

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

In the Matters of

Fostering Innovation and Investment in the
Wireless Communications Market

A National Broadband Plan for Our Future

GN Docket No. 09-157

GN Docket No. 09-51

REPLY COMMENTS OF MICROSOFT CORPORATION

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November 5, 2009

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I. INTRODUCTION AND SUMMARY.

As the thousands of pages filed in response to the Innovation Notice of Inquiry (“NOI”) confirm, FCC policy plays a critical role in supporting and encouraging wireless innovation and investment.¹ Indeed, as a direct result of the Commission’s wireless policies, innovations have occurred throughout the wireless marketplace “value chain.” Microsoft Corporation is a key player in this ecosystem, providing software, applications, and operating systems used by millions of Americans every day to communicate and share information using mobile and portable technologies.²

The benefits of spectrum access by licensed carriers have already been well documented in this proceeding. Microsoft recognizes the critical role played by licensed operators in delivering wireless broadband connectivity to consumers. Microsoft writes in reply, however, to provide a more complete record on the role that unlicensed spectrum plays furthering innovation, including as a test bed for new technologies that ultimately benefit users in both licensed and unlicensed bands.

To ensure the public fully realizes the benefits of unlicensed spectrum access, Microsoft urges the Commission to take three specific actions. First, FCC policy should

¹ *Fostering Innovation and Investment in the Wireless Communications Market, A National Broadband Plan for Our Future*, GN Docket Nos. 09-51 and 09-157, Notice of Inquiry (Aug. 27, 2009) (“NOI”).

² For example, Microsoft recently released a new version of its Windows Mobile® software, Windows Mobile 6.5. This version provides user interface enhancements, more robust browsing capabilities, and direct access to new wireless services including the Microsoft® My Phone service, which enables cloud-based backup and web access to photos, text messages, contacts, calendar and other documents from a user’s phone. In addition, Microsoft is partnering with Nokia to bring mobile versions of Microsoft Office applications to Nokia’s E-series handsets. Microsoft’s operating systems and software available for PCs also enable users to run a wide range of applications on increasingly popular wirelessly connected netbook computers.

fully reflect the significant value that unlicensed technologies create today. Second, the Commission should make additional spectrum available for unlicensed use – particularly spectrum below 3 GHz. Third, the Commission should continue to promote efficiency-enhancing breakthroughs, including the use of software defined radios capable of adaptive operations. In the near term, the FCC should advance this goal by resolving open issues in the white spaces proceeding,³ and ensuring that spectrum policies established in other proceedings do not impede white space operations.

II. UNLICENSED SPECTRUM SUPPORTS ECONOMIC GROWTH AND INNOVATION.

The Commission’s policy of providing consumers access to unlicensed spectrum has been a tremendous success. This policy and the resulting unlicensed bands have created a unique platform and raw material for wireless innovations. The resulting flood of unlicensed technologies has resulted in significant economic growth. Microsoft therefore agrees with commenters that share the Commission’s assessment that there have been “numerous innovations in unlicensed spectrum use,”⁴ and we also encourage the Commission to make additional unlicensed spectrum available to ensure the availability of a mix of unlicensed and licensed spectrum.⁵

A. Access to Unlicensed Spectrum Supports Innovation.

The unlicensed bands have a proven track record of supporting innovation. Technological and business innovations first developed in the unlicensed context have

³ *See generally Unlicensed Operation in the TV Broadcast Bands*, ET Docket No. 04-186. *See also* 47 C.F.R. Section 15 Subpart H.

⁴ NOI ¶ 45.

⁵ *See, e.g.*, Comments of Panasonic Corporation of America at 1-8 (filed Sep. 30, 2009); Comments of the Wireless Internet Providers Association at 3-4 (filed Sep. 30, 2009).

translated to broad consumer benefits. Indeed, the *NOI* specifically recognizes the “explosive growth” of numerous unlicensed technologies in recent years, including Wi-Fi, Bluetooth, and RFID tracking.⁶ In addition, innovations in the unlicensed bands have led to important advances in technologies used in the licensed bands. For example, orthogonal frequency division multiplexing (“OFDM”)—which the Commission highlights as an example of an efficiency enhancing breakthrough—is a modulation technique first standardized for use in wireless local area networks (“WLANs”) in 1999. Seven years later, OFDM first appeared in the Long Term Evolution (“LTE”) standard, now primarily being used for licensed 4G mobile wireless broadband networks.

