

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

In the Matter of:)
) ET Docket No. 02-135
Commission Seeks Public Comment)
on Issues Related to Spectrum Policy)
Task Force Report)

COMMENTS OF COGNIO, INC.

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) ET Docket No. 02-135
Spectrum Policy Task Force Seeks)
Public Comment on Issues Related to)
Commission’s Spectrum Policies)

COMMENTS OF COGNIO, INC.

Cognio, Inc. (“Cognio”) is pleased to submit comments in response to the Commission’s call for public comment on the Spectrum Policy Task Force Report.¹ As a technology company focused on the development and deployment of “cognitive radio” products that operate intelligently by sensing and adapting to their local radio environments, Cognio applauds the Commission’s continuing efforts to promote intelligent and efficient use of the unlicensed spectrum bands in ways that increase the efficiency, reliability, and availability of robust unlicensed devices.

Cognio believes that one of the Commission’s highest priorities should be facilitating the rapid development and deployment of cognitive radios, because supporting cognitive radios promises tremendous increases in spectrum efficiency while imposing very little administrative burden on the Commission. Taking a few simple steps to aid the development of cognitive radios is an investment that is well worth the Commission’s time.

¹ See *Commission Seeks Public Comment Spectrum Policy Task Force Report*, ET Docket No. 02-135, Public Notice, November 25, 2002.

1. INTRODUCTION

The Commission's ambitious undertaking of creating a Spectrum Policy Task Force to consider and evaluate broad changes to Commission spectrum policies has been enthusiastically welcomed by industry and interested parties.² Along with many of its industry colleagues,³ Cognio filed comments urging the Task Force to support and encourage the development of cognitive radio devices, recommending that the Commission take steps to encourage the deployment of cognitive radios, expand spectrum access for unlicensed devices and encourage higher spectral efficiencies.⁴

Cognitive radios enable robust and efficient use of the unlicensed bands and facilitate secondary access applications. Cognitive radios can sense their radio environment, detect the presence of other wireless devices, classify those other devices, and then implement application-specific communications policies. Cognitive radios can also be equipped with location-sensing features to help them determine the manner in which they can most effectively communicate, or in the case of secondary access, whether they may access certain spectrum at all.⁵

Cognitive radios benefit both the cognitive radio device users and the other "dumb" device users that are operating nearby. Through spectrum awareness of their radio environments, cognitive radio devices can avoid interference from other devices and thereby maintain more reliable wireless connections than dumb devices, which are unable to adapt their behavior. Because cognitive radio devices adapt to their environment and transmit on less crowded frequencies, they cause less radio

² Id.

³ See, e.g., *Comments of BellSouth Corporation* at 6, ET Docket No. 02-135, July 8, 2002 (suggesting that unlicensed devices should use mechanisms that automatically select frequencies and minimum power); see also *Comments of Motorola, Inc.* at 20, ET Docket No. 02-135, July 8, 2002 (discussing the importance of "cognitive radio" systems for enhancing public benefit).

⁴ *Reply Comments of Cognio, Inc.*, ET Docket No. 02-135, July 23, 2002.

⁵ Cognitive radios can also contain geographical location equipment that allows the radio to implement location-based spectrum access policies. Cognitive radio principles can also apply to networks of devices that communicate with each other about the larger radio environment.

interference than dumb devices. This leads to improvements in the user experience for both cognitive radio *and* dumb device users.

One of the Task Force Report's many excellent recommendations is that the Commission "consider . . . dynamic use of existing bands – through either cognitive radio techniques to find 'white space' in existing bands or 'use protocols' to get out of the way of primary users."⁶ Cognio wholeheartedly agrees with this recommendation, and offers the following views on steps the Commission can take to speed the deployment⁷ of this promising technology concept.⁸

2. THE COMMISSION SHOULD ENCOURAGE THE DEPLOYMENT OF COGNITIVE RADIO DEVICES

There are many benefits to be realized by consumers, businesses, manufacturers and the Commission through the proliferation of cognitive radio devices. Consumers benefit through a better user experience as well the opportunity to expand applications that require higher levels of reliability than is achievable with dumb radios. Businesses benefit through higher reliability and enhanced manageability, enabling what are currently wireless links of convenience to be deployed and managed as critical office communication elements in support of an increasingly mobile work force. Manufacturers benefit through better end-user experiences and the opportunity to expand wireless product offerings, such as video and audio, which are dependent on maintaining highly

⁶ *Spectrum Task Force Report*, ET Docket No. 02-135, p.67, November 15, 2002 (internal quotation marks modified). Cognio notes that a device that employs "use protocols" is also a cognitive radio [hereinafter *Spectrum Task Force Report*].

