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

In the Matter of	)	
	)	
Amendment of Parts 1, 2, 22, 24, 27, 90 and 95 of	)	WT Docket No. 10-4
the Commission's Rules to Improve Wireless	)	
Coverage Through the Use of Signal Boosters	)	

COMMENTS OF VERIZON WIRELESS

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SUMMARY

Verizon Wireless applauds the Commission's endeavor to craft rules for the design, installation and use of signal boosters in a manner that will protect wireless networks from interference. Verizon Wireless recognizes the benefits to consumers that signal boosters can provide. These benefits include extending coverage in rural areas, buildings, and other areas, and enabling emergency communications in areas where wireless carrier signals are weak. However, these benefits are outweighed where the operation of signal boosters causes interference to wireless networks that prevents many more users from completing calls or initiating data sessions.

In response to the NPRM, Verizon Wireless, V-COMM, a wireless engineering consulting firm, and Wilson Electronics, a leading manufacturer of signal booster products, have jointly developed a proposal ("Joint Proposal") for the design, operation, and, where necessary, installation of signal boosters in a manner that strikes the appropriate balance and better ensures protection against harmful interference.

The Joint Proposal addresses the goals of Commission in this proceeding "to facilitate the development and deployment of well-designed signal boosters" that do not harm wireless networks. It separates signal boosters into three categories: (1) Consumer Boosters, which are small fixed and mobile signal boosters that can purchased, installed and used by consumers; (2) Certified Engineered and Operated ("CEO") Boosters, which are larger, higher powered signal boosters designed for large offices, campuses, and similar settings that require professional installation and close carrier coordination; and (3) Carrier Installed Boosters, which are boosters installed by FCC licensees to operate exclusively on the licensee's frequencies. These distinct

categories of boosters are necessary in order to account for differences in the way each category of booster is designed, installed and operated.

The Joint Proposal fully responds to the Commission request for comment regarding the technical specifications needed to protect wireless networks from interference caused by signal boosters. The highlights of the Joint Proposal are as follows:

Consumer Boosters

- The specifications for Consumer Boosters are designed to enable signal boosters to be installed by consumers and operated without harming CMRS networks.
- Consumer Boosters may be installed and used by consumers for use in buildings or vehicles.
- The specifications are technology neutral and provide protection to all CMRS network technologies.
- Consumer Boosters must be FCC Type Certified to meet the specifications set forth in the Joint Proposal. Consumer Boosters must be registered with the licensed carriers, either manually or through a Bluetooth connection to the device. Consumer Boosters must meet the proposal requirements for antenna gain, emission limits, automatic gain control (AGC), wide band signal design, anti-oscillation protection, in-band noise and base station (BTS) overload limits.

Industry Certified, CEO Boosters

- The CEO Booster proposal would apply to any booster not meeting the Consumer Booster specifications and requirements or not installed by the licensee.
- Standards for CEO Boosters would be developed by industry participants, including industry trade associations, manufacturers, installers, and licensed carriers. Until such standards are developed, installers will work with licensed carriers to ensure that CEO Boosters do not cause interference.
- CEO Booster Systems may support individual or multiple wireless carriers.
- CEO Boosters must be installed and engineered by installers to be certified by an industry organization according to standards developed by the stakeholders.
- CEO Booster installation must be coordinated with the appropriate licensee(s), as necessary, by the installer and records of the installation must be maintained in a database by the installer.
- Because CEO Booster installation and operation would be coordinated with licensees, they would operate under the licensee(s) authority – obviating the need for individual licensing.
- CEO Booster and booster systems must provide licensee(s) with 24 hour contact information so that Boosters may be turned off in the case of interference.
- CEO Boosters and booster systems will require acceptable completion of on-site testing.

Licensee Installed Boosters

- Boosters installed by licensees or their authorized installers that operate on the licensee's frequency bands would not be subject to the requirements for Consumer Boosters or CEO Boosters.

The Commission should adopt the Joint Proposal as the framework for the design and use of each category of signal boosters.

Verizon Wireless supports the Commission's proposal to require that signal boosters be labeled and marketed to consumers with clear information specifying how consumers may legally use the devices, but recommends changes to reflect the different treatment of Consumer Boosters and CEO Boosters set forth in the Joint Proposal. In particular, Consumer Boosters labeling should include instructions regarding the registration requirement and E911 limitations notification language. Boosters other than Consumer Boosters should not be marketed or sold to persons not authorized to install or operate them. They should be clearly labeled to reflect this requirement.

Verizon Wireless also supports the Commission's proposal for a transition period for boosters manufactured and sold in compliance with the new technical specifications. However, those rules do not address the continued use of boosters that do not meet the new specifications. Because these non-complying boosters pose a significant threat to CMRS networks, the transition rules must include provisions addressing the operation of such boosters. Verizon Wireless proposes a two-step approach for existing boosters. First, the Commission should require anyone using a non-conforming signal booster to register it with the licensee(s) of the spectrum on which the booster is operating. Second, the Commission should require persons using a non-conforming signal booster to replace it with a booster that meets the Commission's

new signal booster technical specifications or otherwise bring the booster into compliance with the Commission's booster rules within one year of the effective date of those rules.

The Commission should not adopt the proposal in the NPRM to license individuals by rule to operate signal boosters. The Joint Proposal is designed to ensure that boosters operate with the licensee's knowledge, under the licensee's control, and, for CEO Boosters, only after being coordinated and approved by the licensee(s). Accordingly, the Joint Proposal would obviate the need for the Commission to license individuals by rule to operate signal boosters without CMRS licensee consent. Because interference to wireless networks can arise as a result of changes wireless carriers make to their networks, wireless licensee knowledge, control and consent are critical to ensuring that signal boosters do not interfere, or if they do, to resolving that interference.

Moreover, the Commission's proposal to license individuals by rule to operate signal boosters is contrary to the objectives of the Commission's licensing authority, would constitute a compensable breach of contract between the Commission and existing licensees, and would constitute an improper taking of licensees' rights exclusively to use radio licenses and facilities. Because individual licensing is neither needed nor advisable, and because there are substantial legal infirmities with the Commission's license by rule proposal, the Commission should not license individuals to operate signal boosters.

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COMMENTS OF VERIZON WIRELESS

Verizon Wireless hereby responds to the Commission's Notice of Proposed Rulemaking ("NPRM") in the above-captioned proceeding.[1] In the NPRM, the Commission set forth proposed rules and sought comment regarding the operation of signal boosters by consumers without causing harmful interference to commercial wireless and public safety networks.

In response to the NPRM, Verizon Wireless, V-COMM, a wireless engineering consulting firm,[2] and Wilson Electronics, a leading manufacturer of signal booster products, have jointly developed a proposal ("Joint Proposal") for the design, operation, and, where necessary, installation of signal boosters. The Joint Proposal is attached to these comments as Appendix A (Consumer Boosters) and Appendix B (CEO Boosters) and is also attached to a joint letter being filed today by Wilson and Verizon Wireless. As discussed below, that proposal

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[1] *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*, Notice of Proposed Rulemaking, WT Docket No. 10-4, 26 FCC Rcd 5490 (2011) ("NPRM").

[2] Verizon Wireless retained V-COMM to assist in the development of specifications for Consumer Boosters, elements of an Industry Certified Booster program, and their impact on commercial wireless networks. V-COMM is a wireless engineering consulting firm specializing in providing expertise to wireless operators and governmental agencies in wireless network system design, engineering, performance, optimization and interference analysis.

separates signal boosters into three categories: (1) Consumer Boosters, which are small fixed and mobile signal boosters that can purchased, installed and used by consumers; (2) Certified Engineered and Operated ("CEO") Boosters, which are larger, higher powered signal boosters designed for large offices, campuses, and similar settings that require professional installation and close carrier coordination; and (3) Carrier Installed Boosters, which are boosters installed by FCC licensees to operate exclusively on the licensee's frequencies.[3] As discussed below, these distinct categories of boosters are necessary in order to account for differences in the way each category of booster is designed, installed and operated.

