carriers and located in a densely populated area. Tower # ASR 1221544[7] is located in Census Block Group 120990077169

[7] Tower ASR 1221544 is registered to SBA Properties, Inc.

covering 1.8 square miles and having an estimated 2007 population projection of 4,998 persons. Note that most of this block group is comprised of the shopping center. Its neighbor, Block Group 12099077179, covers even less territory but has nearly triple the population. It is clear that tower ASR # 1221544 is well positioned to serve mobile units without the need for boosters of any sort.

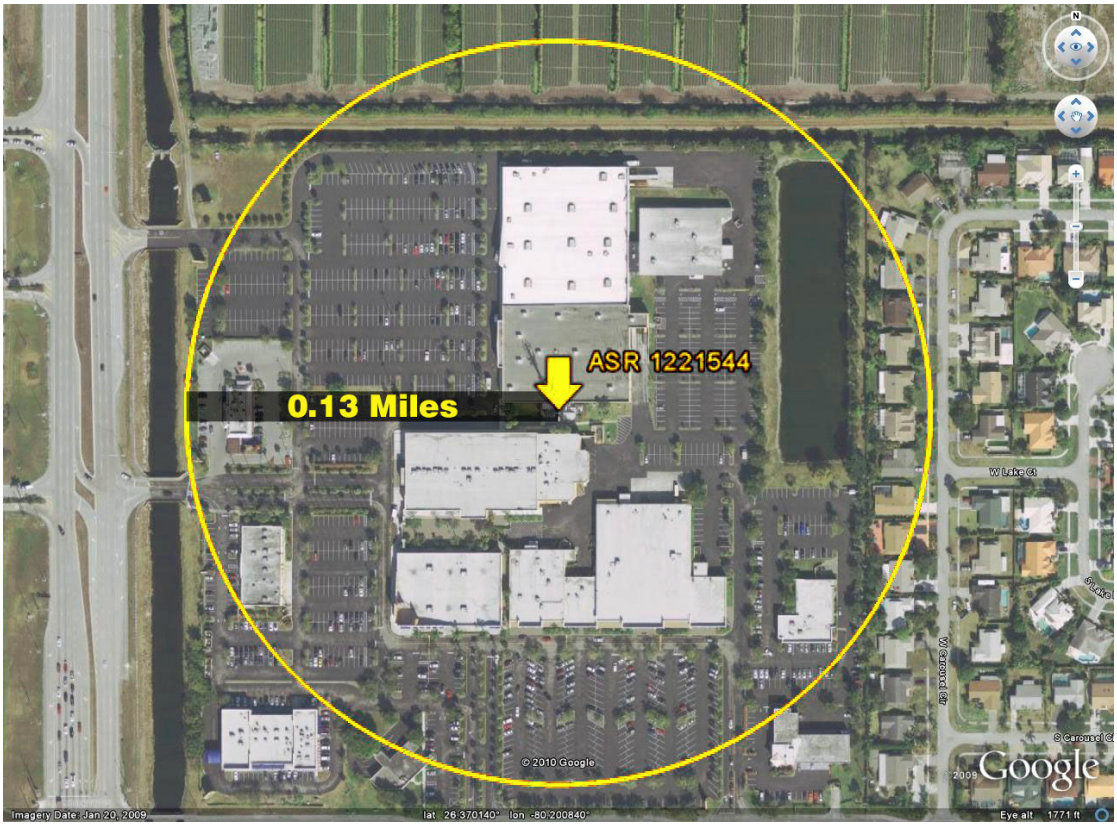

Figure 3 – Aerial view of the shopping center and parking lot depicted in Fig 2, containing cell tower ASR # 1221544. The yellow circle has a radius of 0.13 mile from the tower. According to Wilson, its booster would be activated at all locations outside the yellow circle. Is this necessary and desirable, or, in fact, a source of harmful interference?

Figure 3 shows an aerial view of this same shopping center. The tower is indicated by a yellow arrow at the center of a circle having a 0.13 mile radius. Other than the parking lot, this circle overlaps only 10 residences, as shown at right of the facility. Clearly the carriers and SBA

Properties, Inc. did not collectively spend many millions of dollars constructing this tower facility to serve only these ten residences while assuming boosters would be necessary for all residences outside the 0.13 mile radius!

In fact, this tower facility provides service to a much larger area. Further, at least one major carrier on ASR 1221544 has three additional cell sites located less than two miles away. Signal boosting under these conditions, with so many towers covering the geographic territory, is obviously and completely unnecessary; however, the Wilson booster with its proposed threshold of -45 dBm would, in fact, be on.