But the best is yet to come. Microsoft is confident that the unlicensed bands provide an unparalleled platform that allows application providers and mobile operators to bring even more exceptional technologies to consumers in the years ahead. Experience is showing that mobile operators are benefiting as much as anyone from the ability to shift more wireless data traffic onto unlicensed networks.⁷ Additionally, sufficient access to unlicensed spectrum will be increasingly necessary to promote innovation as technological advances continue to blur the line between licensed and unlicensed spectrum uses.

⁶ *NOI* ¶ 23.

⁷ *See, e.g.*, Mobile Operator Round-Up: AT&T on WiFi, Sales, Signings and government intervention, GOMO NEWS, (Oct. 23, 2009), *available at* <http://www.gomonews.com/mobile-operator-round-up-att-on-wifi-sales-signings-and-government-intervention/>; Lynnette Luna, Operators embracing WiFi, but how far will they go?, FIERCE BROADBAND WIRELESS (Aug. 13, 2009), *available at* <http://www.fiercebroadbandwireless.com/story/operators-embracing-wifi-how-far-will-they-go/2009-08-13>; Kevin Fitchard, The Magic of the Microcell, TELEPHONY ONLINE (Nov. 3, 2009), *available at* <http://telephonyonline.com/connectedplanet/news/magic-microcell-1103/>.

As the Commission recognizes, devices now routinely communicate using both licensed and unlicensed spectrum.⁸ There are numerous handsets and laptops integrating both Wi-Fi and 3G network connectivity, including devices using Unlicensed Mobile Access (“UMA”) protocols to switch seamlessly between licensed and unlicensed networks.⁹ Similarly, devices such as the MiFi offered by Verizon and Sprint extend licensed wireless networks’ connectivity to unlicensed devices. This trend will only continue. Indeed, as a report commissioned by Microsoft submitted in the *National Broadband Plan* docket has concluded, global shipments of devices utilizing both licensed and unlicensed spectrum “will likely double [between 2008 and 2012], perhaps edging out the sales of licensed-only devices.”¹⁰ Accordingly, it is critical that sufficient access to both unlicensed and licensed spectrum be made available to support tomorrow’s technological breakthroughs, and to support devices and applications that will increasingly enable consumers to leverage the benefits of each spectrum access model.

B. Unlicensed Spectrum Creates Substantial Economic Value.

The unlicensed ecosystem encompasses a wide variety of platforms and devices that create significant economic value for Americans. To measure spectrum value in the licensed context, economists often rely on factors such as auction results and the impact of prices on demand to make inferences about producer and consumer surplus. These data points, of course, do not exist for unlicensed spectrum. But as anyone with a Wi-Fi-enabled laptop or handheld can attest, the fact that the economic benefits of unlicensed

⁸ NOI ¶ 51.

⁹ See Comments of CTIA – The Wireless Association® at 23 (filed Sep. 30, 2009).

¹⁰ See Richard Thanki, *The Economic Value Generated by Current and Future Allocations of Unlicensed Spectrum* at 19 (Sep. 2009) (“Thanki Report”), attached hereto.

spectrum allocations are harder to quantify does not mean that these benefits are not massive.

In response to the Commission’s call for more granular data in the *National Broadband Plan* proceeding, Microsoft submitted the attached paper by Richard Thanki, entitled *The Economic Value Generated by Current and Future Allocations of Unlicensed Spectrum*.¹¹ Thanki examined the U.S. economic value generated by the following unlicensed applications: (1) Wi-Fi broadband access within homes, (2) voice over wireless local area networks and wireless electronic health records in hospitals, and (3) RFID tags for in-store item-level tagging in the clothing retail sector.

