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	)	ET Docket No. 00-47 (Terminated)
	)	

Via the ECFS

COMMENTS OF IEEE 802

IEEE 802[1] hereby respectfully offers its Comments on the Notice of Proposed Rulemaking (the "NPRM") in the above-captioned Proceeding.[2]

The members of the IEEE 802 that participate in the IEEE 802 standards process are interested parties in this proceeding. IEEE 802, as a leading consensus-based industry standards body, produces standards for wireless networking devices, including wireless local area networks ("WLANs"), wireless personal area networks ("WPANs"), and wireless metropolitan area networks ("Wireless MANs").

IEEE 802 is an interested party in this Proceeding and we appreciate the opportunity to provide these comments to the Commission.

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[1] The IEEE Local and Metropolitan Area Networks Standards Committee ("IEEE 802" or the "LMSC")

[2] This document solely represents the views of IEEE 802 and does not necessarily represent a position of either the IEEE or the IEEE Standards Association..

INTRODUCTION

1. On December 30, 2003, the FCC released the subject NPRM and Order seeking comment on the cognitive radio technologies and FCC proposed rules related to cognitive radio operation.

2. IEEE 802 commends the Commission for its efforts to amend the rules to support implementation of cognitive radio technologies.

3. In particular, IEEE 802 recognizes the potential of extending the benefits of wireless technologies using cognitive radio as a means of increasing spectrum utilization for license exempt applications through opportunistic use of unoccupied spectrum.

4. As exemplified by the new U-NII band spectrum rules recently adopted by the Commission, cognitive radio technologies, albeit in primitive form, have already made possible interference mitigation sufficiently robust to allow new license exempt spectrum to be made available without risk of harmful interference to incumbents.

5. IEEE 802 supports extending this same paradigm by means of equivalent or more sophisticated cognitive radio approaches to support license exempt operations in other bands in geographic areas where licensed operations do not make full use of available spectrum.

6. The Commission identifies opportunistic use of fallow spectrum as a fourth scenario in the introductory comments to the instant NPRM, but does not address the issue in its rulemaking later in the body of the NPRM.

7. IEEE 802 offers comments in the sections which follow which address opportunistic license exempt use of fallow licensed spectrum. We also address in our comments the proposed changes to Part 15 rules proposed by the Commission to enable higher power operation in rural and other areas where Part 15 spectrum is lightly used.

IEEE 802 SUPPORTS EXTENDING THE FEATURE SET OF COGNITIVE RADIO OPERATION FOR REGULATORY PURPOSES TO INCLUDE INCUMBENT PROFILE DETECTION AS A CRITICAL CHARACTERISTIC

8. In the instant NPRM, the FCC broadens the definition of Dynamic Frequency Selection ("DFS") to *"a mechanism that selects an appropriate operating frequency for a device based on some specific condition."*[3]

9. The Commission also broadens the definition of Transmit Power Control ("TPC") to "*a mechanism that switches the output power of a device based upon specific conditions. The conditions could include the proximity to other devices, the maximum power permitted at a*

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[3] *See* the NPRM, paragraph 24, page 10

geographic location, or an operating requirement to adjust power to the minimum needed to establish a reliable communication link." [4]

10. IEEE 802 agrees with the Commission that DFS and TPC represent two features which are central to cognitive radio operation and supports the broader scope given to them.

11. In exploring a broader view of DFS, the Commission in its comments recognizes that detection of other signals occupying a given spectrum segment is central to DFS operation, and discusses detection techniques (radiometric, cyclostationary)[5] which could be used to identify channel occupancy and the features of the occupying signals.

12. IEEE 802 believes that it would be useful to refer to such signal identification capabilities as a feature called Incumbent Profile Detection ("IPD"), a mechanism which allows a cognitive radio to identify radio signals in the band which have primary, or incumbent, status, and, as a result, must be protected from harmful interference.

IEEE 802 BELIEVES INCUMBENT PROFILE DETECTION CAPABILITY IS THE MEANS BY WHICH OPPORTUNISTIC USE OF FALLOW SPECTRUM BY LICENSED EXEMPT SYSTEMS CAN BE RELIABLY REGULATED

13. Identifying IPD as a distinct capability of a cognitive radio supports regulation of cognitive radio systems which are intended to make opportunistic use of fallow licensed spectrum on a license exempt basis.

