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

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

MOTION OF CORNELL UNIVERSITY
FOR LEAVE TO FILE REPLY COMMENTS

Cornell University, by its attorney, hereby moves for leave to file the attached Reply Comments in the above-captioned proceeding. The attached Reply Comments were originally filed via the Commission's ECFS on June 3, 2004. The deadline for filing Reply Comments in this proceeding was June 1, 2004.

In support of this motion, Cornell notes that the original filing of its Reply Comments on June 3rd was merely two days after the filing deadline. No parties will be prejudiced by this late filing, since there are no further comments called for in the pleading cycle. Furthermore, the Cornell Reply Comments did not respond to or address matters in any of the reply comments filed by other parties in this proceeding. Rather, the Cornell Reply Comments addressed only arguments made in the original comments filed earlier in the proceeding. More important, the public interest would be served by grant of this motion, because

Cornell believes that its Reply Comments contain substantial and significant arguments that will contribute to reasoned decision-making in this proceeding.

WHEREFORE, Cornell University requests that this Motion be granted, and that its Reply Comments be accepted in the record of the above-captioned proceeding.

Respectfully submitted,

CORNELL UNIVERSITY

/s/ Paul J. Feldman
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Its Attorney

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June 4, 2004

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

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

REPLY COMMENTS OF CORNELL UNIVERSITY

Cornell University, by its attorney, hereby submits these reply comments in response to the Commission's December 30, 2003, Notice of Proposed Rulemaking in the above-captioned docket (*"NPRM"*). In these reply comments, Cornell supports the comments filed by the National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (hereinafter, "CORF") and those filed by the National Radio Astronomy Observatory ("NRAO"). In addition, Cornell herein briefly addresses a few issues raised by other commenters.

I. <u>Introduction</u>

Cornell has a substantial interest in this proceeding, as it operates the Arecibo Observatory ("Arecibo") near Arecibo, Puerto Rico. Arecibo is part of the National Astronomy and Ionosphere Center ("NAIC"), a national research center operated under a cooperative agreement with and funded by the National Science Foundation ("NSF"). The NSF is an independent federal agency whose mission is to promote scientific and engineering progress in the U.S.

As the site of the world's largest single-dish radio telescope, Arecibo is recognized as one of the most important centers in the world for research in radio astronomy and planetary radar. Arecibo has a long history of being the site where very significant accomplishments in astronomy have occurred, including: the first discovery of planets outside of our own Solar System; discovery of the first pulsar in a binary system, leading to important confirmation of Einstein's theory of gravitational waves and a Nobel Prize for two radio astronomers who performed their research at Arecibo (the third Nobel Prize for radio astronomy in its short 50 year history); and determination of the correct rotation rate of the planet Mercury, as well as the discovery of ice in craters on Mercury's polar regions (and similar investigation of the polar regions of the Earth's Moon).

Though Arecibo has been operating since 1963, work was completed on a multi-million dollar upgrade to its facilities in 1997. The upgrade significantly expanded the range and sensitivity of the observations that could be made with the telescope, while at the same time increasing the shielding around the telescope to reduce interference from ground radiation. One of the primary purposes of that 1997 upgrade was to enable an immediate expansion of the frequency range of observations that could be made with the telescope, which, with the subsequent incremental upgrades that are now in progress, could be further increased to allow observations at frequencies up to 15 GHz.

The Commission has long recognized the importance of protecting the observations made at Arecibo from harmful interference. For example, in 1997 the Commission created the Puerto Rico Coordination Zone, which applies to applicants for

facilities below 15 GHz. *See*, Radio Astronomy Coordination Zone, Report and Order, 12 FCC Rcd 16522 (1997).

II. Cognitive Radios and Protection of Passive Users of the Spectrum

The general premise of the *NPRM* is that use of cognitive radios would promote spectrum efficiency because such radios would "search the radio spectrum, sense the environment, and operate in spectrum not used by others." *Id*. at para. 13. The *NPRM* suggests that cognitive radios would result in a "more intense, more efficient use of the spectrum" by transmitting in "unused white spaces" of the spectrum. *Id.* at para. 20. Cornell commends the Commission for exploring technologies that might promote greater spectrum efficiency. Indeed, there may be benefits to passive users of the spectrum that result from widespread increases in efficiency by all users of the spectrum. However, passive users of the spectrum are inherently vulnerable to interference, and this vulnerability is magnified by the remarkably weak strength of the signals observed by such users. Thus, before the Commission enacts rules allowing the widespread use of cognitive radios, the Commission should go though a gradual sequence of steps to provide a proven record of non-interference to authorized users of the spectrum. Cornell is concerned that cognitive radios not only lack such a record at this time, but that the Commission's cognitive radio concept ignores the existence of passive scientific users of the spectrum, and thus overlooks the substantial risk that cognitive radios would transmit on frequencies allocated to passive services and cause harmful interference to passive observers. Accordingly the Commission must prohibit

