Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies	)	ET Docket No. 03-108
	)	
Authorization and Use of Software Defined Radios	)	
	)	

REPLY COMMENTS OF SHARED SPECTRUM COMPANY

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SUMMARY

Cognitive Radios should be operated on an independent basis and not subjected to the control of existing licensees, -- pursuant to well-established Commission and Congressional policy in favor of competition and the Constitutional policy of promoting free speech. Existing licensees were not granted property rights in every thing that goes on in the frequency bands they use but merely the right to offer their licensed services free from harmful interference. Given this rapidly developing technology with the ability to increase greatly the communications capacity of the spectrum, it is scarcely appropriate to bar new entrants with the greatest incentive to develop the technology from doing so.

The technical arguments by licensees seeking recognition of monopoly status over the bands they use are highly flawed with erroneous assumptions about their own services contrary to the Commission's previous decisions and even more erroneous assumptions about cognitive radio. Avoidance of interference to services using frequency pairs merely require monitoring each of the paired frequencies. Use of packets by cognitive radio permits monitoring of primary use even after cognitive radio transmissions have begun. For the small number of services characterized by passive receivers, Shared Spectrum had previously addressed the so-called "Hidden-Node: problem. And, in a effort to introduce an extra degree of conservatism and to give existing licensees ample assurance, Shared Spectrum has proposed initially operating cognitive radios on a centrally controlled network basis to firmly establish the concept to general satisfaction prior to instituting operation in the autonomous mode.

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1 The Fundamental Economic Question Is Whether Spectrum Should Be Better Used to Promote Competition Rather Than Monopoly

Although the Comments filed by Shared Spectrum Company and most other parties were primarily technical in nature, it has become apparent that there are issues at stake of a more economic and philosophical nature. The central question is whether the existing primary licensees should exercise complete control over all use of the bands in which they are licensed or whether newcomers with new non-interfering technology should be permitted to compete and increase the overall productivity of the spectrum.

Shared Spectrum agrees with the 22 Technological Companies that the Commission should not hobble innovation by presupposing any additional rents for current bandwidth licensees. Shared Spectrum also strongly agrees with the recommendation of the Commission's Technical Advisory Council that any wireless device may use any bandwidth to perform its function as long as it does not interfere with others. In the past, the practical effect of licensing may have been to exclude other users but that was never a Commission policy and should never be one. While until

recently, another's use of the spectrum diminished the value of the primary license, it is no longer true with the new generation of cognitive radios now at hand.

New voices need not be denied or be turned away by artificially created rents extracted by licensees who got there first with older technology. Exclusion is not only bad economics; it's fundamentally inconsistent with the values of the First Amendment. As Yochai Benkler has written[1]:

> "Building a robust communications environment that is not biased in favor of one type of speaker or one type of speech requires a core communications infrastructure that no one owns and that no one can control to impose a preferred model of discourse. To achieve this goal, we need a core common infrastructure equivalent to our public highway system—nonproprietary and equally open to all."

Shared Spectrum strongly disagrees with the spokesmen of the *ancient regime*, such as Verizon Wireless, Cingular, CTIA, V-COMM, Hazlett and Spitzer, each of whom argues that the incumbent licensees should control anything that goes on in the bands in which they operate. Verizon Wireless (p. 2) characterizes allowing secondary users as a "forced taking of spectrum," using the language of the Fifth Amendment as though it had a some property right to the spectrum – a "right" long and clearly denied by the Communications Act. But Verizon clearly has no such property right. Section 309(h)(1) of the Communications Ac provides that: "The station license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized therein." The Court of Appeals has recognized that the rights of cellular licensees are not property rights but instead represent merely a "right to be protected

[1] *Property, Commons, and the First Amendment: Towards a Core Common Infrastructure*, White Paper for the First Amendment Program Brennan Center for Justice at NYU School of Law, 2001, at 4. *See also Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment,* 11 Harvard Journal of Law & Technology 287 (1998)

from harmful interference. In rejecting a similar attack by the cellular licensees against a proponent of another new technology, the Commission observed that: "Absent harmful interference, AirCell's new system does not trammel upon petitioners' rights as licensees. See AMSC Subsidiary Corp. v. FCC, 216 F.3d 1154, 1158-59 (D.C. Cir. 2000)." AT&T Wireless Services v. FCC, 270 F. 3d 959 (D.C. Cir. 2001)

Verizon Wireless and its allies are, in essence, seeking a return to the now discredited economic analysis that was used for many years to justify maintenance of the Bell System monopoly. Verizon justifies its refusal to tolerate any other use within what it considers its bands no matter how innocuous on the basis that it and it alone will achieve greater efficiencies of band usage in the future. It argues that nothing must be allowed to compete with its potential future improvements. This is essentially the position taken by the Bell System when it opposed the introduction into its monopoly wireline telephone network of specialized common carriers[2] and customer-provided equipment.[3] Then the Bell System companies referred to equipment not under their control deprecatingly and with professed alarm, as "foreign attachments," just as

