

BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

In the Matter of)	
)	
Facilitating Opportunities for Flexible, Efficient)	ET Docket No. 03-108
And Reliable Spectrum Use Employing Cognitive)	
Radio Technologies)	
)	
Authorization and Use of Software Defined)	ET Docket No. 00-47
Radios)	(Terminated)

COMMENTS OF:

AFFERO, INC., WIFINDER, INC., FEEDSTER, DANDIN GROUP, WIDEBAND LOGIC DESIGN, MARCONI PARTNERS, KILLIAN AND ASSOCIATES, DINWIDDIE ASSOCIATES, INC., W AND J PARTNERSHIP, RESILIENT, NEOSOCIETY, DAMAGE STUDIOS, COHEN SOFTWARE CONSULTING, INC., AERIAL, INC., LULU ENTERPRISES, INC., GIBEO LLC, STONEBRICK GROUP, VISION CHAIN, INC., BERG SOFTWARE DESIGN, TOPDOWN DESIGN ASSOCIATES, BLOOTECH, INC., COUGHLIN ASSOCIATES
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Affero, Inc., WiFinder, Inc., Feedster, Dandin Group, WideBand Logic Design, Marconi Partners, Killian And Associates, Dinwiddie Associates, Inc., W and J Partnership, Resilient, Neosociety, Damage Studios, Cohen Software Consulting, Inc., Aereal, Inc., Lulu Enterprises, Inc., Gibeo LLC, Stonebrick Group, Vision Chain, Inc., Berg Software Design, Topdown Design Associates, Blootech, Inc., Coughlin Associates hereby submit these reply comments in connection with the Commission's *Notice of Proposed Rulemaking and Order In the Matter of Facilitating Opportunities for Flexible, Efficient, And Reliable Spectrum Use Employing Cognitive Radio Technologies*, ET Docket No. 03-108 (Dec. 30, 2003) ("*NPRM*") in the above-captioned proceeding.

I. INTRODUCTION

In the very first rulemaking that seriously acknowledges the advances in cognitive radio capabilities that will transform use of the electromagnetic spectrum, the Commission is poised to propose regulations that will eliminate most areas of research and innovation in this field. This will have a disproportionately devastating impact on American technology companies primed to dominate innovation in this area. And will inhibit the full potential innovation that can be

captured from intelligent devices. We urge the Commission to clarify that it is not their intent to inhibit innovation, but to pave the path towards redefining the current spectrum policy paradigm based on the techniques and capabilities provided by cognitive radio.

II. ARGUMENT

We have identified five major problems with the NPRM.

A. **The Commission fails to articulate an overarching vision for how cognitive radio capabilities will transform spectrum policy and use**

It is difficult to answer most of the questions posed in the NPRM because the Commission has failed to propose an overarching vision for a future spectrum policy and how the proposals in the NPRM fit. It readily acknowledges that the technology landscape has radically changed the interference-based rationale for chopping spectrum into swaths and giving it away or auctioning it off to the highest bidder.¹ It proposes certain baby-step style test-beds for exploring how smart radios might be deployed. It states that the rules proposed are intended “to allow a full realization of the potential of these technologies under all our regulatory models for spectrum based service.”² Yet, it fails to address the underlying question: whether centralized regulation of spectrum-based services is still warranted in a world where smart devices can interact in real-time to optimize electromagnetic spectrum use.

We think the proposals in the NPRM might be excellent first steps towards guiding an industry financially dependent on and intellectually married to spectrum auctions towards a new regime where any wireless device may use any bandwidth to perform its function as long as it does not interfere with others. However, absent an articulation of the Commission’s long-term goals for transforming spectrum policy, it is equally possible the proposals here might serve to cut off areas of innovation and opportunities for new comers to the market by entrenching owners’ current interest in purchased or granted spectrum.

For example, rural markets may serve as excellent test beds for studying how devices operating at higher power levels detect the degree of spectrum use in a geographical area and interact with each other to optimize all devices using that space. Data gained from such experimentation would allow innovators to better understand how software radios interact in such an environment.