The FCC requires that base stations provide forward link or downlink signal strength of 32 dBu at the outer limit of their contours or CGSAs (Cellular Geographic Service Areas).[8] At cellular frequencies, 32 dBu is about -103 dBm. At PCS frequencies, it is about -109 dBm. It is seen that these values are about 60 dB weaker than the threshold suggested by Wilson for its downlink sensing. That is, the Wilson booster would be activated, even though the downlink field strength is about a <u>million times stronger</u> than the field at the FCC-defined CGSA contour. Clearly, in the proximity of every base station, regardless of the serving carrier, the Wilson booster will be on when it should be deactivated. Thus, it will contribute to ambient noise and over amplified signals, both forms of interference.

Further, because the Wilson booster is broadband, it will be on within the CGSAs of adjacent carriers' FCC licensed territories when it should be off. It will be on inside FCC mandated Quiet Zones when it should be off. It will be on in general aviation aircraft flying at altitudes where not only boosters but all cell phones should be off. It will be on in sports stadiums and similarly high concentrations of cell phone users when it should be off. It will be on even at locations where

the serving carrier does not have an FCC license! Clearly, the Wilson booster does not have the a priori knowledge of a cellular or PCS network that an intelligent booster must possess.

Figure 4 shows Sun Life Stadium (formerly Pro Player Stadium) in Miami-Dade County, Florida. This is a major sports venue in South Florida, and is host to the Miami Dolphins football team, the Florida Marlins, the Miami Hurricanes, the annual FedEx Orange Bowl college football game, as well as many concerts and other events. The stadium has on-site parking for 14,970 cars and 254 buses. This parking serves a capacity crowd of 56,000 seats.

Of these 15,000 parking spaces, only a small fraction are located within a 0.13 mile radii of permanent and temporary cell sites serving the stadium, including the stadium's existing distributed antenna system.

[Remainder of page intentionally blank.]

[8] See: 47CFR22.911 – Cellular geographic service area, defined.

Figure 4 – Aerial view of Sun Life Stadium, Miami, FL. The red circles indicate areas that are within a 0.13 mile radius of a major carrier's base stations that provide service during major events. These coverage areas are supplemented by the stadium's permanent in-building distributed antenna systems. As proposed by Wilson, its boosters would be activated outside the red circles. Would this be a necessary and desirable aid to wireless communication, or would it, in fact, cause harmful interference?

Here again, Wilson's forward link sensing approach would allow booster operation in a densely populated area, precisely where such signal amplification is neither necessary nor desirable.

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Forward Link Sensing Does Not Remedy Broadband Noise

In its ExParte filing dated May 26, 2010, Wilson argues that its products can meet Verizon's specifications relating to booster-generated broadband noise.[9] These specifications allow for not more than a 1 dB increase in the base station noise floor for 15 in-building boosters operating at a distance of one mile or more from the base station. Note that the specification does not necessarily apply to mobile boosters. In fact, the requirements on mobile boosters might be more rigorous. Wilson claims to satisfy the Verizon specification by asserting that a single one of its boosters causes less than 1/15th of the total allowable broadband noise floor elevation.[10]

Wilson's assertions are completely without merit.

Implicit in the Verizon specification is that boosters are not necessary nor will they be deployed at distances less than one mile from a base station. Wilson fails to mention, however, that its boosters will remain operational at all distances between 0.13 miles and 1 mile. It follows that 15 of its boosters will raise the noise floor far in excess at 1 dB at distances less than one mile, clearly violating the intent of the Verizon specification. Furthermore, as shown in Figure 4, Wilson's forward link sensing allows for the possibility of far greater numbers of boosters to be operational at distances substantially less than the one mile specified by Verizon.

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[9] Verizon Wireless MPE25k (Multi-Partitioned Enterprise Area of Less Than 25k sq. ft.) Over-The-Air Repeater Specifications, Requirements, and Test Procedures, Version 1.2, May 2006, par. 2.11.

[10] Notice of ExParte. Wilson Electronics, Inc. ECFS: 05/26/2010 Supporting Documents "Wilson's Comments on Verizon's Technical Issues", pg. 3., "Based on this criterion, a single booster may cause no more than a 0.06 db increase of the noise floor."

More troublesome, Wilson's mathematical analysis of the noise generated by its boosters is seriously flawed. Linear arithmetic is incorrectly mixed with logarithmic observables. To calculate the allowable noise floor elevation for one its boosters, Wilson simply divides 1 dB by 15 to obtain a value of 0.06 dB.[11] Both the value and the method for obtaining it are incorrect. The correct method is as follows.