[2] For example, the President of AT&T Long Lines testified in court that interconnection with new carriers would seriously damage the integrity of the nation's telephone network. *MCI Communications Corporation v. AT&T*, U.S.D.C. E.D. Pa. Civil Action No. 73-2499 at 328-341. (See *The Communications Act: A Legislative History of Major Amendments*, 1934-1996, Paglin ed. 1999. at 38) The Commission's disposition of these spurious claims is found at *Bell System Tariff Offerings*, 46 FCC2d 413 (1974), *aff'd sub nom. Bell Telephone Co. of Pennsylvania v. FCC*, 503 F.2d 1250 (3d Cir. 1974), *cert. denied*, 422 U.S. 1026 (1975). Subsequent history has vindicated the Commission's decision and made the Bell claims of technical harm appear ludicrous.

[3] *Carterfone Device in Message Toll Telephone Service*, 13 FCC2d 420, *aff'd* 14 FCC2d 571 (1968).

Cingular now calls them ”rogue devices” (at 6).[4] The meaning is the same. Anything not under their control must be eliminated.

Now, as then, a dominant carrier proclaims its fear of allegedly enormous damage to its operations by even the most modest introduction of new equipment by parties not under its direct control. The allegations here of enormous potential harm turn out to be based on worst case assumptions, incorrect use of the Shannon limit and disregard of factors characteristic of its own service. They are shown to be fundamentally flawed in the Appendix to these Reply Comments.

Verizon seeks to rule out at the outset a new type of service and prevent it from being tested in the marketplace with vague assertions that if the Commission has given it complete control over everything taking place in the bands in question. It claims that its unitary control will be more productive than would be the opening of the bands to new independent services. The unfortunate instinct of firms with established market power is to suppress technological innovation and that is what Verizon seeks to do here. Verizon is certainly not precluded from developing its own smart radio services, but it prefers instead to try to suppress new technology and deprive others of the incentive to pursue it.

Verizon is, in effect, asking for monopoly control over the bands it is using by regulatory exclusion of new technology used by others. Its position is essentially a reiteration of the old Bell monopoly theory (once described by the Bell slogan “The System is the Solution” and sometimes identified with the “Vail Paradigm”) that the Commission, and history, have squarely rejected. It is well established now that competition is the most effective agent for development and implementation of new

[4] Verizon engages in similar tendentious distortions of semantics by referring to devices not subject to its control as “non-voluntary” (at 3) and their co-existence with equipment under its control as “forced sharing” (at 6).

technology. Over the last generation, the Commission has recognized that competition is the key to development of the most efficient services. That policy should be applied here.

In 1996 Congress explicitly determined to establish an explicitly "pro-competitive, deregulatory national policy framework"[5] Senator Hollings summarized the conclusions in enacting the Telecommunications Act of 1996[6]:

> "Competition is the best regulator of the marketplace. But until that competition exists, until the markets are opened, monopoly-provided services must not be able to exploit the monopoly power to the consumers' disadvantage. Competitors are ready and willing to enter the new markets as soon as they are opened."

Section 332 (a) of the Communications Act requires the Commission, in managing "the spectrum to be made available for use by the private mobile service" take actions that will "encourage competition and provide services to the largest feasible number of users" and will" increase interservice sharing opportunities between private mobile services and other services." Providing for access to mobile spectrum for independent cognitive radio will greatly increase the overall communications capacity of spectrum and will increase competition.

Verizon Wireless points out the distinctive feature of cellular or PCS service of moving toward lower power operation to enlarge capacity. It cites the V-COMM measurements of particularly low operating noise figures that are said to be only slightly above the thermal noise floor. But Shared Spectrum's system is adjusted to reflect the primary receiver noise levels for primary users in each band and Shared Spectrum has proposed use of the figure of 3 dB below the typical noise figure as the appropriate initial limit for secondary smart radio operation. The low power of the primary users of the bands is a significant factor in making a market-based technical judgment that they may

[5] S. Conf. Rep. 104-230, 104th Cong., 2d Sess. 1 (1996) ("Joint Explanatory Statement")

[6] 114 Cong. Rec. S7984.

not be attractive candidates for early implementation of shared use. It is hard to escape the impression, however, that Verizon is attempting to bootstrap a technical point into an occasion for convincing the Commission to make an ill-advised ruling conferring monopoly privileges on it that will entail a priori exclusion of any future spectrum sharing beyond its complete control.