¹ The ability of cognitive radio technologies to adapt a radio’s use of spectrum to the real-time conditions of its operating environment offers regulators, licensees, and the public the potential for more flexible, efficient, and comprehensive use of available spectrum while reducing the risk of harmful interference. NPRM p. 2.

² NPRM p 3.

However, the NPRM's limits on the range of devices, spectrum, and geography are completely arbitrary and raise concerns as to why they are being imposed. There is no reason to assume that higher power devices are the optimal solution for the particular problems raised by rural markets. Wideband, opportunistic sharing or interweaving, ad hoc networks, space-time coding, or techniques not yet discovered may be equally viable options. Limiting the testing of high power devices to the ISM bands is equally arbitrary, as is limiting the geography in which the devices may function. High power devices may be particularly suited for less desirable frequencies used in high-density areas.

Is the rural market proposal a means to limit high-power device proposals by geography and frequency, or a means of limiting solutions to the lower population density problem to high-powered transmissions by geographically limited devices? If so, we would strongly urge the Commission to reject these proposals. However, accompanied by a strong statement that this is a limited test bed and a timeline for expanding the geography, scope, and frequency parameters of the experiment's scope, the proposal is an important first step.

The questions as to how a beacon system may be implemented raise similar concerns. Coupled with a strong statement by the Commission that the secondary markets proposal is an intermediary step, and accompanied by a timeline for expanding its scope, a test bed makes sense. Opening up space where smart radios can exercise their inherent ability to negotiate and optimize spectrum use in real time will permit and promote significant innovation in these devices.

However as drafted, the proposal limits innovation and deployment to that which effectuates pre-negotiated lease arrangements. This ignores the underlying technological change that is the impetus for the rulemaking. The inherent quality of smart radios is their intelligence—particularly their ability to adapt to their environment.

B. The Commission treats cognitive radio as deterministic rather than heuristic, ignoring the defining capacity of software defined radios-that they can adapt to their environment.

A major problem with the NPRM is that it is destined to fail-- assuming that the goal of the proposed regulations is to capture the benefits of cognitive radio technologies to optimize spectrum use. The inherent quality of smart radios is their intelligence—particularly their ability to adapt to their environment. Ideally, this means one would want to load a smart transmitter with all the tools and techniques on the market, then allow the device to choose how best to achieve its general purpose of communicating information across electromagnetic spectrum.

This is similar to how the Internet works. Routers determine the best way to send packets, not the FCC. The implementation of this nondiscriminatory model in Ethernet has proven so superior to other models that alternatives like token ring networks are obsolete, and there has been little investment or innovation into alternative models—attempts to implement so

called “quality of service” rules on packets (where certain content is given priority over other content) have failed.

Yet, what the NPRM asks for is comment on dozens of proposals for implementing a specific technology, in a specific geography, in a specific frequency, to implement a specific prioritization of signals. The total effect is to micromanage the devices to the point where their smarts are severely restrained and their ability to learn stalled. The effect on innovation will be to focus research and development efforts towards dozens of devices, each hardwired for a single implementation. This will be as if the FCC regulated routers so that certain equipment could only carry certain types of packets, from certain types of machines, that went to certain geographical locations, or if the Commission regulated chips so that certain ones were hardwired for word processing tasks, and others for communications, and still others for graphics. The benefits to innovation from general purpose routers or microchips are obvious: Anyone can develop software to communicate any message knowing that the router will allow their messages to be transmitted and the chips will process their code.

The Commission should promote a spectrum infrastructure that allows equal degrees of freedom to develop code that carries wireless communications. A final rule that limits research efforts towards hard-wired implementations will retard development of intelligent devices by limiting innovation in software defined radios. This result will not only be antithetical to the purpose of the rulemaking but devastating to the software industry.

C. The Commission limits opportunities for innovation by choosing technology winners.

It is a widely accepted maxim that the government is not as good as the market in picking technology winners. Generally, the government should only step in where there is a market failure, or where an important public interest is at stake that will not be valued adequately by a market derived solution. While the state of radio technology might have weighed these factors to favor government intervention in 1946, adding cognitive radio to the mix tips the balance against regulation today.

