

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

In the matter of:)
)
Unlicensed Operation in the Band 3650-3700) ET Docket 04-151
3650-3700 MHz)
)
Additional Spectrum for Unlicensed Devices) ET Docket 02-380
Below 900 MHz and in the 3 GHz Band)
)
Amendment of the Commission's Rules With) ET Docket 98-237
Regard to the 3650-3700 MHz Government)
Transfer Band)
)

REPLY COMMENTS OF PROFESSOR CHRISTIAN SANDVIG

INTRODUCTION

A research team at the University of Illinois at Urbana-Champaign (UIUC) headed by Prof. Christian Sandvig (the commentor) is now conducting a multi-year research study of “grassroots” use of wireless technologies for data networking by local municipalities, businesses, and not-for-profit organizations. We did not file initial comments in this docket, but both published and preliminary results of this research project are relevant to statements made by other commentors in Docket 04-151.¹ This comment reviews empirical research findings and makes three conclusions contrary to statements made by other commentors.² First, that empirical studies of users indicate a strong need for additional unlicensed spectrum. Second, evidence exists that a professional certification requirement would be harmful to the utilization

¹ In this comment, “published” refers to peer-reviewed results, while “preliminary” results have not been peer-reviewed.

² All citations refer to comments filed in ET Docket 04-151.

of this spectrum. Third, no user findings from our research yet support a need for higher-powered unlicensed operation.

EMPIRICAL BASIS FOR THESE COMMENTS

UIUC has been conducting a tracking study of 59 “grassroots” community based organizations that are trying to use unlicensed 802.11 (“Wi-Fi”) and related wireless technologies in five countries for a variety of purposes using a variety of organizational models (municipal, commercial, not-for-profit). This study began in 2002 under a project for basic research funded by the National Science Foundation.³ This is an extension of an existing independent empirical research program on cooperatively provided communication infrastructure (which will continue through 2007). A central research question of this project is: *Are decentralized cooperative attempts to provide telecommunications infrastructure viable?* The groups under study have chiefly used unlicensed spectrum in the US and both unlicensed and “light-licensed” spectrum in the UK, making this research project directly relevant to this FCC docket.

In this project, quantitative evaluation includes: (1) mapping and evaluating all Wi-Fi activity surrounding selected community wireless projects,⁴ cluster analysis of a large corpus of full-text mailing list archives produced by the wireless projects, and employing (3) Geographic Information System (GIS) methods to analyze network spread and participation. Qualitative methods include (4) open-ended interviews with twenty of the groups and (5) participant observation in two of the groups. Both the tracking and the mapping study are relevant to these reply comments.

³ This material is based on work supported by the National Science Foundation under Grant No. 0308269. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

⁴ After Byers, S., & Kormann, D. (2003). 802.11b Access Point Mapping. *Communications of the ACM*, 46(5): 41-46.

(a) UIUC Tracking Study. The larger UIUC tracking study employs purposive sampling of groups who self-identify as community, non-profit, independent, or cooperative (these include commercial, municipal and hybrids) and maintain listings in Web directories related to Wi-Fi groups, supplemented with snowball sampling for opinion leaders and “model” groups. To evaluate both success and failure, this sample intentionally includes groups that have failed at their objectives, and we expect some new groups to fail and/or disband during the study. Research into this sample is divided into varying degrees of depth. First, a corpus of Web information about *every group* is compiled and stored. As many of these groups do much of their business on the Web, about 80% of these groups maintain large public archives of all mailing list traffic. One archive might span three years at 1,000 messages per year. Second, eighteen groups were selected for further study on the basis of their accessibility to the researchers. This additional study includes site visits, open-ended interview, and content analysis of mailing list archives. Fourteen of these studies are completed as of this writing, including 36 in-depth interviews, each between 1-2 hours (about 20 hours transcribed). Finally, two groups have been selected for ethnographic participant observation with contact on a weekly basis over an extended period (one for 9 months per year, one for 3 months – the summer). Participant observation began in August 2003 and is continuing.