The economic theory propounded here by Verizon would, if adopted, set back the Commission's economic policy a generation. The Commission has consistently found in favor of competition in every area it regulates. Verizon Wireless's theory is that the dominant firm should have complete unitary control over necessary resources in order to achieve economic efficiency. While it occasionally refers to its theory as a matter of established Commission "spectrum policy," it was only the absence of any sharing alternative under the technology available in the past that left it in sole control over a portion of the spectrum and not an economic policy in favor of Commission-conferred market control. The current Verizon argument bears a significant resemblance to the Bell System argument that it had been given a Commission-sanctioned monopoly over interstate telephone service that was rejected by the courts in the "Execunet case," MCI Telecommunications Corporation v. FCC, 561 F.2d 365, 379-380 (D.C. Cir.), cert denied, 434 U.S. 1040 (1978), mandate enforced, 580 F.2d 590 (D.C. Cir 1978), cert. denied, 439 U.S. 980 (1978). In neither case was a monopoly granted by the Commission. The incumbents simply tried to transform the current absence of other parties into a de jure monopoly. The Court observed, at 380, that:

> "As the Commission staff explained in *Specialized Carriers*, absence of competition in the "general domestic common carrier service field *** is due primarily to the fact that until the filing of [MCI's first Section 214 applications] the Commission had no occasion to consider applications for competitive service in this area." The question whether AT&T should be granted a *de jure* monopoly was not among those proposed to be decided in *Specialized Carriers*, and nowhere in that decision can justification be found for continuing or propagating a monopoly that, according to the staff, had theretofore just grown like Topsy."

Cingular's demand for a "detailed, quantitative cost-benefit analysis" of alternative future spectrum plans for competitive and monopoly alternatives is simply an effort to turn back the clock to the old RCA, or "Three Circuits" international record carrier case, 354 U.S. 86 (1954), which has long been inoperative in view of the Commission's and Congress's adoption of a general policy favoring competition. See, e.g., Washington Utilities and Transportation Commission v. FCC, 513 F. 2d 1142 (9th Cir), cert. denied, 423 U.S. 836 (1975). No longer can competitive alternatives be delayed by lengthy hearings while monopolists continue to ply their trade. It would be particularly destructive to revive such obstructive practices in the context of a new technology that is developing so fast that any detailed economic showings would be completely out of date before such a hearing could be completed.

This theory has also been rejected by other agencies in addition to the FCC. For example, United Airlines, if it had the audacity of Verizon, could argue that it should have complete control over the use of the skies for air transport since it could then efficiently distribute the air traffic without the need to coordinate with other parties. The Government, however, has pursued, instead, a policy of airline competition with only the minimally necessary technical rules to avoid interference with one another's operations, such as the maintenance of minimum separations between aircraft. (And just as aircraft seldom come close to the minimum separation requirements, Shared Spectrum's hole-finding technology would seldom even come close to an interference temperature limit.) Competition has borne fruit for the public. The most successful airline operation is currently Jet Blue, a smaller newcomer, which pursues a different service concept than had been pursued by the much larger and more established airlines. If the economic theory propounded here by Verizon had been employed in air transportation, however, the entry by Jet Blue would have been precluded at the outset and the public would have

been ill-served. Such regulatory preclusion of entry should not be allowed to thwart vital new services, such as those made possible by Shared Spectrum.

2 Cognitive Radios Can Co-Exist With FDD Networks

Cingular claims that co-existence with FDD networks using paired frequencies presents some supposedly insurmountable problem for cognitive radio. While TDD networks use only one frequency for two-way conversation and FDD networks use frequency pairs for conversations, the difference gives rise at most to only a modest increase in cognitive systems. The frequency pairings are well known. Section 22.907 of the Commission's Rules establishes pairing for cellular radio, Section 24.129 for narrowband PCS and Section 24.229 for broadband PCS. Other sections of the Commission's Rules establish pairing for other mobile services.[7] The pairing simply mean that the cognitive radios need to sense levels in both frequencies of each pair to determine whether either is available. It would rule out the use of both if either has a signal greater than the permitted threshold. That represents a relatively modest increase in the complexity of programmed instructions for the cognitive radio and scarcely the bugaboo Cingular suggests.

3 Cognitive Radios Do Not Prevent Primary Licensees from Initiating Transmissions

Verizon Wireless maintains (at 5) that:

> "Unlicensed devices, like any other radio, cannot sense the channel status while unlicensed device will not readily relinquish the channel."

[7] E.g., Sections 22.561 (public land mobile), 22.1007 (offshore radio), 27.5 (miscellaneous), 90.175 (private land mobile) , 101.147 (fixed microwave) of the Commission's Rules.

This claim simply assumes, contrary to fact, that cognitive radios will make continuous uninterrupted transmissions. In fact and in accordance with established practice, the cognitive radios will use packet switching. Between packets there are quiet periods in which monitoring of other uses can take place many times a second. That is what is done by IEEE 802.11a transmissions, which share the 5 GHz band with Government radars and other primary uses.[8] Before each packet is transmitted, each device monitors the RF channel to determine if it is occupied or not.[9] This well developed solution negates Verizon's expressed concern.