Thanki estimates that the annual consumer surplus generated by Wi-Fi in homes in the United States—which accounts for only about 15% of the total projected market for unlicensed chipsets—is between \$4.3 and \$12.6 billion.¹² This translates to a consumer surplus per U.S. household per month of between \$5.40 and \$15.70. Moreover, by increasing the value of consumers’ broadband connections, Wi-Fi may be driving home U.S. broadband adoption by anywhere between 4.3 to 9.8 million additional connected households.¹³ Significantly, Thanki’s estimates do not take into account the value of wireless carriers’ and consumers’ dramatically increasing use of unlicensed Wi-Fi on devices that also provide licensed 3G mobile wireless broadband connectivity.¹⁴ They also do not account for the considerable economic benefits associated with

¹¹ *See generally* Thanki Report.

¹² *See id.* at 27.

¹³ *Id.*

¹⁴ *See, e.g.,* Comments of the Mercatus Center, George Mason University at 6-8 (filed Sep. 30, 2009) (“Mercatus Center Comments”).

business, educational, and other Wi-Fi uses. So Thanki's findings underestimate the economic value of unlicensed technologies.

Wireless local area networks using unlicensed spectrum also create significant economic benefits for healthcare providers. According to Thanki, the projected cost savings generated by use of voice over Wi-Fi and wireless electronic health records in U.S. hospitals have a net present value of \$91 to \$152 billion, or an annualized value of \$9.6 to \$16.1 billion a year between 2009 and 2025.¹⁵ These savings can translate to reduced costs and/or resources reallocated to improving the quality of healthcare for patients.

Finally, Thanki estimates the annual economic value derived from using RFID tags for in-store item-level tagging in the U.S. clothing retail sector to range from \$2.0 to \$8.1 billion per year between 2009 and 2025.¹⁶ The three applications Thanki chose to analyze—Wi-Fi enhancing broadband access in homes, Wi-Fi delivering voice services and wireless access to patient records in hospitals, and RFID tracking inventory in clothing retail stores—together may generate between \$16 to \$37 billion per year in economic value for the U.S. economy over the next 15 years.

Thanki's analysis is quite conservative. It does not include the economic value associated with Bluetooth, RFID beyond the U.S. retail clothing sector, cordless phones, telemetry, monitoring, sensor networks, and other applications. In light of the widespread adoption of these technologies, it would not be unreasonable to assume that these applications deliver economic value of a similar magnitude to household Wi-Fi, wireless local area networks in hospitals, or the retail clothing RFID applications

¹⁵ See Thanki Report at 30.

¹⁶ See *id.* at 34.

described above. Thanki's analysis also did not account for the incredible economic potential that could be derived from using spectrum below 1 GHz for unlicensed applications.¹⁷ Indeed, Thanki concludes that the historical lack of unlicensed spectrum allocations below 1 GHz has "adversely affected the development of longer-range, more reliable and ultra low-power unlicensed applications."¹⁸

The Commission has long recognized that certain frequency bands are more desirable than others.¹⁹ Indeed, the *NOI* specifically notes that "[i]nnovators have to consider the physical properties of different frequency bands ... which differ over the range of the radio spectrum"²⁰ when developing services and applications. The amount of spectrum under 3 GHz available today for unlicensed use is only about 120 MHz.²¹ Of that only 26 MHz of unlicensed spectrum is currently available below 1 GHz. This shortage highlights the importance not only of moving ahead with the proceedings needed to bring the TV Band White Spaces to consumers, but also the need to allocate additional unlicensed spectrum bands below 3 GHz.

III. MICROSOFT'S RESEARCH AND DEVELOPMENT EFFORTS HIGHLIGHT POTENTIAL INNOVATIONS IN UNLICENSED SPECTRUM.

Microsoft agrees with the Commission that research and development are key generators of innovation and, ultimately, investment in new wireless applications and services.²² For its part, Microsoft spends approximately \$9.3 billion on R&D each year.

¹⁷ See generally Part IV below.

¹⁸ See *Thanki Report* at 44.

¹⁹ See *NOI* ¶ 26.

²⁰ *NOI* ¶¶ 25-26.

²¹ See Comments of Verizon Wireless at 144 (filed September 30, 2009).

²² See *NOI* ¶ 14.

While Microsoft's research encompasses a broad range of information and communications technologies, we are increasingly interested in spectrum utilization as a result of the Commission's willingness to support efficiency-enhancing technologies, including those that use vacant television band spectrum.