transmissions by such devices in the “restricted bands” set forth in Section 15.205 of the Commission’s rules.

CORF and NRAO ably demonstrated the problems of trying to apply the interference protection concepts set forth in the NPRM to the passive bands. As noted by CORF at pages 8-9 of its Comments, while the *NPRM* suggests that dynamic frequency selection and frequency agility would be the primary capabilities used by cognitive radios to avoid interference to incumbent authorized users of the spectrum, such capabilities, by definition, cannot sense the presence of passive observation of a frequency. In the case of passive observation there is no identifiable “transmission” for cognitive radios to sense – the “transmission” being observed by scientists is nothing more than an extremely weak fluctuation in the noise floor. Indeed, as NRAO demonstrates (Comments at page 3), areas perceived by cognitive radios as quiet due to the lack of active transmissions may well be areas where significant amounts of passive observation are occurring, since passive observers seek out areas where there is a reduced noise level. It is for this very reason that the *NPRM*’s suggestion that cognitive radios be allowed to operate with higher power in rural areas is particularly troublesome to passive observers, as noted by CORF (Comments at pages 11-12) and NRAO (Comments at page 4).

While the use of dynamic frequency selection and frequency agility capabilities do not appear to be useful in preventing cognitive radios from causing interference to passive observers, the *NPRM* also explores the possibility that a cognitive radio could use geo-location technologies such as those based on GPS to determine its own

location and the location of other users of the spectrum, and thus determine the proper parameters of transmission to avoid interference. As noted by CORF (Comments at pages 9-10), it is possible that cognitive radios could protect radio astronomy observatories through use of 1) location determination, 2) real-time inquiries to a data base of observatory locations, and 3) software to prevent operations within a minimum distance from radio astronomy observatories. However, as shown by CORF, there are problems with such an approach, including the possibility that location determination technologies in a cognitive radio could malfunction, or be manipulated by the user. Furthermore, the use of location determination to prevent interference in remote sensing bands would be even more complex, since remote sensing scientists make regular observations of the entire continental United States.

Once cognitive radios are authorized to use a band, it will be almost impossible to disable such radios if it is subsequently discovered that they are causing harmful interference. Identifying interference from such radios will be complicated by the fact that users will not be registered, and so will have to be identified by triangulation. That process will be even more difficult in the case of mobile cognitive radios. Thought needs to be given to the likely burden the introduction of these devices may place on the authorized users of the spectrum. For these reasons the Commission should take a gradualist approach to introducing cognitive radios. Initially, the Commission should restrict the number of bands in which such use is authorized, until a proven record of non-interference to authorized users of the spectrum can be placed on record. Such initially authorized bands should be as removed as possible from the Part 15 restricted

bands, in order to limit the danger of purposeful or inadvertent transmissions on those bands. Upon creation of a substantial record, the Commission could authorize use of additional frequencies by cognitive radios. However, the Commission should not authorize transmissions on the Part 15 restricted bands.

Cornell takes seriously the comments made by the Electronic Frontier Foundation ("EFF") on the feasibility of constructing cognitive radio units from off-the-shelf items that are driven by a personal computer (Comments at pages 6-7). Allowing cognitive radio units to operate may well open a Pandora's box of problems, where regulation of components is inherently challenging.[1] In such an environment it is going to be difficult to ensure the absence of transmissions in the passive bands, if only due to the ignorance of their existence and importance by users of cognitive radios. Cornell recommends that the Commission address this issue. One possibility might be to require all manufacturers of cognitive radios to deposit open code with the FCC or another entity, so that it is available for anyone to download. The idea would be that the very best open-source software for operating cognitive radios would be made publicly available, and that the avoidance of interference to other spectrum users (including passive bands) would be so deeply integrated into this software that potential users would have no incentive to disable it or reconfigure it. The notes accompanying the software should also explicitly point out the need to avoid transmissions in any of the restricted bands.