The Joint Proposal and Verizon Wireless' other recommendations set forth below fully address the Commission's goals in this proceeding "to facilitate the development and deployment of well-designed signal boosters" that do not harm wireless networks.[4] Because the Joint Proposal was developed by parties who have held adverse views on the regulatory treatment of signal boosters, the Joint Proposal reflects a compromise framework and solution that addresses the booster design and use issues raised in the NPRM and enables boosters to be manufactured and used to improve coverage without causing harmful interference to wireless networks. Accordingly, Verizon Wireless urges the Commission to adopt the Joint Proposal as the framework for the design and use of each category of signal boosters and to adopt requirements for the marketing of boosters and for the continued use of non-compliant boosters.

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[3] The Joint Proposal does not address boosters for use in the Part 90 (PLMR) bands. While a framework and rules similar to those set forth in the Joint Proposal might be appropriate for Part 90 boosters, due to the enhanced interference potential to public safety works that will continue to exist until 800 MHz re-banding is completed, Verizon Wireless and Wilson believe that technical rules for boosters used in those bands would best be considered after rebanding is completed.

[4] NPRM at paras. 1-2.

I. DISCUSSION

Verizon Wireless recognizes the benefits to consumers that signal boosters can provide. These benefits include extending coverage in rural areas, buildings, and other areas, and enabling emergency communications in areas where wireless carrier signals are weak. The Commission must proceed cautiously, however, to ensure that these benefits are not outweighed by the operation of signal boosters that cause interference to wireless networks and, as a result, prevent many more users from completing calls or initiating data sessions. Verizon Wireless has previously expressed concerns about the significant threat of harmful interference posed by signal boosters. It has provided evidence of the magnitude of the booster interference problem and numerous examples of network harm caused by poorly designed, installed and/or faulty signal boosters.[5] Verizon Wireless welcomes the opportunity provided in this NPRM to develop rules regarding the design and operation of signal boosters in a manner that will not result in harmful interference to wireless networks.

A. Signal Boosters Must be Divided into Three Categories.

While the Commission's proposed rules did not divide boosters operating on commercial wireless frequencies into distinct categories,[6] certain aspects of those rules recognized that different types of signal boosters may require different design, operating and installation features. For example, the Commission sought comment on whether the existing technical requirements in Parts 22, 24, and 27 are adequate to address varying types of signal booster

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[5] *See* Verizon Wireless Comments, WT Docket No. 10-4, filed February 4, 2010, at 6-8; March 29, 2011 Letter from Tamara Priess, Verizon, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 10-4.

[6] The proposed rules did distinguish Part 90 boosters from boosters operating on commercial wireless frequency bands. NPRM at pp. 25-36.

installations, *e.g.*, personal use vs. carrier and enterprise installations.[7] The Commission also sought comment on specific design criteria to protect networks from mobile boosters,[8] and asked whether certain types of fixed booster systems should require professional installation or other safeguards.[9]

In developing the Joint Proposal, Verizon and Wilson determined that signal boosters of different types have different uses and different interference potential. For example, to facilitate the use of signal boosters by consumers in home, small office and mobile settings, consumers must be able to purchase, install and use Consumer Boosters without third party assistance. In order to accomplish this goal, however, such boosters need to be designed in a manner to protect against interference that could be caused by mobility and faulty installation. The specifications for Consumer Boosters, therefore, must be carefully designed to protect against in-band and adjacent band emissions and noise, in-band receiver overload, and oscillation.

CEO Boosters and booster systems are used to amplify signals in larger areas, such as medium to large offices, buildings, campuses, and large outdoors areas. CEO Boosters and booster systems are often complex. They utilize multiple donor antennas (those pointed at cell sites - one for each CMRS carrier), multiple amplifiers, combiners, splitters and multiple serving antennas (those pointed to the area receiving coverage). In many cases, separate amplifiers and/or antennae are needed for each spectrum band. These systems could utilize a Distributed Antenna System ("DAS") or could use fiber or leaking coax to distribute signals. A critical operating parameter for boosters is the isolation (the path loss from the donor antenna to the

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[7] NPRM at para. 38.

[8] *Id.*, at paras. 53-54.

[9] *Id.*, at para. 51.

serving antenna), which is dependent on the antennas used, where they are located, where they point, and the structure and shape of the building. In addition, these systems may carry significant traffic (similar to actual cell sites), making the determination of which cell is used as a donor extremely important. In some cases, the CMRS carrier may need to re-engineer the donor cell site to handle this additional traffic load.

Based on these factors, Verizon Wireless and Wilson determined that it was appropriate to design different technical and operational parameters for Consumer Boosters versus CEO Boosters. The third category, Carrier Installed Boosters, was deemed necessary because boosters and booster systems installed by carriers are engineered to operate only on frequency bands licensed to the carrier and engineered to be integrated into that carrier's own network in a manner that will not cause harmful interference. Accordingly, this category of boosters does not require rules to protect wireless carrier networks and would not be subject to the safeguards proposed for the other two categories of signal boosters.

B. The Joint Proposal Provides Technical Detail for Proposed Booster Design Features and Responds to Questions about the Need for Additional Design Features.

The Commission proposed to authorize individuals to use fixed and mobile signal boosters subject to certain requirements. These requirements set forth new technical standards for boosters, including: (1) limitations on power and unwanted emissions for the applicable spectrum bands – specifying that boosters must meet the requirements set forth in the rules for operations in each band;[10] (2) requiring self-monitoring and automatic shut down if the booster is

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[10] *Id.*, at p. 44, proposed Rule Section 95.1611.

not in compliance with the technical rules;[11] (3) requiring boosters to be able to detect feedback or oscillation and deactivate the uplink transmitter within 10 seconds of detection;[12] and (4) requiring boosters to shut down or power down automatically when approaching the base station with which they are communicating.[13]

The Commission sought detailed comment on each proposal and on other technical requirements that may be necessary to ensure that signal boosters do not negatively affect carriers' networks.[14] For mobile boosters, the Commission sought comment on how to implement the requirement that a booster power down or shut down when approaching the base station with which it is communicating, and on how to prevent interference to base stations with which the booster is not communicating.[15]

The Joint Proposal for Consumer Boosters addresses and provides technical detail for implementing each of the Commission's proposed technical requirements for signal boosters. It also addresses the Commission's request for comment regarding other features necessary to protect wireless networks from interference. The Joint Proposal for CEO boosters sets forth a framework for approving the design, installation and use of CEO boosters. When considering the complex issues presented by this category of boosters, Verizon and Wilson concluded that CEO Boosters could not be addressed by generally applicable specifications and must be custom

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[11] *Id.*, at p. 45, proposed Rule Section 95.1623(a).

[12] *Id.*, at p. 45, proposed Rule Section 95.1623(b). This rule would also require that after 5 restarts, the device must shut off until manually reset.

[13] *Id.*, at p. 45, proposed Rule Section 95.1623(c).

[14] *Id.*, at paras. 38-39.

[15] *Id.*, at paras. 53-54.

engineered by certified entities. In the sections below, Verizon Wireless explains the Joint Proposal goals and specifications for Consumer Boosters and the framework for CEO Boosters.

1. Consumer Booster Technical Specifications

a) General Requirements

- Specifications are designed to enable signal boosters to be installed and operated by consumers without harming CMRS networks.

- The Consumer Booster specifications are technology neutral and provide protection to all CMRS network technologies and that are used on Cellular, PCS, AWS and 700 MHz commercial mobile radio frequency bands.[16]

- The Consumer Booster specifications are designed to protect CMRS base stations and mobiles against harmful interference in the form of emissions, noise and receiver overload. These specifications protect CMRS networks against harmful effects from adjacent band emissions and noise, in-band emission and noise, in-band receiver overload, and interference due to amplifier oscillation, all of which are required to prevent harmful interference to CMRS networks.

- Customer registration of signal boosters (or, in the alternative, Bluetooth connection of the booster to the customer device) is required. This requirement is designed to enable the boosters to be operated pursuant to the licensee's authority and to enable licensees to exert operational control over the Consumer Boosters that are operating on each licensee's network, including the ability to locate and shut down interfering units as required.

- Consumer Boosters are defined to support both uplink and downlinks in a manner that provides enhancements to the consumer devices without harming carrier networks.