14. IPD can enable a license exempt cognitive radio using DFS to reliably select a channel where there is no incumbent presently in operation, thereby guaranteeing operation on a non-interfering basis.

15. In addition, the IPD capability can be used to monitor the channel to assure that, should a signal appear in the band whose characteristics match those of an incumbent, the DFS mechanism is triggered to move the cognitive system to another unoccupied frequency.

16. IPD is a particularly effective approach where incumbents have very specific spectrum signatures and band occupancy characteristics.

17. Analog and digital TV transmissions, for example, have spectrum features which lend themselves to IPD operation. Analog TV signals have video and sound carriers and digital TV signals have a pilot tone. These signals are narrowband and located at a fixed frequency within the signal spectrums, allowing relatively simple detection techniques to establish channel occupancy.

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[4] Id, paragraph 27, page 11

[5] Id, paragraph 25, page 10

18. In addition, TV transmissions, because of their broadcast nature, have easy to distinguish temporal characteristics. The TV signal is normally on for long periods of time, so detection algorithms do not have to deal with transient signal detection. Since licensed operation persists, a cognitive radio could survey all of the TV band channels using IPD and create a map of unused frequencies to select from. The resulting map would eliminate the need for a geographic database linked to Global Positioning System ("GPS") or other geolocation technology to identify unoccupied channels.

19. More sophisticated approaches using mathematical techniques to do spectrum analysis (for instance, Fast Fourier Transform, "FFT", techniques) would be necessary to allow robust identification of other types of incumbents, such as private land mobile radio systems, cellular radio systems, and similar systems operating with primarily narrow band carriers, or a mix of narrow band and wideband carriers (for instance, GSM systems operating in the same general frequency range as CDMA 2000 systems). Such extended IPD could identify the signatures of these systems.

20. Extending the capabilities of IPD further would allow more sophisticated license exempt cognitive radio networks to identify other license exempt networks operating in the band of interest, especially those based on published standards. As a result, the cognitive network could setup shared operation on that band based on presently available listen before talk and collision detection techniques.

21. Ultimately, it should be possible to define a set of industry standard common signaling protocols with more sophisticated arbitration methods to allow heterogeneous networks to share the channel more efficiently than currently possible with listen before talk. This yet to be defined set of protocols would then become the new baseline for coexistence of licensed exempt systems sharing the same spectrum.

22. From a regulatory standpoint, the IPD concept becomes a means of identifying those parts of the spectrum which could easily support opportunistic licensed exempt operation. If the spectrum signatures of incumbents in any band are readily identifiable, opportunistic use of fallow spectrum on a non-interfering basis can be supported by an appropriate IPD implementation. In this manner, regulations could evolve for cognitive radio operation, allowing those frequency segments with unique incumbent signatures to be opened up for opportunistic sharing first, followed by other bands as IPD becomes more sophisticated.

23. The IPD mechanism is in effect a class of policy based radio which allows the radio to use spectrum in certain cases and prevents it from using it in other cases. A robust IPD implementation guarantees that the radio will not interfere with an incumbent service.

24. Additionally, IPD facilitates automatic detection of incumbents during the initial DFS process, and throughout the active operation of the network, eliminating the need for GPS based geolocation and incumbent databases. In those situations where incumbent transmissions persist for long periods of time, incumbent mapping becomes more reliable and more adaptive than geolocation with a database. For example, network applications that may involve the setup and breakdown of wireless networks to support short duration indoor conferences, entertainment activity, or other nomadic scenarios. Geolocation techniques can be unreliable; GPS reception is problematic, databases may need to be reprogrammed or device settings changed manually to deal with location changes, and human error could result in unintended interference to licensed operations. Robust IPD eliminates these issues and provides built-in protection to incumbents.

IEEE 802 URGES THE COMMISSION TO CREATE NEW RULES WHICH SUPPORT OPPORTUNISTIC USE OF FALLOW SPECTRUM BY LICENSE EXEMPT DEVICES WITH COGNITIVE RADIOS EMPLOYING ROBUST IPD CAPABILITIES

25. Because cognitive radios with more robust DFS capability using sophisticated IPD technologies have the potential to automatically identify incumbents which have unique spectrum signatures and appropriate operational characteristics, unlicensed devices can by design avoid interfering with incumbents. Such license exempt cognitive radio networks would automatically map and monitor the operating bands to detect and avoid existing or new incumbents, setting up operations on channels where interference to licensed operations is not an issue.