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[1] The Commission has previously had to address similar problems with PC-controlled re-programmable radio receiver components.

III. Extreme Proposals Calling for No Regulation of Cognitive Radios Are Based on Unsupported Premises and Fallacious Arguments.

While the overwhelming majority of comments filed in this proceeding express significant concerns about the limited use of cognitive radios proposed in the *NPRM*, two commenters suggest that the Commission should impose no or only very limited regulation on the use of cognitive radios. These comments are based on unproven premises and their arguments are accordingly fallacious, and thus, their proposals should not be followed.

The Comments of Affero, Inc. et. al. ("The Technology Companies") assert (at page 8) in almost messianic terms that "[i]nnovations in cognitive radio techniques have obliterated the underlying rationale for the current spectrum regulatory regime." Based on this assertion, The Technology Companies conclude that "[t]here is no longer any reason to grant an entitlement to incumbents [to exclude others from using the spectrum]" and that there should be no regulation of cognitive radios other than a generic prohibition on use of such radios that cause harmful interference to others. *Id*. at page 7. The obvious fallacy in this argument, though, is the vague and completely unsupported premise that cognitive technology practically and effectively allows radios to operate without causing interference to other users. There is no such evidence in the record. Indeed, there is almost no evidence of any sort in the record regarding the impact on incumbent users from the operation of cognitive radios. Thus, this argument provides no rational basis for enacting the proposal of The Technology Companies.

Similarly fallacious is the attempt by the EFF to use the First Amendment to justify forbearance from regulating cognitive radios. The EFF suggests that transmissions of any sort on cognitive radios constitute "speech" protected by the First Amendment, and that because cognitive radios negate or reduce the "spectrum scarcity" previously used by courts to justify the regulation of broadcasting under the First Amendment, the regulation of cognitive radios (other than a general prohibition on causing interference) would be a violation of the First Amendment. Comments at pages 3-4, 5-8. The EFF argument is fatally flawed.

First, like the comments of The Technologies Companies, EFF assumes as a premise that cognitive radios are effective and efficient. Yet this proceeding is designed to explore whether that is the case, through analysis of the evidence. The mere assertion that cognitive radios are effective and do not cause harmful interference does not make it so – it merely begs the question.

Furthermore, the EFF provides almost no support for its bold assertion that any transmission of data, regardless of content or lack thereof, is a form of "speech" protected by the First Amendment.[1] For example, there does not appear to be any

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[1] The one citation for this assertion provided in the EFF Comments is to Stuart M. Benjamin, *The Logic of Scarcity: Idle Spectrum as a First Amendment Violation,* 52 Duke L.J. 1(2002). That article almost exclusively addresses use of the spectrum by the media to transmit ideas and entertainment, *i.e.*, transmissions that have long been recognized as core First Amendment speech, which Benjamin appears to classify as "communications." Indeed, Benjamin asserts that "spectrum is almost exclusively used for communications." *Id*. at page 53. Yet while Benjamin briefly acknowledges that the spectrum can be used for purposes other than "communications," such as the "radiation of some microwaves," (*Id.* at note 180) the author generally ignores the functional uses of the spectrum at issue in this proceeding.

precedent suggesting that the transmission of data used to remotely operate industrial equipment has been held to be protected "speech". Yet this sort of purely functional use is central to the concept of cognitive radios as described in the *NPRM*.

IV. Conclusion

Given the new and unproven nature of cognitive radio technology and the unique vulnerability of passive services to interference, the Commission should not permit intentional transmissions by cognitive radios on the Part 15 restricted bands.

Respectfully submitted,

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June 3, 2004

CERTIFICATE OF SERVICE

I, Joan P. George, a secretary in the law firm of Fletcher, Heald & Hildreth, P.L.C., do hereby certify that a true copy of the *Reply Comments of Cornell University* was sent this 3rd day of June, 2004, via United States First Class Mail, postage prepaid, to the following:

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/s/ Joan P. George
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Federal Communications Commission

The FCC Acknowledges Receipt of Comments From ...

Cornell University

...and Thank You for Your Comments

Your Confirmation Number is: '200463014338 '

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