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[16] The Joint Proposal did not consider and does not advocate using the Consumer Booster specifications for other licensed commercial services bands or Public Safety bands such as those operating under Part 90 bands (i.e. 150, 450, 800 and 900MHz), Part 27 EBS/BRS (2.5 GHz band), Part 27 WCS (2.3 GHz band), 3.6 GHz shared licensed band, Guard Bands operating under Part 27 in 700MHz spectrum, narrowband PCS service operating under Part 24, commercial satellite service bands with ancillary terrestrial components, and other licensed services bands not identified above.

b) Power Limits, Antenna Requirements, and Emission Limits

(i) Power Limits & EIRP Limits

- The NPRM recognized that "[h]igher power signal booster operation can create the potential for adjacent-channel interference to other wireless carrier's base stations that may be nearby if the device is not properly installed or not operating with appropriate safeguards."[17]

- The NPRM proposed to require signal boosters to meet the mobile power and emission limits for each band.[18]

- FCC mobile power limits are: 7 Watts ERP for Cellular band, 30 Watts ERP for 700 MHz CMRS bands,[19] 2 Watts EIRP for PCS band, 1 Watt EIRP for AWS band.[20]

- The Joint Proposal specifies that the booster power and EIRP limits for uplink are 1 Watt, and for downlink are 0.05 Watt for Cellular, PCS, AWS and 700MHz bands.

- This change from the Commission's proposal was deemed necessary because the maximum power levels for CMRS mobiles are within the range of 0.2 Watts to 1 Watt EIRP, with the vast majority of CMRS mobiles operating at the lower end of that range. CMRS networks are designed for a balanced system with these mobile uplink power levels. Thus, additional uplink power would be unnecessary for Consumer Boosters and only have the potential to cause harm to the CMRS networks.

(ii) Antenna Requirements

- The Joint Proposal specifies that Consumer Boosters be marketed, sold and tested for FCC type certification with antennas and cables as specified by the manufacturers.

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[17] NPRM at para.15.

[18] *Id.*, at 44, proposed Rule Section 95.1611.

[19] Mobile station and portable station power limits are 30 Watts and 3 Watts ERP for 700 MHz CMRS bands, respectively.

[20] In addition, Commission rules for the AWS uplink 1710–1755 MHz band limit power to 1 Watt EIRP. Fixed stations in this band are limited to a maximum antenna height of 10 meters above ground, and mobile and portable stations operating in this band must employ a means for limiting power to the minimum necessary for successful communications.

- This requirement is deemed necessary to ensure that the booster system – which refers to the booster coupled with the antennas and cabeling -- will comply with all limits specified herein, including power, emissions, noise and overload limits.

(iii) Emissions Limits

- The Joint Proposal specifies that Consumer Boosters be required to be 6 dB below the FCC mobile emission limits, such that the total combined emissions of the booster and a mobile device operating at the FCC mobile emissions limits would not exceed the FCC mobile emission limits by more than 1 dB.[21]

- This requirement is more stringent than the emissions limits proposed by the Commission. The more stringent requirement was deemed necessary to limit the additional emissions caused by the consumer booster into adjacent bands (which may be Public Safety, CMRS or bands with other licensed services).[22]

c) Design Requirements

- The Commission acknowledged that signal boosters can produce "noise," which has the potential to interfere with wireless networks. Interference can also take the form of adjacent channel interference, oscillation, or base station receiver overload.[23]

- The specifications below are designed to eliminate adjacent channel interference, oscillation, and base stations receiver overload.

(i) AGC Overload Control

- The Consumer Booster must use automatic gain control (AGC) to prevent booster overload when high input signals are received on the uplink or downlink for protection against booster amplifier overload and exceeding the power, emissions, noise, base station overload, and other limits outlined in the specifications.

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[21] The total combination emissions of 2 signals, one 6 dB below the other, is equal to 1 dB increase. The two emissions are additive in the power domain.

[22] Consumer booster emission limits need to be less than mobile device limits as proposed by the Commission, because the boosters amplify and increase the emissions from mobile devices and combine additive emissions created by the booster's amplifiers, both of which increase the total emissions. FCC type certification testing for booster emissions do not use actual mobile devices, but instead uses signal generator sources having lower emissions characteristics as compared to mobile devices. This results in lower booster emissions captured in these tests compared to actual mobile devices served by boosters.

[23] NPRM at para. 14.

(ii) Amplifier Design

- Booster amplifiers need to be properly designed and to support the wireless technologies used in CMRS networks, which include wireless signal peak to average ratio requirements. Consumer Booster amplifiers need to perform and operate without degrading CMRS networks.

(iii) Anti-Oscillation Protection

- The NPRM recognized that oscillation detection and prevention should be required and proposed that "the device must be capable of shutting itself down automatically within ten (10) seconds (or less)."

- The Joint Proposal adds a requirement that the device must remain off for at least one (1) minute before restarting. If after five (5) restarts, the device is still not operating consistent with applicable technical rules, it must shut off and remain off until manually restarted by the device operator.

- The Joint Proposal changes the automatic shut-down time interval from 10 seconds to 0.3 seconds on the uplink and 1.0 seconds on the downlink. This change was made because allowing oscillation to continue for as long as 10 seconds would cause harmful interference on uplink to base stations that could disconnect all calls served by the base station. On the downlink, the change was deemed necessary to limit interference to nearby mobiles.

d) Transmitter Requirements, In-band Noise Limits, and BTS Overload Limits

(i) Uplink Power Off Mode (Uplink Squelch)

- In order to prevent interference from in-band noise or base station overload, the Joint Proposal specifies that signal boosters must either shut down the uplink transmitter when uplink signals are not received for 15 minutes, limit the uplink noise output power level to -70 dBm/MHz, or reduce the uplink noise power limit to 10 dB below the uplink noise power limits specified for different types of boosters.

- The downlink transmitter may remain active in the uplink power off mode.

- Consumer Boosters with maximum uplink noise power less than -59 dBm/MHz are excluded from the uplink power off mode requirement.

(ii) Transmit Power Off Mode and Power Off Limit

- Transmit Power Off Mode is required when the booster cannot otherwise meet the specifications defined in the Joint Proposal for power, emissions, noise or overload limits.

- The Joint Proposal specifies that the transmitters shall be turned off, and the noise power and gain shall be limited depending on the design and use of the booster.

(iii) In-Band Noise Power Limits

- The Joint Proposal specifies limits for uplink noise power and for maximum noise power.

- These limits vary depending on the design and use of the booster.

(iv) BTS Overload Gain Limits

- The NPRM identifies the need for base station overload protection.[24] It proposes a requirement that the booster power down or shut down when approaching the base station with which it is communicating, and seeks comment on how to implement this requirement and on how to prevent interference to base stations with which the booster is not communicating.[25]

- Overload has the potential to interfere with and block all mobiles being served at the base station, and to degrade network coverage and capacity of the system for voice and data services. It has the potential to defeat the power control and base station overload protections designated and defined within the wireless standards to protect CMRS networks.

- To adequately protect against BTS overload, the Joint Proposal specifies uplink and downlink gain limits which vary depending on the type of booster, antenna, and coupling or connection used in the booster system.

e) GPS/E911 Location and Registration Requirements

(i) GPS/E911 Location Requirements

- Signal boosters do not amplify GPS signals. As such, handsets placing 911 calls that are completed using signals amplified by signal boosters may be in locations where the

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[24] *Id.*, at para. 17.

[25] *Id.,* at paras. 53-54.

handset cannot detect GPS signals and, as a result, may not be able to pass accurate E911 location information.

- In addition, network based E911 CMRS systems may not be able to triangulate location where there is only CMRS service being extended from a single base station.[26]

- Accordingly, the Joint Proposal specifies that signal boosters must be labeled to notify customers that E911 location information may not be provided on calls served by the booster.[27]

- Consumer Boosters that are directly connected to or otherwise coupled to the handset and that are designed to pass through satellite GPS signals with no interference to CMRS or GPS operations are excluded from this notification requirement.

(ii) Registration

- In order for CMRS licensees to know about the Consumer Boosters that are operating on their licensed frequencies and to maintain operational control over such boosters, the Joint Proposal requires that consumers register Consumer Boosters with the licensed carrier(s).

- Each licensed carrier will be responsible for establishing Consumer Booster registration procedures.

- This requirement will enable the licensees to locate boosters that are causing interference, work with consumers to resolve such interference, and, if the interference cannot be resolved, shut down the interfering boosters.