⁷ As the Commission has recently noted, cognitive radio devices that can sense and react to their environment are already coming into use. See *In the Matter of Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Notice of Inquiry, ET Docket No. 02-380 at ¶ 13, December 22, 2002 (" . . . equipment can be designed that is frequency agile, with the capability of changing operating frequencies or bandwidth as needed to avoid interference to licensed users. . . . equipment with some of these capabilities is already in use both commercially and in the military. For example, wireless LANs operating in the 2.4 GHz and 5.8 GHz bands have the capability of sensing when a frequency is in use and changing to an available frequency.") [hereinafter *Additional Spectrum NOI*].

⁸ It is important to note that cognitive radio is not a proprietary standard being put forth by any particular company or industry group. Instead, cognitive radio is a broad term to describe any number of intelligent devices that are programmed with any number of cooperative features.

reliable communication links. The Commission benefits from the deployment of cognitive radio devices by enabling more efficient use of existing unlicensed band spectrum and expanding the pool of available unlicensed spectrum through secondary access opportunities.

A. THE COMMISSION SHOULD ESTABLISH AND MAINTAIN A DATABASE OF UNLICENSED BAND TRANSMITTER PARAMETERS

Cognio agrees with the Spectrum Policy Task Force’s Interference Avoidance Recommendation of creating a public/private partnership for long term noise monitoring and archiving of data for use by FCC or public.⁹ The Commission has the opportunity to take a dramatic step in helping manufacturers deploy cognitive radio devices by establishing a database that characterizes the physical transmission parameters of unlicensed band transmitters. Just as towns maintain zoning maps and parks have trail maps, cognitive radios need a technical database first to classify unlicensed band transmitters, and subsequently determine the optimum manner in which to operate. Manufacturers already file emission measurements and often include additional transmission waveform measurements to demonstrate compliance to specific Part 15 provisions, such as 15.249(d) which specifies the maximum difference between the peak field strength and the average field strength. Very little additional effort is required by manufacturers and the Commission to capture and maintain a database of unlicensed band transmitters and transmission parameters, and thereby support the tremendous benefits for end-users, businesses, manufacturers and the Commission in the deployment of cognitive radio devices. Accordingly, the Commission should move swiftly to partner with industry and establish a technical database for Part 15 devices which includes the following transmission parameters:

- Frequency range of operation
- Spectrum channelization and characterization:

⁹ *Spectrum Task Force Report* at 64.

- ▶ Frequency-hopping: hop rate and hop center frequencies
 - ▶ Stationary channel: channel center frequencies
- Symbol rates
- Modulation modes (e.g., QPSK, OFDM, QAM, ...)
- Transmit spectrum masks
- Transmit power levels
- Transmit on/off time characterizations
 - ▶ Minimum and maximum “on” times
 - ▶ Minimum and maximum “off” times
 - ▶ Slot times, if appropriate, between channel accesses

Cognitive radio devices make intelligent decisions on how best to use unlicensed spectrum after first characterizing its radio environment, which is equivalent to saying that a cognitive radio device needs to be able to classify unlicensed band devices. For example, a cognitive radio device supporting a wireless local area network (WLAN) application makes more intelligent spectrum access and waveform decisions, and ultimately provides a higher link reliability, by adapting its data rate, packet size and frequency channel after classifying the interferer as a microwave oven, frequency-hopping device or another WLAN network. A database capturing the above transmission parameters would be a significant and helpful aid to cognitive radio device manufacturers.

Cognio would be pleased to work with the Commission to help establish a framework and database for the collection of unlicensed band device transmission characteristics.

B. THE COMMISSION SHOULD ALLOCATE ADDITIONAL SPECTRUM OR A PORTION OF EXISTING UNLICENSED BAND SPECTRUM FOR COGNITIVE RADIO DEVICES

As a specific step to encourage innovation, Cognio recommends that the Commission consider designating a small portion of the unlicensed spectrum for devices that use smart, adaptive, cognitive or otherwise intelligent power and/or spectrum management techniques. Such an allocation would encourage the development and deployment of advanced radio etiquettes and could ultimately enable all devices to share spectrum more intelligently.

The existence of such a band could be an important catalyst to the deployment of unlicensed band services – such as video, audio and corporate data, which need reliable quality of service – and pave the way for a new wave of wireless innovations and applications. Current regulations limit a device’s transmit level but do not require it to recognize its local unlicensed band environment. Presently there is nowhere in the unlicensed band for robust applications to hide from the risk of dumb devices, and it stands to reason that at least some small portion of the unlicensed band should be set aside for cognitive devices to see what might develop. By setting aside some unlicensed spectrum for devices that agree to work cooperatively, the Commission will undoubtedly encourage this beneficial technology to be adopted. As a result, all spectrum users will benefit.