First, it is important to understand that if we are to consider the cumulative noise from multiple boosters, then we must express the noise from each booster as a linear quantity, not as a logarithmic one. That is because noise from multiple sources, expressed in linear units, may be added or superimposed; however, noise expressed in logarithmic units may not. To that end, we convert the prescribed limit of 1 dB from logarithmic to linear units:

$$10^{(1\ \mathrm{dB}/10)} = 1.26$$

It is seen that a 1 dB increase is the same as an increase of 26 percent, or 0.26. This is a linear quantity that we may divide to obtain the increase allowable for each booster. For 15 boosters, the allowable increase, as a fraction of the ambient noise, must be less than or equal to,

$$0.26/(15\ \text{boosters}) = 0.0173\ \text{per booster}$$

We can convert the above result into logarithmic quantities and thus obtain the allowable increase per booster, expressed in decibels:

$$10 \log (0.0173) = -17.6\ \mathrm{dB}$$

[11] Actually, 1 divided by 15 is more accurately 0.07 than 0.06. Evidently, Wilson rounded the result down instead of up.

That is, each booster may contribute no more than -17.6 dB with respect to the ambient noise level. For example, if the noise level is -113 dBm, then each booster may only contribute up to -130.6 dBm. For 15 boosters, this will result in an increase of 1 dB, to -112 dBm. This is a far cry from Wilson's assertion that 0.06 dB is an acceptable noise contribution from each one of its units.

Let's quickly verify our arithmetic as follows. The total noise elevation from 15 boosters, each contributing -17.6 dB is:

$$10 \log (15) - 17.6 \text{ dB} = -5.8 \text{ dB}$$

What fraction of the ambient noise floor is -5.8 dB?

$$10^{(-5.8 \text{ dB}/10)} = 0.26$$

We recognize the answer 0.26 as the same as the 1 dB increase specified at the beginning of our mathematical exercise.

Note that the contribution from each booster depends upon its distance from where the ambient noise level is measured. Obviously, the contribution is going to <u>increase tremendously</u> when the booster is moved from a distance of 1 mile to a distance of 0.13 mile, with respect to the location where the noise level is measured.

Before leaving this discussion, note that the value of 0.06 dB calculated by Wilson actually means that each one of its boosters generates noise greater than the total ambient noise. The value of 0.06 is positive, and that means its linear value is greater than unity:

$$10^{(0.06\ \mathrm{dB}/10)} = 1.01$$

It is seen that, if each Wilson booster generates noise of 0.06 dB with respect to the ambient noise, then the Wilson noise is actually 1 percent greater than the ambient, not some small fraction of it. Fifteen Wilson boosters will generate total noise 15.15 times, or 11.8 dB, greater than the ambient level, far greater than the 1 dB increase specified by Verizon.

Intelligent Boosters Avoid Future Band Clearing Obstacles

An important and unique advantage of intelligent boosters, such as the Smart Booster, is that they will not present band clearing problems when advancing technology requires that boosters must be either modified in some way to continue in operation, or removed from service entirely. If intelligent boosters are ever required to be cleared from the band, the industry has only to cease issuing memory card updates for the devices. The devices will cease to operate once their current memory cards expire.

For example, the FCC recently issued a Public Notice seeking to clear the 700 MHz band of wireless microphones.[12] Similar band-clearing and band re-farming efforts have taken place in the recent past, most notably the recent Sprint/Nextel 800 MHz rebanding effort.[13]

[12] See: "Manufacture, Importation, Sale, and Lease of 700 MHz Wireless Microphones Is Prohibited; Consumer Alert Required for All Other Wireless Microphones At the Point of Sale or Lease," Public Notice, DA 10-969 (2010).

Intelligent Boosters Use Existing Technology and They Are Not Too Complicated

While the Smart Booster is an innovative combination of components and technologies, none of these components and technologies requires a state of the art advancement. They have been fully developed and tested as parts of other products, and there should be no concern about their application in an intelligent booster design. The Smart Booster has already been successfully drive tested on a major carrier's 3G cellular network, with the assistance and participation of their engineers. According to these engineers, "the Smart Booster obviously works!"

Essentially, the Smart Booster combines a position sensor, such as GPS, a memory card, a microprocessor, and band filters with existing BDA designs. In this way, it has a priori knowledge of the network. It knows where it must deactivate and where it is needed for amplification. It knows which spectrum to amplify, and which spectrum to avoid.