(iii) Bluetooth Connection

- As an alternative to registration, the Joint Proposal specifies that a Bluetooth connection and registration can be made between the mobile device and the booster unit for the booster to operate as an extension of the mobile device.

- Additional features that are available when the booster is connected to the wireless device by Bluetooth include the ability for the wireless device to request the booster to turn on or off as needed, providing the booster amplifier information about the radio spectrum being used so that the booster can tune to the actual frequencies in use, and the ability for the

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[26] Network-based E911 Phase 2 location service requires reception of mobile signals at a minimum of 3 base stations for time difference of arrival (TDOA) location determination.

[27] Because the coverage extension provided by the signal booster may enable 911 calls that otherwise could not be made, the use of non-interfering signal boosters provides net benefits to public safety, even if callers cannot be located precisely.

device to notify the booster to re-tune when a radio band change has occurred, such as when the mobile has crossed into a new license area.

f) FCC Type Certification for Consumer Boosters

- The Joint Proposal specifies that compliance with all specifications set forth in Appendix A is required for FCC type certification to ensure Consumer Boosters meet the protections for CMRS networks.

2. CEO Booster Proposal

The Joint Proposal does not specify particular technical standards for CEO Boosters or standards that certified installers of CEO Boosters would be required to meet. Rather, the Joint Proposal specifies a framework for approving the design, installation and use of CEO Boosters. The highlights of that proposal are set forth below.

a) Operation of CEO Boosters

- CEO Boosters would be authorized to operate on licensed frequencies through coordination with the appropriate licensee(s) and authorization by such licensee(s).

- CEO Booster installers would be required to perform the licensee coordination, obtain the licensee consent, and provide information about all CEO Booster installations to a database accessible to carriers.

- Operation of CEO Boosters will require 24x7 contact information for a person able to turn off the booster(s) in case of interference to be provided to the appropriate licensee(s).

b) CEO Booster Installers

- CEO Booster installers would be required to attend training and pass an industry certified test. The certification standards and training would be jointly developed by stakeholders including licensees, installers and/or their trade associations and designed to demonstrate competence in radiofrequency engineering of booster systems and knowledge of CMRS networks and technologies.

- The certification program would be run by a third party to be selected, such as a trade association.

- CEO Booster installer certification may be revoked by the certifying entity based on a showing that the installer failed to comply with CEO Booster installation practices and requirements, and certification must be renewed every five years.

- CEO Booster installers must provide to the licensee(s), or if a third party database is established, to the database manager, information about the models of boosters installed, operating parameters, location, and other relevant information. This information will be accessible to licensees for resolving problems, for use when upgrading network technology, and to address orientation of donor antennas when new base stations are deployed.

- CEO Booster installers and operators must have access to appropriate test equipment for installation and ongoing operation of the CEO Booster system.

c) CEO Boosters Proof of Performance

- CEO Booster installers will be responsible for properly engineering, installing, testing and ensuring that equipment operates as authorized by the supported licensed carrier(s).

- Installations will require acceptable completion of on-site testing, measurements of isolation between donor and server antennas, verification of gain to isolation ratio, measurement of gain and output power levels utilized, and coupling measurements to confirm base station noise and overload conditions are not exceeded.

- CEO Boosters must be installed and configured to meet minimum performance specifications for each wireless technology supported by the CMRS licensee(s).

- Minimum performance standards will be developed by industry engineers and published by industry organizations.

d) CEO Booster Equipment

- CEO Boosters can use a wide range of power levels and technologies.

- Donor antennas must be directional and oriented to nearby base stations as specified by the CMRS licensee(s).

- CEO Booster Systems should be flexible enough to enhance coverage in most locations while providing for existing licensee base station protection and performance.

e) CEO Booster Database Requirements

- CEO Booster installers must provide booster database information to the database manager and/or licensee(s).

- CEO Booster database information will include:

    - Booster Location
    - Building and booster installation and configuration information and diagrams

- Booster manufacturer, model number(s), FCC ID number(s) and operating and design parameters
- Measured cable and component losses
- Outside donor antenna description, model, specifications, orientation, and location on building, including diagrams
- Booster description and location inside building
- Booster operator 24x7 contact information
- Access requirements for surveying booster equipment and installation
- Software remote control requirements and account security information

C. The Commission Should Adopt the Proposed Marketing Rules for Consumer and CEO Boosters.

The Commission proposes to require that signal boosters be labeled and marketed to consumers with clear information specifying how consumers may legally use the devices. It proposes that such information would include a prominently placed consumer disclosure to be included with marketing materials and on signal booster packaging. The labeling would require a warning stating that signal booster operation is on a secondary non-interference basis and must cease immediately if requested by the FCC or a licensed carrier. Labeling for fixed boosters would also notify consumers of the need to coordinate operation with licensed carriers.[28]

Verizon Wireless agrees with the Commission that signal boosters should be appropriately labeled, but the Commission's proposal should be amended to reflect the changes to the proposed rules set forth in the Joint Proposal. In particular, the labeling requirement should be amended to reflect the different treatment of Consumer Boosters and CEO Boosters. Consumer Boosters labeling, in addition to the Commission's proposed language regarding shut-down in the event of interference, should include instructions regarding the registration requirement and the E911 notification language discussed above. Boosters other than Consumer

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[28] NPRM at paras. 43-44.

Boosters should not be marketed or sold to persons not authorized to install or operate them. They should be clearly labeled to reflect this requirement.

D. Once New Technical Standards and Operational Rules Are Adopted, the Commission Should Move Quickly to Mandate that Non-Compliant Boosters May No Longer Be Operated.

The Commission proposes a two-step approach to enabling customers to transition from signal boosters in use today that may not meet the new requirements adopted in this proceeding. It proposes that within 30 days after the effective date of the rules adopted in this proceeding, all certification applications for new signal boosters must comply with the new technical rules adopted. It proposes further that within 6 months of the effective date of the rules, all signal boosters marketed or sold in the United States must be in compliance with the new rules.[29] While Verizon Wireless agrees that some transition is appropriate, that transition period should be as short as possible and should address existing, non-conforming signal boosters. The rules proposed by the Commission for transitioning to boosters manufactured, marketed and sold in compliance with the new rules appear to strike an appropriate balance between the need to transition quickly to boosters that meet the new design parameters and allowing manufacturers and booster sales outlets a reasonable period of time to comply with the new rules.

The rules, however, do not address the use of existing boosters by consumers. As discussed throughout this proceeding, those non-conforming boosters pose a significant threat to CMRS networks. Accordingly, the transition rules must include provisions regarding the operation of non-conforming boosters. Verizon Wireless proposes a two-step approach for existing boosters. First, the Commission should require anyone using a non-conforming signal

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[29] *Id.,* at para. 63.

booster (which would not include Carrier Installed Boosters) to register that booster with the licensee(s) of the spectrum on which the booster is operating. Registration with the licensee(s) is necessary to provide some measure of carrier control over the boosters and to enable the carrier to track and resolve instances of interference. The Commission should make clear that these non-conforming boosters must be shut down immediately upon a request by the FCC or a licensed carrier. Second, the Commission should require persons using a non-conforming signal booster to replace it with a booster that meets the Commission's new signal booster technical specification rules, or otherwise bring the booster into compliance with the Commission's booster rules – such as by certifying the installation of the booster -- within one year of the effective date of those rules. Verizon Wireless believes that these transition rules would help eliminate interference by removing existing boosters that are more likely to cause interference, while allowing consumers a reasonable period of time to transition to boosters manufactured in conformance with the new specifications.

E. The Commission Should Not Separately Authorize Individuals to Operate Boosters.

1. The Joint Proposal Obviates the Need for Individual Licensing by Authorizing Boosters to be Operated Under Carrier Licenses.

For wireless carriers, a particularly troubling aspect of the Commission's signal booster proposal is the proposal to separately license individuals to operate signal boosters on frequency bands exclusively licensed to wireless carriers. Carriers have invested billions of dollars acquiring interests in their spectrum bands and billions more to construct and maintain their networks. These investments have been made in reliance on the exclusivity of the license and the ability to operate free from interference from other users of the same frequency bands. Carriers' ability to use their license bands and to change their networks as new technologies become available is threatened by the presence of other users of the frequency bands – users of

which the licensee has no knowledge, and over which the licensee has no control. Thus, for example, a booster that is operating without causing interference today may begin to cause interference if the carrier installs a new base station or changes network technology on the frequency bands being used by the booster.