Some commenters attempt to portray unlicensed spectrum as an ancillary "complement" to licensed technologies that promises little innovation beyond short range communications.²³ Microsoft's research demonstrates that this is not the case. Microsoft has conducted extensive studies since 2003 demonstrating that mesh networking in the 2.4 GHz spectrum band using Wi-Fi would advance broadband deployment.²⁴ Specifically, Microsoft's research has concluded that, for a typical suburban topology such as those located outside of Seattle, Washington, only 5 to 10 percent of the households in a community would need to participate to create a viable mesh network, even assuming that each participating node in the network would have a range equal only to the range of a current off-the-shelf 2.4 GHz Wi-Fi device (typically between 100 to 250 meters outdoors).²⁵

The use of white spaces spectrum below 1 GHz will unlock even more powerful innovations. This is true for two reasons. First, the substantially better propagation characteristics of spectrum below 1 GHz permit each node of a wireless network to take

²³ See, e.g. Mercatus Center Comments at 6-8. See also Comments of MetroPCS Communications, Inc. at 42-43 (filed Sep. 30, 2009).

²⁴ See ex parte letter of Microsoft Corp., GN Docket no. 09-51 at 16-17 (filed Sep. 21, 2009) ("Microsoft Sep. 21 ex parte"). See also NOI ¶ 51 and n. 57 (seeking comment on different wireless networking approaches, including mesh networking).

²⁵ Microsoft Sep. 21 ex parte at 16. A viable mesh network, in this case, can be conceived of as a network containing at least 25 participating nodes with each node having at least two points of connection to the Internet to safeguard against random link failures.

advantage of dramatically improved range—approximately three to five times greater than a Wi-Fi network node— using otherwise identical operating parameters.²⁶ This range increase, in turn, can expand the network coverage area by a factor of nine. Second, spectrum below 1 GHz is better able to penetrate walls and other structures, making a white spaces-based network viable for users operating indoors who are less likely to receive a usable signal at higher frequencies.

Microsoft has recently completed design and initial implementation of the first white spaces-based network on Microsoft’s Redmond, WA campus using an experimental license issued by the Commission earlier this year.²⁷ This “White-Fi” network trial includes a new adaptive spectrum assignment algorithm to handle the spectrum variation and fragmentation unique to the white spaces environment. By using this algorithm, the network is able to adaptively configure itself to operate in the most efficient part of the available white spaces. Microsoft is eager to apply the lessons learned in developing this network prototype, which successfully demonstrates the feasibility of Wi-Fi-like networking in the UHF white spaces, to commercial applications—and, more generally, the promise of unlicensed spectrum to unleash exciting new innovations.

²⁶ See *id.* at 17. See also P. Bahl, *et al.*, *White Spaces Networking with Wi-Fi like Connectivity*, Microsoft Research, at 2 (Aug. 2009), available at <http://research.microsoft.com/pubs/80952/whitefi.pdf>.

²⁷ See generally *id.*

IV. THE COMMISSION SHOULD CONTINUE TO PROMOTE EFFICIENCY-ENHANCING BREAKTHROUGHS BY RESOLVING ISSUES RELATED TO THE WHITE SPACES PROCEEDING.

Microsoft shares the Commission’s view that innovation plays a crucial role in promoting more efficient spectrum use.²⁸ The best way to encourage development of devices and techniques that improve efficiency, in the near term, is to resolve open issues related to the white spaces proceeding.

The white spaces rules take only a “cautious and conservative” first step toward unlocking the potential of unused TV band spectrum. The techniques developed for the white spaces will enable more efficient use of the designated frequencies immediately—even commenters in this proceeding that generally do not favor spectrum sharing have pointed to the white spaces as a band where such techniques are feasible.²⁹ But these innovations will also lead to advances in software defined radios more generally, and support innovation even in licensed bands.³⁰ Completing the remaining proceedings related to the TV white spaces is therefore necessary to advance the FCC’s goal of furthering wireless innovation both in the critical TV band and across currently available frequencies.