4 Under Shared Spectrum's Proposal, Cognitive Radios Would Not Initially Operate Autonomously

Cingular hinges its argument (at 7) on the assumption that "no cognitive radios designed to coexist autonomously (*i.e.,* not under central control)" can allegedly share successfully bands with PCS and cellular services. But Shared Spectrum, in its initial Comments (at 2) in this proceeding, suggested that initially smart radios be operated on a licensed system basis with central system control. In this way during initial operations the Cognitive Radio software can be adjusted instantly to respond to any harmful interference that may be experienced or to any direction by the Commission it may decide to order. In this way, claims of potential interference can be subjected to analysis on the basis of substantial operational experience before units are operated in an

[8] *See Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band*, 18 FCC Rec. 24484 (2003).

[9] *Se e.g.,* Comments of IEEE 802, filed July 2003 in FCC Docket No. 03-122.

autonomous mode. Furthermore, other adjustments to increase efficiency can be made in Cognitive Radio software on the basis of statistical analysis of operating data.

The other advantage of operating on a network basis is that the overall detection capability of the intercommunicating units is substantial increased. Since it becomes possible to detect signals from many locations not all of which will be obstructed, the potential problem of possible obstruction of some primary signals to a stationary cognitive radio claimed by Verizon Wireless (at 4) is more easily overcome. As a result, in a system bringing the combined detection capability of all its detection units to bear it may not, for instance, be necessary to rely upon cyclostationary feature detection in individual units.

5 The Hidden Node Problem Has Been Addressed

A number of parties have brought up the so-called hidden node problem that pertains to the special case in which receivers exist in the absence of transmitting capability from the same site. On September 29, 2003, Spectrum Sharing entered into the record of this proceeding a presentation concerning the hidden node problems that indicated several solutions to the problem. The contents of that presentation are herein incorporated by reference.

6 The V-COMM Argument is Inconsistent with the Commission's Rulings

Cingular and Verizon Wireless sponsored a study by V-COMM of the effect of interference on CMRS operations, which it has filed in this proceeding as well as the Commission's Interference Temperature proceeding, and upon which Cingular and

Verizon Wireless have placed heavy reliance.[10] What is obscured in the telling and retelling of V-COMM's report is that, rather than applying established Commission policy with respect to interference to CDMA systems, it is attacking the Commission's policy in an effort to replace with a much more restrictive policy that would give its sponsors effective monopoly protection over the bands they use. V-COMM claims (at 10) that the Commissions definition of harmful interference "is somewhat arbitrary and very subjective — e.g., what constitutes serious obstructions to service?" V-COMM then correctly observes that: "The current definition does not offer any protection to licensed carriers unless they can demonstrate that the interference is causing serious detrimental harm to their networks." Indeed, the Commission's definition of harmful interference is the interference level that "seriously degrades, or repeatedly interrupts" service. AirCell Remand Decision, 18 FCCR 1926, 1935-36, ¶ 22, aff'd sub nom. AT&T Wireless Services v. FCC (slip op. No. 03-1043, released May 4, 2004), But V-COMM's premise for its conclusions is, in essence, that the Commission's established test is wrong and should be changed.

V-COMM then goes on to claim (at 13), for example, that the operating noise floor for cellular service in rural areas is -127 dBm and that ,and with a 17 dB buffer, a potentially interfering signal would need to be less than a threshold of -110 dBm. It ignores the fact that the Commission has already found that that noise floor is -110 dBm and that the threshold[11] should be -117 dBm. As summarized by the Court of Appeals for the District of Columbia Circuit, in affirming the Commission, the Commission "derived the –117 dBm figure by starting from the strength of the weakest ground-based call that could still be considered acceptable quality in a rural area, which the

[10] *See* Cingular at 6 and Verizon Wireless at 4, 5 and 6.

[11] The Commission used the term "interference tolerance level" or "ITL" to describe the threshold. AirCell Remand Decision, 18 FCCR 1926 at ¶ 12.

Commission claimed was –100 dBm, and subtracting a 17 dB 'buffer,' which is the industry standard for the amount by which a cellular call must exceed other signals in order to be effective." AT&T Wireless Services v. FCC (No. 03-1043, released May 4, 2004), Slip op. at 4. The Commission specifically rejected an AirTouch argument by that the threshold should be –124 dBm as ''too conservative.'' But V-COMM presents a proposal even more "conservative" than the one already rejected by the Commission. It is simply reasserting an already rejected technical proposition and implicitly espousing a policy change in Commission and Congressional policy.

7 Conclusion

The Commission should adopt a policy in favor of authorizing independent frequency-agile cognitive radio systems using spatial and temporal holes, initially on a licensed basis, to operate in substantial portions of the VHF and UHF bands.

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