In a world of dumb transmitters and dumb receivers, it made sense to partition the electromagnetic radiation that traveled between them into frequencies and assign exclusive use of each frequency to one user. That way no two parties would transmit simultaneously to receivers incapable of distinguishing between them with the result that no voice was heard. Under this model, the government-granted entitlement to exclusive use of a frequency served to promote innovation by a company certain to be able to implement the products of its research, and served the public interest in promoting speech—by radio and TV.

In a world of intelligent devices, there is no reason to assume a market failure. In the future, software defined radio can allow all desired uses of spectrum. The usable spectrum today is 5,000 times larger in terms of bandwidth than when the federal Radio Act was adopted. As cognitive radio capabilities improve, that number will increase. American technology companies

have a proven record for phenomenal innovations in software development when they are left alone to do what they do best. There is absolutely no reason the Commission should presume to pick which innovations get deployed, as the NPRM does. In fact, the surest way for the Commission (or incumbents afraid of losing their frequency monopolies) to impede the market's pace at increasing usable spectrum is to limit the areas of research already dedicated to that goal today.

D. **The Commission should not presupposes any additional rents from optimization of interference will accrue to current bandwidth licensees.**

It is a historical artifact of spectrum policy that a corollary entitlement to exclude users from a frequency is thought to always accompany an entitlement to use that frequency. This made sense in a paradigm where another's concurrent use *always* diminished the value of the underlying entitlement. It does not make sense in a paradigm that accounts for cognitive radio. At minimum, the Commission should use this rulemaking to clarify that the paradigm has shifted.

The increased utility from using smart radio devices significantly increases the value of frequency partitions assigned or auctioned before the techniques were developed. And any regulation that allows intelligent devices to be deployed also radically changes the economics. There is absolutely no reason the Commission should choose regulations that assign all the additional rents to current bandwidth holders.

From an efficiency perspective, it is bad policy, as the current bandwidth holders are unlikely to license uses to competitors. From a First Amendment perspective, it is bad policy because incumbents can artificially prop up the price of communication, thus preventing new voices from being heard. And from an innovation perspective, it is bad policy because the threshold costs of entering the market will be artificially inflated, preventing newcomers, especially the small and innovative start-up sector, from entering the market.

It will not be easy for incumbents to adjust to the paradigm shift we describe. Intermediary steps to test software's ability to negotiate simultaneous uses of frequencies are valuable to confirm that smart devices live up to their billing, and prevent interference that harms another's use. But the Commission must make clear that once the devices have proven themselves, all rights to exclude non-interfering users from any spectrum are voided.

E. **The Commission fails to address how a diminishing (if not disappeared) interference effect might alter the categorization of spectrum as a "limited resource."**

As stated above, the FCC's original spectrum policy developed at a time when radio transmitters were dumb and receivers were dumber. In order to avoid the wavy lines on a television, or fuzziness in a radio program, swaths of spectrum were given to broadcasters so that this "interference" could be minimized. This raised a constitutional problem, as there were a

limited number of wavelengths that could carry radio and TV programs. By giving some speakers the exclusive right to broadcast on a specific wavelength, the government was denying other speakers the ability to have their voices heard—a potential violation of the First Amendment.

The Supreme Court addressed whether this method of spectrum allocation was a constitutional problem in 1943 in Nat'l Broad. Co. v. US.³ The Court relied on the scarcity of the broadcast media to justify licensing stations and regulating them. The Court also applied the scarcity reasoning to force so-called “fairness principles” requiring broadcasters to allot equal time to opposing views in Red Lion.⁴ We believe that the current state of cognitive radio technology minimizes interference to the point that scarcity is no longer a constitutionally acceptable reasoning for silencing citizens who do not enjoy access to government sanctioned bandwidth megaphones.

As the FCC outlined in the NPRM,⁵ cognitive radio capabilities are advancing to the point where spectrum is no longer scarce. Multiple speakers can broadcast their views simultaneously with little, if any, degradation to either's voice. This radically changes the constitutional analysis. There is no justification for the Commission to silence anyone's voice by assigning or selling the right to use swaths of spectrum. There is certainly no constitutionally forgivable justification for selling a corresponding right to exclude others voices where technology could allow all voices to flourish on a non-discriminatory basis.