A. The Commission Should Resolve Open Issues Regarding White Space Device Operating Parameters.

Microsoft agrees with Google that the Commission can further innovation by moving quickly to resolve open issues related to petitions for consideration in the white

²⁸ See NOI ¶ 32.

²⁹ See, e.g., Comments of AT&T Inc. at 76 (filed Sept. 30, 2009).

³⁰ *Unlicensed Operations in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices, Below 900 MHz and in the 3 GHz Band*, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd. 16807, 16808-10 ¶¶ 1-3 (2008) (“White Spaces Order”).

spaces proceeding.³¹ As Microsoft and others have explained in that proceeding, the Commission needs only to make certain minor, but necessary, rule adjustments to allow effective use of the white spaces.³² In particular, the Commission should add a class of white space device that does not require spectrum sensing, but rather relies on the geolocation and database mechanisms set forth in the Commission's rules.³³ The Commission should also provide greater flexibility for white space devices to access vacant spectrum, including removing certain restrictions on operation below 512 MHz and transmissions near cable head ends.³⁴

The Commission also should reject calls to overturn its decision to open up access to the white spaces on an unlicensed basis, whether for wireless backhaul or other applications.³⁵ The Commission has appropriately considered both licensed and unlicensed use of the TV band spectrum, and concluded that the public should receive the benefits of licensed use (through the 700 MHz auction) and unlicensed use (through the white spaces). Moreover, as the record in the white spaces proceeding amply reflects, a fixed, point-to-point network proposed by some licensed use advocates is not an efficient

³¹ Comments of Google Inc. at 9-10 (filed Sep. 30, 2009).

³² *See generally* Petition for Reconsideration of Dell, Inc. and Microsoft Corp., ET Docket No. 04-186 (filed March 19, 2009); Consolidated Opposition to Petitions for Reconsideration of Dell, Inc. and Microsoft Corp., ET Docket No. 04-186 (filed May 8, 2009); Dell, Inc. and Microsoft Corp. Reply in Support of Petition for Reconsideration, ET Docket No. 04-186.

³³ *See* 47 C.F.R. Section 15 Subpart H; *See also* Comments of Google Inc. at 9-10 (advocating geolocation-only devices).

³⁴ Petition for Reconsideration of Dell, Inc. and Microsoft Corp. at 5-9.

³⁵ *See, e.g.,* Comments of The Rural Telecommunications Group, Inc. at 6 (filed Sept. 30, 2009); Comments of Sprint Nextel Corp. at 33-35 (filed Sept. 30, 2009); Comments of T-Mobile USA, Inc. at 28 (filed Sept. 30, 2009).

use of “beachfront” TV-band spectrum, particularly since such use necessarily will preclude unlicensed operations.³⁶

B. Overprotecting Legacy Wireless Microphone Systems Will Impede White Space Innovations and Reward Unauthorized Operation.

Verizon Wireless and others correctly point out that the Commission should resolve issues surrounding unauthorized use of Part 74 wireless microphones and proceed to clear the 700 MHz band of all wireless microphone operations, including the small number of authorized microphone operations.³⁷ Microsoft software, including Windows software running on smartphones and netbooks, plays a critical role in licensed wireless operations, and Microsoft is eager to help usher in the benefits of next generation networks using this spectrum. However, clearing the 700 MHz band also directly impacts the white spaces, as many wireless microphone users—overwhelmingly unauthorized—presumably will seek to relocate to spectrum that will be used for white spaces operations.

The Commission should take two actions in order to ensure that TV-band wireless microphones do not render white space use infeasible. First, as Microsoft and others have explained elsewhere, existing rules intended to protect even the relatively small number of *authorized* wireless microphones operating in the TV bands are significantly overprotective, and should be improved.³⁸ For example, Microsoft earlier this year commissioned Shared Spectrum Company to undertake a program of measurements and

³⁶ Consolidated Opposition to Petitions for Reconsideration of Dell Inc. and Microsoft Corp. at 18.

³⁷ Comments of Verizon Wireless at 196 (filed Sept. 30, 2009). *See also* Comments of the White Spaces Coalition, WT Docket No. 08-166, 08-167 (filed Oct. 3, 2008).