Through advanced spectrum management techniques, wireless devices that can recognize and react to other devices that may use different wireless communications technologies, can be more effectively managed and enable more reliable wireless deployment, benefiting all users of the bands. For those cases of low device density or low spectrum utilization, a device could seize the entire available spectrum for short intervals of time and transmit at extremely high data rates. As the radio environment changes and becomes more ”crowded,” the cognitive radio device could free up spectrum and negotiate spectrum occupation with other users of the bands.

3. THE COMMISSION SHOULD ADOPT REGULATIONS THAT INCREASE SPECTRUM ACCESS AND SPECTRUM EFFICIENCY

Cognio agrees with the strong recommendation made in the Spectrum Policy Task Force Report concerning mitigating the scarcity of spectrum.¹⁰ Together with cognitive radio devices, the creation of additional unlicensed bands and the expansion of secondary access opportunities will go a long way towards meeting the projected needs of wireless applications and devices. Cognio does

¹⁰ *Spectrum Task Force Report* at 14-15 (noting that new, smart technologies can sense the spectrum environment and adapt or adjust operations and thus improve utilization of the radio spectrum).

not however, support the recommendation that the Commission begin to focus on promoting improved throughput only after the spectrum is fully licensed and heavily used.¹¹ The Task Force Report is correct in referring to spectrum as a limited resource, and as such the Commission should instead expand spectrum access opportunities while simultaneously encouraging advancements in spectrum use efficiency.

A combined approach of more spectrum and more effective use of it will go much further to meeting future bandwidth demands, and this is consistent with the government's approach to other resource scarcities. To draw analogy to fossil fuel scarcity mitigation efforts, it is well understood that everyone benefits from gradual increases in fuel standards. The government has used an effective combination of incentives and penalties to improve fuel efficiency, while limiting these incentives and penalties to future product deployments. The Commission does not want to expand spectrum access opportunities only to have a proliferation of dumb devices that inefficiently hog spectrum. Just as new cars are required to meet certain emissions standards, we should require new wireless devices to do likewise.

A. The Commission Should Encourage Deployment Of Cognitive Radio And Multi-Antenna Technologies To Reduce Radio Interference

It is intuitive and straightforward to show that a wireless device communicates more reliably when it is exposed to reduced levels of interference. By adjusting its own transmission parameters (e.g., packet length, data rate) in the presence of interfering communication devices, a cognitive radio device improves its communications link reliability as well as that of the dumb interfering device. The cognitive radio device is motivated to avoid interfering with the dumb device to improve its own reliability as well as that of the dumb device, which might otherwise request

¹¹ *Spectrum Task Force Report* at 15.

retransmissions in the event that its received signal has been corrupted, and thus further escalate the level of radio interference. This inherent motivation for a cognitive radio device to reduce radio interference to other nearby devices accessing and to share unlicensed band spectrum is another compelling reason why the Commission should encourage the deployment of cognitive radio technologies.

The deployment of multi-antenna solutions is a powerful technique that can dramatically reduce radio interference, particularly for indoor applications. When placed a relatively small distance apart (e.g., 5 centimeters at 2.4 GHz), multiple antennas can substantially reduce the required transmit signal power required to achieve a reliable link. For example, two IEEE 802.11a devices communicating with each other that each have 4 antennas and use advanced signal processing can reduce their transmit signal levels by more than 95% over what is required using today's state-of-the-art solution.¹² The ability to reduce the transmit signal level while maintaining a high reliability link provides a dramatic reduction in interference to nearby devices. Accordingly, Cognio recommends the Commission provide incentives for devices to adopt multiple-antenna implementations to reduce the level of radio interference and so enable higher density deployments of unlicensed band devices.

It is Cognio's view that multiple-antenna implementations, referred to in the communications industry as Multiple-Input Multiple-Output (MIMO) technology, will rightly form the basis for future high data rate wireless standards. MIMO technology offers the potential cost-effectively to expand data rates by an order of magnitude over current standards (e.g., IEEE 802.11a) while accessing a similar amount of spectrum. Accordingly, Cognio recommends that the Commission encourage standards developments and product deployments that incorporate MIMO

¹² Today's state-of-the-art antenna solution for IEEE 802.11a WLAN is 2-antenna switched diversity.

technology to increase significantly spectral efficiency, and thereby provide an important component in spectrum scarcity mitigation.

4. CONCLUSION

The Spectrum Policy Task Force has risen to the challenge of evaluating, socializing and recommending spectrum policy reform. By enacting regulations and incentives that aid the deployment of cognitive radio devices, expand spectrum opportunity and increase spectrum use efficiency, the Commission can be confident in its long-term responsibility of ensuring that all American businesses and consumers can continue to benefit from the creativity of American entrepreneurs who continue to develop innovative tools that enable us all to enjoy the precious public resource the Commission is trusted to protect.

Respectfully submitted,

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