The only way adequately to protect licensee networks from interference caused by signal boosters today or in the future is to mandate that boosters may only be operated under the control of the CMRS licensee. The Joint Proposal is designed to ensure that boosters operate with the licensee's knowledge, under the licensee's control, and, for CEO Boosters, only after being coordinated and approved by the licensee(s). For the reasons stated above, the Commission should adopt the Joint Proposal rather than licensing individuals by rule to operate signal boosters without CMRS licensee consent.

2. The Commission Cannot Lawfully Grant Individual Licenses to Operate Signal Boosters.

There are numerous legal impediments to licensing individuals by rule to operate signal boosters. First, limiting the rights of licensees to use auctioned spectrum by granting new licenses on the same spectrum to third parties is directly contrary to the Congressional dictates granting the Commission auction authority.[30] The achievement of the objectives for spectrum auctions set forth in the statute depend upon the active participation in the auction by a broad group of entities that are willing to invest in telecommunications infrastructure to serve the public. If auction winners have their licenses impaired several years into their license terms, they and others would be less likely to participate in future auctions.

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[30] 47 U.S.C. § 309(j).

Second, licensing third parties to operate in spectrum already covered by an exclusive license constitutes a compensable breach of contract between the Commission and the existing licensee. A spectrum license is a contract with the Commission in which the licensee is authorized to exploit a government resource (spectrum) to the benefit of both parties with complementary contractual obligations to enable that result.[31] Accepting the right to use spectrum commits the licensee to a variety of responsibilities, including payment of auction bids, investment in and building out physical facilities, abiding by applicable FCC rules, and providing service to consumers. But, as an inducement to make the investment to build out and provide service, licensees enjoy a reasonable expectation of and rely on the continued ability to use the spectrum exclusively and free from increased harmful interference. Like other contracts with the government, a spectrum license comes with the potential for subsequent changes in government rules. Courts have recognized, however, that an implied covenant of good faith and fair dealing places limits on the government's ability to change the terms of an agreement through subsequent legislation to the detriment of the private party.[32]

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[31] *See Amendment of the Commission's Rules Regarding Installment Payment Financing for Personal Communications Services (PCS) Licensees; Amendment of Part 1 of the Commission's Rules—Competitive Bidding Procedures,* Second Order on Reconsideration of the Second Report and Order, 14 FCC Rcd 6571, 6581 n.66, ¶ 17 (1999) ("At the time the Commission accepts the winning bid in its public notice closing the auction, the Commission becomes bound to issue a license to the winning bidder if it is determined to be qualified as a licensee pursuant to the Commission's rules and procedures, and concomitantly, the winning bidder becomes contractually bound at the close of the auction to pay the full winning bid."); *see also NextWave Personal Communications, Inc. v. FCC,* 200 F.3d 43, 60 (2d Cir. 1999) ("The close of the auction established the FCC's obligation to grant NextWave the Licenses if the company fulfilled the statutory eligibility requirements.").

[32] *See United States v. Winstar*, 518 U.S. 839 (1996); *Centex Corp. v. United States,* 395 F.3d 1283 (Fed. Cir. 2005); *Mobil Oil Exploration and Producing Southeast, Inc. v. United States*, 530 U.S. 604 (2000); *see also Franconia Assocs. v. United States*, 61 Fed. Cl. 718 (2004).

In the case of a spectrum license, the Commission would breach the covenant of good faith and fair dealing if it were to devalue the licensee's beneficial use and enjoyment of the authorized spectrum by licensing new and interfering uses. Because the Commission's action here is targeted at particular licensees, it would not qualify as a sovereign act that would be exempt from the good faith and fair dealing restrictions.[33] The remedy for such breach is either financial compensation to the licensees for the economic value lost or an award of equivalent spectrum rights in other spectrum.[34]

Third, licensing new interfering uses in previously licensed spectrum constitutes an unlawful taking of property of the existing licensees. The Commission lacks statutory authority to order a taking of property for public use pursuant to the Fifth Amendment Takings Clause. Accordingly, the FCC is barred from implementing requirements that would impair the rights of spectrum licensees if such rights are cognizable property interests that would be "taken" in the constitutional sense by the proposed rules. While the Commission and courts generally recognize that a spectrum licensee does not hold a property interest in the license itself, courts have found that rights integral to the license do constitute cognizable (and highly valuable) property interests, which the Commission may not lawfully impair.[35]

Like other property interests, a licensee's rights in radio licenses and facilities can be "taken" by government action. Government action that appropriates the use and

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[33] As noted in *Centex*, only generally applicable legislation (or regulations) qualify as sovereign acts, not provisions "specifically targeted at the fruits of contracts enjoyed by the government's contracting partners." *Centex*, 395 F.3d at 1308.

[34] *See, e.g.*, *Centex*, 395 F.3d at 1314.

[35] *Atlantic Business and Community Development Corp.*, 994 F.2d 1069, 1073-74 (3d Cir. 1993) (citations omitted); *L.B. Wilson, Inc. v. FCC*, 170 F.2d 793, 798 (D.C. Cir. 1948).

enjoyment of property from the owner is deemed a taking *per se*. Government laws or regulations that reduce or eliminate uses of an owner's property, without actually appropriating the property itself, are regulatory takings. An FCC decision to license third-party use of signal boosters in licensed bands would effectuate a taking under either standard.

II. CONCLUSION

The Joint Proposal submitted today by Verizon Wireless and Wilson Electronics provides a path forward to the Commission for adopting technical rules and operational requirements for three categories of signal boosters; Consumer Boosters, CEO Boosters and Carrier Installed Boosters. This proposal reflects a compromise that enables consumers to use boosters to improve coverage, where needed, while enabling wireless licensees to maintain operational control over signal boosters and protect wireless networks from harmful interference. The Commission should adopt the Joint Proposal as the framework for the rules it adopts in this proceeding.

Respectfully submitted,

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APPENDIX A

Consumer Booster Specifications for CMRS Spectrum Bands

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July 25, 2011

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Consumer Boosters Specifications for Commercial Mobile Radio Service Bands (Cellular, PCS, AWS & 700MHz Spectrum Bands)

General Requirements

- Consumer Boosters must not cause interference to CMRS base stations or user devices. Consumer Boosters must be FCC Type Certified to meet the specifications listed below. Any boosters not in compliance with these specifications, must be installed, operated and certified by CMRS licensees or certified installers. Consumer Boosters may utilize channel block specific filters, provided that the uplink filter attenuation is equal to or greater than the downlink filter attenuation for frequencies outside the supported channel blocks.
- A Consumer Booster is defined as a bi-directional RF amplifier with associated antenna systems that transmits and receive signals on uplinks and downlink CMRS spectrum bands using an outdoor antenna for transmission and reception to CMRS base station(s) and an indoor or in-vehicle antenna, or direct connection to enhance service for CMRS mobiles, meets all specifications outlined herein, and are registered with licensed carriers. Consumer Boosters do not require industry certification and may be installed and used by CMRS consumers.
- Consumer boosters will be licensed under Part 22 (Cellular), Part 24 (Broadband PCS), and Part 27 (AWS & 700MHz) of FCC rules. Part 90 (PLMR) bands are excluded at this time, and recommended for future consideration after 800MHz re-banding has completed.

Power Limits, Antenna Requirements, and Emission Limits

Power Limits & EIRP Limits

- Uplink: 1 Watt (30 dBm) composite power per band of operation
- Downlink: 0.05 Watt (17 dBm) composite power per band of operation
- Compliance to power limits will measured over intervals of continuous transmission using instrumentation calibrated in terms of an RMS equivalent voltage.

Antenna Requirements

- Antenna system net gain including cable loss of up to 0 dBi is permitted without de-rating adjustments. Higher antenna system gains require per dB power de-rating that limits EIRP to 1 Watt for uplink and 0.05 Watt for downlink composite power per band. Consumer Boosters must be sold and FCC type certified with specified antennas and cables.

Emission Limits

- The booster out of band emissions (OOBE) shall be 6 dB below the FCC's mobile emission limits for the supported bands of operation. This is required to limit the additional emissions caused by the booster into the adjacent bands (which may be a Public Safety band in some cases) such that it will not add more than 1 dB to the input signal's emissions.