³⁸ *See, e.g.* Consolidated Opposition to Petitions for Reconsideration of Dell, Inc. and Microsoft Corp. at 2-4.

analysis to examine the level of protection that would be necessary to accommodate wireless microphone systems operating under real-world conditions.³⁹ This report concluded that, for devices relying on geolocation technologies, radii for the “keep out zone” in which white space devices may not operate in proximity to licensed microphones could be conservatively set at 130 meters.⁴⁰ For devices relying on spectrum-sensing technology, the threshold at which microphones should be detected could be reduced by several dB.⁴¹

Second, efforts to allow unauthorized TV-band microphone users to operate in compliance with FCC rules should not result in the vast majority of these users being granted the status of a television broadcaster. As Microsoft and others have explained in detail in the 700 MHz wireless microphone proceeding, aggressive and misleading marketing by Shure and other manufacturers has resulted in widespread unauthorized use of Part 74 “broadcast auxiliary” wireless microphones by individuals who play no role in television content production.⁴² Microsoft agrees with the 700 MHz auction winners and public interest groups that these individuals reasonably relied on the actions of manufacturers, and therefore should not be punished for operating devices without Commission authorization.⁴³ Indeed, Microsoft specifically supports proposals to accommodate many currently unauthorized wireless microphone uses in the white spaces

³⁹ See generally Microsoft ex parte, The Impact of Man-Made Noise On Protection Requirements For Wireless Microphones, ET Docket No. 04-186 (filed Oct. 26, 2009).

⁴⁰ *Id.* at 14.

⁴¹ See *id.*

⁴² See generally Comments of the White Spaces Coalition, WT Docket No. 08-166 (filed Oct. 3, 2008).

⁴³ *Id.* at 2.

by enabling those devices to legally operate as unlicensed devices pursuant to Part 15 rules.

What the Commission should *not* do, however, is expand protections for licensed broadcast auxiliary wireless microphones, including by expanding white spaces “keep out” zones established through a geolocation database, for large classes of currently unauthorized microphones. This action would render the white spaces completely unusable in many urban areas, making investment in the technology significantly less attractive for Microsoft and other technology companies.⁴⁴ This lack of investment would, in turn, significantly drive up development and deployment costs even in rural areas where microphones are not present in great numbers.

These issues have been briefed in substantial detail in the white spaces and 700 MHz wireless microphone dockets.⁴⁵ In the context of this proceeding, Microsoft only adds that, unlike almost any other wireless service identified in the *NOI*, TV band wireless microphone users and manufacturers cannot point to a track record of innovations that have resulted in increased spectral efficiency over the many years they have operated. Indeed, TV band wireless microphones still require the same amount of bandwidth to operate that they did when the service was first authorized over thirty years ago.⁴⁶ The Commission should not foreclose access to spectrum that could enable

⁴⁴ See *NOI* ¶ 11 (seeking comment on the Commission’s role in encouraging innovation and investment).

⁴⁵ See, e.g., Comments of the White Spaces Coalition, WT Docket No. 08-166 (filed Oct. 3, 2008); Reply Comments of the White Spaces Coalition, WT Docket No. 08-166 (filed Oct. 20, 2008); Consolidated Opposition to Petitions for Reconsideration of Dell Inc. and Microsoft Corp., ET Docket No. 04-186 (filed May 8, 2009).

⁴⁶ For example, by wireless microphone advocates’ own admission, it takes 15 six MHz TV channels – a full 90 MHz – to deploy 49 narrowband microphones at a single

exciting new wireless broadband applications to accommodate inefficient legacy uses that overwhelmingly operate contrary to the Commission's rules.

V. CONCLUSION.

Although the last few years have witnessed an explosion of wireless innovation, Microsoft shares the Commission's optimism that we have only seen the tip of the iceberg. Microsoft looks forward to providing tools to help consumers meet their increasing wireless needs, and to continuing research and development that will enable more efficient and innovative spectrum uses. By taking the actions set forth above, the Commission can ensure that the public realizes the benefits of both licensed and unlicensed spectrum, maximizing the potential for access to innovative wireless applications and services for all Americans.

Respectfully submitted,

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November 5, 2009

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