Even if the Commission believes that the current state of the technology does not yet tip the balance against a scarcity analysis, it is a radical position for the Commission to assert the power to regulate in a manner that eliminates research and development opportunities that undeniably will eliminate scarcity in the future.

As stated above, we are extremely concerned that the regulation the Commission looks ready to adopt will hurt our business by stifling creativity and stopping much of the progress currently underway in smart radio innovation. But we are also concerned because we think constitutional values like free speech are important and are proud of our role developing technology that creates new avenues for more voices to be heard. We urge the Commission to not regulate in a manner that diminishes both the market for smart radios, and the marketplace of ideas.

³ Nat'l Broad. Co. v. US 319 US 190, 216 (1943).

⁴ Red Lion Broadcasting Co. v. FCC, 395 U.S. 367 (1969).

⁵ NPRM pps. 20- 33.

III. SPECIFIC PROPOSALS FOR THE RULEMAKING.

We believe there are four components necessary for the Commission to include in this rulemaking that are absent from the NPRM.

- A. **The Commission must confirm that its long-term goal is to eliminate the old interference and property- based system that currently impedes innovation in cognitive radio devices, and that the proposals in the NPRM are first steps towards achievement of that policy.**

Cognitive radio capabilities have radically replaced assumptions on which the current spectrum model depends. The ability of intelligent devices to respond to their local environment make them the logical repository for “regulation” of how communications move through electromagnetic space. Their continuing ability to increase usable spectrum eliminates any rationale for the Commission to pick technology winners. There is no longer any reason to grant an entitlement to exclude, nor to presume increased rents for optimized spectrum use must accrue to incumbents. And the elimination of a scarcity rationale for spectrum regulation calls into question the constitutionality of the Commission granting exclusive rights to certain entities to have their voices heard.

- B. **The Commission must develop a timeline for this transformation.**

If the technology industry and its funders are to invest in software defined radio research and development efforts, they need certainty that resultant products will be deployable. Without a timeline, and with the potential for deploying devices only under the limitations described in the NPRM, no rational company will gamble on investment in this area. The Commission needs to set strategic goals for authorizing software defined radios “on spec”—limiting deployment opportunities to innovations currently on the market will halt all future innovation in this area.

- C. **The Commission must adopt the "Intelligent Device Bill of Rights" proposed by the Commission's Technical Advisory Council that states that that any wireless device may use any bandwidth to perform its function as long as it does not interfere with others, and that all users of the spectrum shall have the right to operate without harmful interference from others.**

This is the logical first step towards complete integration and deployment of intelligent devices and will give innovators a guiding principle to use when writing software programs. The intelligent devices of the future will adapt to their environment like the robots of science fiction programmed to “NOT INJURE A HUMAN BEING OR, THROUGH INACTION, ALLOW A HUMAN BEING TO COME TO HARM.” Researchers and developers should be free to explore all options and avenues for software defined radio development limited only by a restriction to “create no harmful interference.”

D. The Commission must reaffirm its commitment to continue releasing spectrum for unlicensed common use.

This is the “holy grail” for intelligent devices, and must be in the regulatory endgame if they are to reach their full potential to maximize spectrum use. The innovation derived from unlicensed use of the 2.4 GHz band continues to astound. The benefits to consumers are obvious. To an American software industry desperate for new areas to explore, the opportunities presented by increased access to bandwidth for experimenting with new techniques and devices cannot be overstated. It is imperative that the Commission continue to dedicate spectrum to common use. Without a commitment to this goal, all other proposals to capture the potential for cognitive radio to “facilitate opportunities for flexible and reliable spectrum use” are inadequate.

IV. CONCLUSION

Innovations in cognitive radio techniques have obliterated the underlying rationale for the current spectrum regulatory regime. Today, intelligent devices can make real time decisions about communications paths. Software defined radios are an important research and development area for the U.S. technology industry. Future innovations in this field will increase the usable spectrum, which will increase the number of voices that can be heard at any moment, in turn expanding and enriching the marketplace of ideas. However companies will not invest in this R&D without assurances that they will be able to deploy the technology they develop. We urge the Commission to take into account the changed paradigm and the interests of speech and innovation as it rules in this area and to adopt the four proposals we outline above.

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