Design Requirements

AGC Overload Control

- The Consumer Booster must use automatic gain control (AGC) to prevent booster overload when high input signals are received on the uplink and downlink for protection against booster amplifier overload and exceeding specifications under these conditions. The uplink and downlink AGC dynamic range should be at least the gain of the booster or 30 dB, whichever is less.
- Consumer Boosters that do not have sufficient AGC dynamic range to meet the BTS Overload Gain limits and In band Noise Limits specified below must go into Transmit Power Off Mode. In addition, the booster must have sufficient AGC to meet all specifications including maximum output power and emission limits, otherwise the booster must go into the Transmit Power Off Mode.

Amplifier Design

- Consumer booster amplifiers must be designed for wide band signals with a minimum of 10 dB peak to average ratio (PAR) ratio, such as LTE or WiMax signals.

Anti-Oscillation Protection

- Boosters must be able to detect and mitigate (i.e. via AGC or shut down) any oscillations on uplink and downlink bands, including operations that exceeds any specified limits (i.e. power, emissions, etc.). Oscillation detection and mitigation must occur automatically within 0.3 seconds on the uplink and 1 second on downlink, and remain off for at least one (1) minute before restarting. If after five (5) restarts, the booster must shut off and remain off until manually reset by the device operator.

Requirements for Boosters Having Gain Greater Than 50 dB

- Consumer Boosters with gain greater than 50 dB must meet the following requirements: a.) must provide notice to consumers that they cannot be used in mobile applications, b.) must not use input power voltage of 12 VDC, and c.) must not use RF connector types FME or SMA.[1]

Connector Type Requirements for Mobile Boosters & Antennas

- Boosters and antennas designed for mobile applications must use FME or SMA type connectors.

Requirements for Mobile Boosters Having Gain Greater Than 23 dB

- Consumer Boosters intended for mobile applications having uplink gain greater than 23 dB must provide notice to consumers that a.) they can only be used with

[1] Consumer Boosters with gain greater than 50 dB are reserved for fixed indoor applications only. Specifications for fixed indoor boosters permit higher maximum gains, higher BTS overload gains with increased coupling losses to mobiles, and higher uplink gains in shut off modes than mobile boosters, which would not protect nearby mobiles and base stations from noise and overload limits.

supplied antenna accessories, or b.) they cannot be used with direct connected or coupled antenna accessories.[2]

Requirements for Mobile Boosters Having Gain Greater Than 15 dB

- Consumer Boosters intended for mobile applications having uplink gain greater than 15 dB must provide notice to consumers that a.) they can only be used with supplied antenna accessories, or b.) they cannot be used with direct connected antenna accessories.

Uplink and Downlink Requirements

- Consumer Boosters must be designed to provide equivalent performance for the base station reverse link (uplink) and the base station forward link (downlink) to the mobile devices. One-way boosters (i.e. uplink only, downlink only, uplink impaired, downlink impaired) are not permitted.

<u>Transmitter Requirements, In band Noise Limits, and BTS Overload Limits</u>

Uplink Power Off Mode (Uplink Squelch)

- Consumer Booster that do not receive mobile device transmissions at their uplink input port after a maximum of 15 minutes must either: a.) turn off the booster's uplink transmitter, or (b) limit its uplink noise power output level to -70 dBm/MHz, or (c) reduce its Uplink Noise Power limit to 10 dB below the Uplink Noise Power Limit specified in the section below, which results in the limit: Uplink Noise Power <= -113 dBm/MHz - RSSI.
- The booster's downlink transmitter may remain active in the Uplink Power Off Mode. Sensing algorithms must use RMS detectors and measure uplink signals received a minimum of 4 dB above the noise floor of the sensing receiver for positive identification of mobile device transmissions to activate the booster's uplink transmitter.
- Consumer Boosters with maximum uplink noise power greater than -59 dBm/MHz that do not support the Uplink Power Off Mode must reduce its Uplink Noise Power limit to 10 dB below the Uplink Noise Power Limit specified in the section below, which results in the limit: Uplink Noise Power <= -113 dBm/MHz - RSSI.
- Consumer Boosters with maximum uplink noise power less than -59 dBm/MHz are excluded from the Uplink Power Off Mode requirement.

Transmit Power Off Mode

- In this mode of operation, the Consumer Booster's uplink and downlink transmitters shall be turned off, and not exceed the "Transmit Power Off Limit" specified below. The Transmit Power Off Mode is required when the booster

[2] Mobile Boosters with uplink gain greater than 23 dB cannot be used with antenna couplers, cradles or direct connected mobile devices. Specifications for mobile boosters with in-vehicle antennas permit higher maximum gains (i.e. 50 dB), higher BTS overload gains with increased coupling losses to mobiles, and higher uplink gains in shut off modes than mobile boosters, which would not protect nearby base stations from BTS overload limits.

cannot otherwise meet the specifications defined herein (i.e. for power, emissions, noise, or overload limits).

Transmit Power Off Limit

- When operating in the "Transmit Power OFF Mode", the Consumer Booster transmitters shall be turned off, and not exceed the noise power and gain limits specified below:
    - Uplink & Downlink Noise power <= -70 dBm/MHz
    - Uplink Gain <= 23 dB, for fixed indoor consumer boosters
    - Uplink Gain <= 23 dB, for mobile boosters with antennas
    - Uplink Gain <= 7 dB, for mobile boosters with cradles/couplers
    - Uplink Gain <= 3 dB, for mobile boosters with direct connects.

- The Transmit Power Off Mode protects nearby mobiles from elevated noise floors, and nearby base stations (BTS) from elevated noise levels and overload.

In Band Noise Power Limits

- The Consumer Booster transmitted noise power output at its uplink and downlink ports must not exceed the limits specified below.

  Uplink Noise Power <= -103 dBm/MHz - RSSI

  Noise Power Maximum <= -102.5 dBm/MHz + 20 Log (Frequency)
  (for Fixed Indoor Boosters, for Uplink and Downlink)

  Noise Power Maximum for Mobile Boosters <= -59 dBm/MHz
  (i.e. Max. Gain of 50 dB for UL & DL, for 5 dB Noise Figure Booster)

- Where, RSSI is the downlink composite received signal at the booster input port from the base station. Measurements must contain the total (composite) power received in the supported spectrum band with wideband RMS detectors using peak samples measured over a minimum period of 1 second. Measurements must be performed separately for each band (i.e. Cellular, PCS, etc.) supported by the booster.
- Where, Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz units.
- Consumer Booster's uplink and downlink gains must be within range of each other during active connections to maintain equivalent performance and balance for uplinks and downlinks.[3]
- For example, at the measured downlink composite RSSI of -50 dBm at the booster's input port, the booster's Uplink Noise Power is limited to -103

[3] Consumer Boosters must be designed to provide equivalent performance for the base station reverse link (uplink) and the base station forward link (downlink) to mobile devices when connections are active. When boosters are operating with UL Squelch mode enabled uplink transmissions are reduced when devices are not active.

dBm/MHz - -50 dBm, which limits the Uplink Noise Power to -53 dBm/MHz. The Noise Power Limit is independent of the supported frequency band.

- A booster's transmitted noise power is related to its noise figure and Gain as follows: Noise Power = Thermal Noise (KTB) + Gain + Booster Noise Figure. Varying its uplink and downlink gain varies its transmitted noise power at its uplink and downlink ports. The Uplink Noise Power limit will limit the uplink Gain of the booster as follows. For a consumer booster with an uplink noise figure of 5 dB, downlink RSSI of -50 dBm, and thermal noise of -114 dBm/MHz at room temperature, the uplink Gain would be limited to: Gain <= 6 dB - RSSI, which limits Uplink Gain to 56 dB in this case.
- For example, for fixed indoor consumer boosters the uplink and downlink Noise Power Output Maximum is -37 dBm/MHz for PCS (1880MHz), -38 dBm/MHz for AWS (1730MHz), -44 dBm/MHz for Cellular (835MHz), and -45 dBm/MHz at 750 MHz. For a consumer booster with 5 dB noise figure, this corresponds to the uplink and downlink Maximum Gain of 72 dB for PCS, 71 dB AWS, 65 dB for Cellular, and 64 dB at 750 MHz. The Noise Power Maximum Limit varies by frequency band.
- Consumer Boosters with maximum uplink noise power greater than -59 dBm/MHz that do not support the Uplink Power Off Mode (UL Squelch) must reduce its Uplink Noise Power limit to 10 dB below the Uplink Noise Power Limit specified above, which results in the limit: Uplink Noise Power <= -113 dBm/MHz - RSSI.
- Consumer Boosters that do not have sufficient AGC dynamic range to meet the uplink and downlink Noise Power Limit must go into Transmit Power Off Mode when AGC is exhausted.[4]
- Compliance to this limit is measured in FCC type certification testing, with the peak level within the supported spectrum bands not exceeding the specified limit using a spectrum analyzer employing a resolution bandwidth (RBW) of 1 MHz and RMS detector.