26. We believe that such automatic operation minimizes the possibility of unintended or deliberate harmful interference by eliminating the need for preprogrammed databases of incumbents, which can be deliberately or erroneously modified, and geolocation features like GPS which can be disabled or spoofed. Automatic operation using DFS with robust IPD assures that the rights of incumbents are preserved while opening up new economic opportunities for licensed exempt applications using cognitive radio technology.

WE SUPPORT THE COMMISSION'S PROPOSAL TO ALLOW HIGHER POWER OPERATIONS ON ISM BANDS IN RURAL AREAS

27. We agree with the Commission that spectrum access in rural areas should be given increased support through new rules initiatives. We feel that permitting higher power operation for ISM band devices operating in rural areas is a reasonable way to achieve this objective and applaud the Commission's action in bringing these proposals forward in this proceeding.

WE PROPOSE THAT THE SPECTRUM OCCUPANCY THRESHOLD BE SET AT 10% OF THE SPECTRUM AVAILABLE IN THE BAND OF INTEREST

28. In order to avoid unnecessary interference to lower power operations in any given band, we believe that a conservative threshold should be established to determine if spectrum is lightly used. Such a threshold protects lower power non-hopping spread spectrum networks and networks based on digital modulations, especially networks based on IEEE 802.11x, 802.15x, 802.16x, from excessive co-channel or adjacent channel interference due to the presence of a high power system in the same operating band. In addition, since frequency hopping systems are more difficult to detect than non-hopping systems, this conservative limit provides some additional protection to those systems.

WE SUPPORT THE COMMISSION'S PROPOSED DEFINITION OF UNUSED SPECTRUM

29. We agree with the Commission's use of one of the unlicensed PCS criteria for band occupancy, namely 30 dB above thermal noise in a 1.25 MHz bandwidth.

30. We suggest that an omni-directional antenna be used in establishing the standard for band occupancy, in keeping with rules newly approved spectrum at 5 GHz.

31. We further suggest that the measurement bandwidth required for devices whose channel occupancy is greater than 1.25 MHz be allowed to measure the equivalent noise plus interference

power in their respective bandwidths. For instance, an IEEE 802.11g device would measure in an approximately 16 MHz bandwidth, so the noise plus interference threshold would be approximately 11 dB higher.

32. We recommend that, consistent with the original unlicensed PCS rules, the wider band system be required to monitor the spectrum for a minimum of 10 ms.

WE RECOMMEND THAT THE HIGH POWER SYSTEM RESCAN THE SPECTRUM TO DETERMINE BAND OCCUPANCY AT LEAST ONCE AN HOUR

33. Since this high power application is intended to apply only to ISM band operation, we believe that it is sufficient if the higher power network rescan the spectrum at least once an hour to determine the channel occupancy.

34. We don't believe this approach will seriously impair the operations of higher power WISP operations.

35. Further, we don't recommend that a WISP operating a high power network be required to shut down periodically.

WE RECOMMEND THAT ALL NODES IN THE NETWORK BE REQUIRED TO HAVE THE CAPABILITY TO SENSE SPECTRUM OCCUPANCY AND APPROPRIATELY CONTROL THEIR OWN TRANSMITTER POWER

36. For networks where the controlling access point is located some distance from a given client node, the controlling access point may not be able to reliably sense the local environment at the client node. So, in the case where spectrum occupancy is high near the client node, only the client may be aware of the higher level of spectrum use. Requiring only controlling access points to have the capability to make measurements and set client power levels in this situation would be contrary to the intent of the high power rules. Client nodes need to be able to set their power levels based on the local spectrum conditions.

FINAL COMMENTS

37. In this proceeding, the Commission has taken another important step forward in addressing the issue of improving spectrum utilization.

38. In making our recommendations, we believe we are fostering the development of new technologies, and, thereby, enhanced services for the marketplace.

39. While not precluding the use of geolocation and other, possibly as yet unforeseen, techniques, we reiterate our support for the concept of Incumbent Profile Detection as a robust means to implement and regulate devices and services which might be permitted to opportunistically use fallow spectrum.

40. We believe enabling more pervasive rural broadband access to underserved communities by using higher-power operational capabilities in the ISM bands is much needed enhancement of the rules, and urge the Commission to proceed as rapidly as possible to implement these high power rules changes.

41. We appreciate this opportunity to offer these comments to the Commission.

Respectfully submitted,

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