Further, because the memory card is removable, and therefore updatable, that knowledge remains current. As cellular networks change, either by design, merger and acquisition, advances in technology, or by emergency, so too will the data in the memory card.

Network providers have expressed reservations about the practicality of the memory card. They have speculated that it is burdensome to create, maintain, and distribute such a card. We believe this is simply resistance to change.

The most conservative business models show conclusively that the memory card will create very lucrative opportunities, either for the network providers or for a third party.[14] In the case of providers, the memory card is a unique opportunity to maintain control of their networks, including the signal boosters operating on them. It is also a valuable customer retention tool for subscribers operating in fringe reception areas.

With respect to distribution, the memory card is no more difficult than renewing a pay-as-you-go cell phone. With respect to the creation of the memory cards, the networks can readily draw upon their databases to construct cards that function optimally. Carriers already create the equivalent of a memory card because the same underlying data is needed to publish their online coverage maps. The simple fact is carriers already manage a huge amount of data that far exceeds that needed to effectively administer the Smart Booster.

If the networks choose not to participate, then the 32 dBu coverage contours of their base stations should be sufficient for a third party to create memory cards that function adequately.
If those 32 dBu coverage contours are not already on file with the FCC, then they should be required, in similar fashion to coverage contours for broadcast radio and television.

Network providers further speculate that memory cards cannot be updated often enough to reflect continuous changes in progress. More critical examination shows this not to be the case. In fact, the vast majority of changes will occur at locations within markets providing saturated coverage, and that is where the intelligent booster is deactivated anyway. The occasional

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[13] See: Report and Order, Fifth Report and Order, Forth Memorandum Opinion and Order, Improving Public Safety Communications in the 800 MHz Band. Consolidating the 800 and 900 MHz Industrial/Land Transportation and Business Pool Channels. FCC Docket: 04-168 (2004)
[14] A comprehensive carrier financial model is available in Excel format from Smart Booster.

changes in rural areas where the intelligent booster is activated are typically planned well in advance, in time for the next memory card update.

We suggest a six-month memory card update schedule as new sites are rarely commissioned in rural areas on a shorter timetable. A carrier must first establish the need for a new site, locate and select from suitable candidate sites, negotiate a land lease or purchase, (or execute a lease on an existing third party tower), obtain local zoning and other necessary permits, order materials, arrange for voice and data circuit backhaul to the site, construct the site, and finally, test the site for proper operation. Rarely does this process complete in less than six months. However, a carrier has the option to accelerate any memory card update schedule to more closely coincide with its business models, billing cycles, or predetermined regional site buildout plans.

Conclusions

Signal boosters will play an increasing role in wireless networks. It is crucial that they include all the essential features that will prevent interference to those networks, now and in the future.

The number of signal boosters presently deployed is uncertain. Estimates range from a few hundred thousand to a couple million. In any case, some of them are causing serious interference that can completely disable a base station for extended periods of time. What will happen when boosters number in the tens of millions?

As the US population increasingly depends upon wireless communication, signal boosters will inevitably become commonplace. They will be installed in homes, in offices, in public safety vehicles, in charter buses, and in seagoing vessels. They will become standard or optional

equipment in every luxury automobile. If they are not sufficiently intelligent, then these boosters can cripple wireless networks with interference.

Intelligent boosters will maintain their knowledge base to keep up with changes in technology, for example from 3G to 4G to ?G. To that end, they will have memories that can be revised as technology advances, or can be allowed to expire in order to clear the band of unwanted devices. None of the boosters presently available provide this capability.

In one form or another, boosters almost certainly cannot be excluded from wireless networks. Haphazardly designed boosters will become an increasingly serious handicap. Intelligent boosters will become an essential enhancement.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I, Jeremy K. Raines, Ph.D., P.E., do hereby certify that on this 3rd day of June, 2010, I caused copies of the foregoing "Notice of ExParte Communications of Millard/Raines Partnership" to be delivered to the following via electronic or First Class US mail.

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FCC 2.803 Compliance Notice:

Prototype - Not for Sale
The Smart Booster device has not been authorized as required by the rules of the Federal Communications Commission. This device is not, and may not be, offered for sale or lease, or sold or leased, until authorization is obtained.

Intellectual Property Notice:

Smart Booster™ and the Smart Booster logo are trademarks of the Millard/Raines Partnership.
The Smart Booster device is patent-pending in the United States under application US 12/319,242.

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