BTS Overload Gain Limits

- The uplink and downlink Gain of the Consumer Booster shall not exceed the limits specified below.

Uplink Gain <= -34 dB - RSSI + MS Coupling Loss

Where, MS Coupling Loss (MSCL) is equal to: [5]

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[4] Consumer Boosters that do not have sufficient AGC dynamic range to meet Noise Power limits must go into Transmit Power Off Mode when AGC is exhausted, which occurs at the downlink RSSI levels: RSSI >= 11 dB - Booster's Noise Figure - Max. Gain of the Booster + Max. AGC of Booster. For example, a fixed indoor booster having a maximum uplink gain of 65 dB, maximum AGC of 30 dB, minimum gain of 35 dB, and uplink noise figure of 5 dB, must shut off at the downlink RSSI of -29 dBm.

[5] The MS Coupling Loss represents the minimum inside net coupling loss from a CMRS mobile to the booster input port, specified as a positive loss value. The losses were derived from measurements at cellular and PCS frequencies with standard antennas and configurations for indoor fixed and mobile applications. For example, for an indoor dome antenna mounted at the ceiling with 20 feet RG58 cable to the booster, the

Fixed Indoor Booster with Dome Antenna: MSCL = 40 dB
Fixed Indoor Booster with Panel Antenna: [6] MSCL = 36 dB
Fixed Indoor Booster w/ Monopole Antenna: MSCL = 36 dB
Mobile Booster with Inside Antenna: MSCL = 23 dB
Mobile Booster with Cradle/Coupler: MSCL = 7 dB
Mobile Booster with Direct Connect: MSCL = 3 dB

Maximum Gain for Fixed Indoor Boosters <= 6.5 dB + 20 Log (Frequency)
(i.e. PCS 72 dB, Cell 65 dB, maximum uplink and downlink gains)

Maximum Gain for Mobile Boosters (for Uplink and Downlink):
With Inside Antennas: Gain <= 50 dB
With Cradle/Couplers: Gain <= 23 dB
With Direct Connects: Gain <= 15 dB

- Where, RSSI is the downlink composite received signal at the booster input port from the base station (BTS). Measurements must contain the total (composite) power received in the supported spectrum band with wideband RMS detectors using peak samples measured over a minimum period of 1 second. Measurements must be performed separately for each band (i.e. Cellular, PCS, etc.) supported by the booster.
- Where, Frequency is the uplink mid-band frequency of the supported spectrum bands in MHz units.
- Where, the Maximum Gain for fixed and mobile boosters is the limit for uplink (UL) and downlink (DL) directions.
- Consumer Booster's uplink and downlink gains must be within range of each other during active connections to maintain equivalent performance and balance for uplinks and downlinks.[7]
- For example, at the measured downlink composite RSSI of -50 dBm at a fixed indoor booster's input port, with dome antenna MS Coupling Loss of 40 dB, the Uplink Gain <= -34 dB - -50 dBm + 40 dB, which limits the Uplink Gain to 56. The BTS Overload Gain Limit is independent of the supported frequency band.
- For the fixed indoor booster with dome antenna (MS Coupling Loss = 40 dB), the overload Uplink Gain is limited to -34 dB - RSSI + 40 dB, which is equal to 6 dB - RSSI. This is equal to the uplink gain limit for a 5 dB Noise Figure booster from the Uplink Noise Power limit. For all other booster and antenna cases, the MS Coupling Loss is less than 40 dB, and the BTS Overload's Uplink Gain limit

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minimum measured coupling loss to a 1/4 wave antenna (0 dBi) at 5 feet above floor level was 37 dB for cellular and PCS frequencies, with 3 dB user body/head/misc. loss, is equal to MS Coupling Loss = 40 dB.

[6] Fixed indoor booster systems with panel, monopole or dipole antennas must a.) provide notice to consumers that antenna installations must maintain a minimum 6 foot standoff from CMRS devices or be mounted at ceilings heights, or b.) vendors must assume the MS Coupling Loss of 30 dB.

[7] Consumer Boosters must be designed to provide equivalent performance for the base station reverse link (uplink) and the base station forward link (downlink) to mobile devices when connections are active. When boosters are operating with UL Squelch mode enabled uplink transmissions are reduced when devices are not active.

is more stringent than the uplink gain limited by the Noise Power limit for a booster with noise figure of 5 dB.

- For example, the uplink and downlink Maximum Gain of Consumer Boosters is 72 dB for PCS, 71 dB for AWS, 65 dB for Cellular, and 64 dB at 750 MHz. The Maximum Gain Limit varies by frequency band.
- Low power mobile boosters designed for single user devices with cradles, couplers or direct connects having gains less than 23 dB may increase the BTS Overload Uplink Gain limit when uplink received levels at the booster input exceeds -10 dBm. For every 1 dB above -10 dBm received on uplink, an additional 1 dB can be added to the BTS Overload Uplink Gain limit. Note that all other limits remain unchanged, including Power, Emissions, Noise, Maximum Gain, and Transmit Power Off Limits. Uplink received levels must measured as wideband composite power levels using RMS detectors, averaged over a minimum period of 1 second, and be performed separately for each band supported by the booster.[8]
- Consumer Boosters that do not have sufficient AGC dynamic range to meet the uplink and downlink BTS Overload Gain limits must go into Transmit Power Off Mode when AGC is exhausted.[9]
- Compliance to this limit is measured in FCC type certification testing, using peak Gain values (including amplifier ripple) within the supported bands.

GPS and Registration Requirements

GPS Requirements

- Product labeling requirements include notification to consumers that E911 location information may not be provided to calls served by the booster. Consumer Boosters designed to pass through satellite GPS signals with no interference to CMRS or GPS operations for direct connected or device coupled boosters are excluded from this consumer notification requirement.

Registration

- Consumers are required to register their Consumer Boosters by contacting their CMRS service provider(s), and include the following information: booster model number, FCC ID #, supported frequency band(s), contact name, address, e-mail, and phone number for the licensee's ability to maintain and shut down interfering units as required. Consumers must be notified of registration requirements in user installation manual(s) or other supplied product documentation. Unregistered

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[8] For example, when uplink received levels (UL_RX) at the booster input exceeds -10 dBm, the uplink gain is limited to -34 dB - RSSI + MS Coupling Loss + UL_RX - -10dBm. For the MS Coupling Loss of 7 dB for a booster with cradle, downlink RSSI of -40 dBm, UL_Rx of -5 dBm, the uplink gain is limited to 18 dB. Dual-band and multi-band boosters must measure and perform uplink controls for each band separately (i.e. Cellular, PCS, etc.) supported by the booster.

[9] Consumer Boosters that do not have sufficient AGC dynamic range to meet BTS Overload Gain limits must go into Transmit Power Off Mode when AGC is exhausted, which occurs at the downlink RSSI levels: RSSI >= -34 dB + MS Coupling Loss - Max. Gain of the Booster + Max. AGC of Booster. For example, a mobile booster with cradle has MS Coupling loss 7 dB, a maximum uplink gain of 22 dB, maximum AGC of 20 dB, and minimum gain of 2 dB, must shut off at the downlink RSSI of -29 dBm.

Consumer Boosters would be subject to FCC enforcement and fines. Consumers must be active CMRS customers.

Bluetooth Connection

- As an alternative to registration, a Bluetooth connection and registration can be made between the mobile device and the booster unit for the booster operate.[10] The booster will operate as an extension to an authorized mobile device. When a booster amplifier is controlled by a supported wireless device the following functions are supported: 1.) booster and device information exchange, 2.) booster registration with licensed carrier through wireless device, 3.) device determines whether booster amplifier can support spectrum and technology, 4.) device requests amplifier to turn on and off, 5.) device provides information to the booster to change spectrum bands as required for mobile operation.

FCC Type Certification for Consumer Boosters

- Compliance to all specifications listed herein is required. Consumer Boosters must be FCC type certified to meet these specifications and include installation manual(s) with specified antennas and cables. Type certified boosters must display the FCC ID number.
- Compliance to power and emission limits require using input signals on standard frequency assignments for all bands supported by the booster, and must utilize source signals with a minimum of 1 MHz occupied bandwidth and having a minimum peak-to-average (PAR) ratio of 10 dB (i.e. LTE or WiMax signals). Compliance to emission limits require input signals on standard frequency assignments at the band edges for all supported bands.
- Certification tests for emissions and output power will be performed at maximum rated output power, and verify AGC prevents booster overload when input exceeds input rated power range.

[10] Bluetooth is a wireless technology standard for exchanging data using radio transmissions in the ISM band from 2400-2480 MHz from fixed and mobile devices, creating personal area networks with high levels of security. Bluetooth is managed by Bluetooth Special Interest Group, which has more than 14,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics.

APPENDIX B

FCC WT Docket 10-4
Improving Wireless Coverage
Through the Use of Signal Boosters

Industry Certified Signal Booster Program

Dave Hunt – Senior RF Engineer
Sean Haynberg – Director of RF Technologies

July 25, 2011

Overview

- Introduction
- Summary
- Authorization of CEO Booster Operation
- Certified Engineered and Operated “CEO” Installers
- Proof of Performance
- Booster Equipment and Operation
- Database Information Requirements

Introduction

- Consumer Boosters are not required to meet the requirements of this program for Industry Certified Boosters.
- The Booster Certification Program is a commercial wireless industry accepted program to ensure that non-consumer booster equipment and installations meet minimum performance standards and the installers successfully integrate boosters into the macro network with proper engineering design and coordination pursuant to industry standards.
- For the purposes of this document, a "Booster" is defined as a bi-directional RF amplifier that transmits and receive signals using an outdoor "donor" antenna orientated to a nearby serving CMRS base station and uses an indoor "server" antenna to enhance CMRS coverage indoors. The antenna systems may be distributed via coaxial cable or fiber.
- The proposed name for the certified booster systems are "Certified Engineered and Operated" boosters ("CEO"). They will be able to serve large offices, business, enterprises, etc.
- The technical operating specifications of the CEO boosters will be developed by industry participants including industry trade association, manufacturers, installers, and licensed carriers. From a technical view, CEO system operating specifications are expected to be similar to booster systems installed by wireless carriers. CEO booster systems may support individual or multiple wireless carriers.

Summary

- Certified Boosters will be required to be installed and engineered by certified installers.
- Certified installers will be required to be trained and follow the developed industry standards. They will coordinate with the existing licensees as necessary and maintain a database of information. CEO installers will be required to attend and pass an industry certified test compliance program.
- CEO installers will maintain necessary accepted documentation according industry standards that will be developed for this program, which will include proof of performance, measurements and test results.
- CEO booster systems must be installed, engineered, and operated by companies that are certified by an industry organization such as the CTIA.
- CEO installers must provide and maintain specific booster information when coordinating with licensees and for record keeping.

Authorization of CEO Booster Operation

- The CEO boosters would be authorized to operate through coordination with the supported licensee(s). Entities would not be allowed to operate CEO boosters without carrier authorization.
- CEO installers would be required to coordinate, obtain licensee consent and provide booster database and operating parameters for all bands and licensees' spectrum bands supported by the booster.
- Authorization and operation requests to the licensee must include 24 hour contact information, to turn off boosters in case of interference.
- The booster operator is responsible to the licensed carrier for the technical performance of the system. All interference and traffic engineering issues are coordinated with the licensed carrier .

"Certified Engineered and Operated" Installers

- CEO installers would be required to demonstrated competence in RF engineering booster systems and knowledge of commercial wireless networks and technologies, including an advanced training in RF engineering and certification for CMRS certified booster systems.
- CEO boosters installed must be adjustable with parameters on a license spectrum block basis.
- CEO installers must provide booster information including model #, operating parameters, location, etc. to the database manager and/or licensee(s), which will be maintained in a database for resolution of problems, and for future upgradeability to support new technologies, and to address required re-orientation of donor antennas in cases of newly deployed base stations nearby.
- CEO installers will be required to attend and pass an industry certified test compliance program. This compliance program will mandate test requirements, test plans, test documentation requirements.
- CEO installer certification may be revoked upon failure to comply with industry defined practices and requirements in the compliance program.
- Installer certification must be renewed every five years.
- CEO booster installer and operator must have access to appropriate test equipment for installation and on going operation of the CEO booster system. Booster system calibration information is provided in the CEO database.

Proof of Performance

- CEO installers will properly engineer, install, test and confirm equipment is operating according to developed standards and is operating as authorized by the supported licensed carriers.
- Installations will require acceptable completion of on-site testing, which will include required test plans and documentation, measurements of isolation between donor and server antennas, verification of gain to isolation ratio, measurement of gain and output power levels utilized, coupling measurements to confirm base station noise and overload conditions are not exceeded.
- The industry certified booster will be installed and configured to meet minimum performance specifications for each wireless technology supported as specified by the CMRS licensee(s). Minimum performance standards will be developed with industry engineers and published by industry organizations.

Booster Equipment and Operation

- CEO systems must be engineered and operated by companies that are certified by the specified industry organization.
- They can use a wide range of power levels and technologies.
- Donor antennas must be directional and oriented to nearby base stations as specified by the CMRS licensee(s).
- Operating parameters are adjusted per licensed spectrum block(s).
- CEO systems should be flexible enough to enhance coverage in most locations, while providing for existing licensee base station protection and performance.

Database Information Requirements

- CEO installers must provide booster database information below to the database manager and/or licensee(s).
- Licensees will maintain a booster database for
  - Interference and problem resolution
  - Future upgradeability to support new technologies
  - Address re-orientation of donor antennas toward newer cell sites deployed nearby or as required for traffic engineering.
- Booster database installation & information will include
  - Booster Location (Latitude & Longitude, Street Address, Location within Building, Picture of building)
  - Building and booster installation and configuration information and diagrams (inside and outside equipment and antennas, locations, specifications and operating parameters)
  - Booster Manufacturer, Model, FCC ID #, Operating and Design Parameters

Database Information Requirements (Cont')

- Equipment information including measured cable and component losses, equipment types, models, operating specifications
- Outside Donor antenna description, model, specifications, orientation, location on building, pictures and diagram of antenna and location, Repeater description and location inside of building
- Booster operators contact information (24x7)
- Access requirements for surveying booster equipment and installation
- Software remote control requirements and account security information
- Booster contact information will be used as necessary to confirm installation, operation and maintenance of booster systems in compliance to the program requirements, and in cases of potential interference.

V-COMM is a leading provider of quality engineering and engineering consulting services to the worldwide wireless telecommunications industry with offices in Cranbury, NJ and Blue Bell, PA. V-COMM's engineering staff is experienced in Cellular, Personal Communications Services (PCS), Wireless Broadband Data, Enhanced Specialized Mobile Radio (ESMR), Paging, 2-Way radio, Microwave, and Broadcast Mobile TV networks. We have provided our expertise to wireless operators in engineering, system design, implementation, performance, optimization, and evaluation of new wireless technologies.

We have extensive experience in analyzing interference in various spectrum bands including Cellular, SMR, PCS, AWS, Air-to-ground, Public Safety, and 700 MHz spectrum. We have engineering experience in all commercial wireless technologies, including LTE, HSPA, UMTS, EVDO, CDMA, GSM, WiMAX, DVB-H, and Public Safety wireless technologies including analog and digital Project 25, EDACS, Opensky, and other trunking and conventional radio networks. Further, V-COMM was selected by the FCC & Department of Justice to provide expert analysis and testimony in the Nextwave and Pocket Communications Bankruptcy cases.

For additional information, visit V-COMM's web site at www.vcomm-eng.com.