(b) UIUC Mapping Study. To verify and contextualize claims these groups make about Wi-Fi, researchers have selected five locations (each comprising most of a census tract) to sample and map Wi-Fi “clouds.” Three are in a large Midwestern city, one is in rural Illinois, and one is in Urbana, IL. This mapping sample contains decentralized cooperatively provided Wi-Fi activity and also represents a diversity of income, education, population densities, race, and neighborhood character. Mapping began in May 2003. Researchers employ handheld computers (personal organizers) on which the original operating system has been removed and

replaced with Linux, allowing researchers to use and modify the open-source sniffer software *Kismet*. The CF port of the handheld is modified with a custom sleeve to allow it to accept a more powerful PCMCIA 802.11 packet radio/network interface card than is usually available, and handheld is connected to roof-mountable GPS device and a 19" 7.4 dBi omnidirectional antenna that can be clamped to the hood of a university motor pool vehicle. The GPS device reports a stream of latitude and longitude coordinates and a timestamp, while information from the 802.11 packet radio is used to identify each Wi-Fi signal, recording summary information such as signal strength, reported identifier, security in use, frequency/protocol, and manufacturer. (The content of the wireless communication is not recorded.)

RELEVANT FINDINGS

Empirical Studies of Users Indicate a Strong Need for Additional Unlicensed Spectrum.

Preliminary results from this research indicate that a very high demand exists among consumers, WISPs, and community wireless projects for additional unlicensed, low-powered spectrum for data networking. In our mapping study of a large Midwestern city, in neighborhoods of medium-to-high affluence where educational attainment is high, approximately **one in ten residents owns** either an 802.11b or 802.11g access point. In neighborhoods with a high population density, this indicates that unlicensed spectrum in the 2.4 GHz range is already congested. In Spring, 2004 we **detected 1,954 b/g access points per square mile at street level**. A visualization of a neighborhood with this density in an urban area of a large Midwestern city is attached. Users have yet to notice routine congestion in this band because their "broadband" Internet access is comparatively much slower than their 802.11 devices, but this will not continue to hold as broadband speeds increase. In addition, interviews with not-for-profit wireless projects indicate an increasing incidence of interference in the unlicensed 2.4 GHz band.

In contrast to the comments filed by *Intel Corporation, Motorola, Inc., and Satellite Industry Association*, we do not find that the lack of an exclusive license is preventing commercial activity in the existing unlicensed bands, and we see no reason why this would apply to additional unlicensed bands. We have consistently found a wide variety of activity by businesses in unlicensed bands, and other researchers are guardedly optimistic about a wide variety of unlicensed activities that may lead to local economic development.⁵

Evidence Exists That a Professional Certification Requirement Would Be Harmful to the Utilization of This Spectrum. In the published results from this research project (appearing this month in *Telecommunications Policy*, copy attached) we found that considerably more experience exists among amateur operators in the unlicensed band than among businesses – even telecommunications operators. Indeed, the “amateurs” we have studied have often end up starting WISPs or taking jobs in them (or in more traditional telecommunications companies) on the basis of the experience gained as amateurs. On the basis of our research to date, easy access to unlicensed bands for experimentation is a necessary condition for innovation in wireless services and applications. In light of the current distribution of skill among “amateur” groups, requiring a professional certification would retard the efficient utilization of this spectrum. This finding is consistent with the comments of *NYCWireless, et al.* but we would also like to emphasize that our results indicate that this is consistent with the interests of independent WISPs, as these “amateur” groups create an important pool of expertise that is also put to work in commercial organizations.

⁵ See Barranaca, M. (2004, April 16). “Unlicensed Wireless Broadband Profiles: Community, Municipal and Commercial Success Stories,” Washington, DC: New America Foundation. http://www.newamerica.net/Download_Docs/pdfs/Pub_File_1547_1.pdf and Shamp, S. A. (2004, August 10). “WiFi Clouds and Zones: A Survey of Municipal Wireless Initiatives.” University of Georgia: Mobile Media Consortium. <http://www.nmi.uga.edu/research/WiFiCloudsZones--8-10-04.pdf>

No User Findings Yet Support a Need for Higher-Powered Unlicensed Operation. While the project to date has studied only three rural projects in detail, interviews with these groups do not support a need or desire for high-powered operation, contrary to the appeal for power flexibility in the *Notice of Ex Parte presentation* in filed by the Media Access Project and the need for higher power transmission claimed by *IEEE 802 Metropolitan and Local Area Networks Standards Committee*. This need may exist but with our methods to date we have found no evidence for it. Indeed, from the interviews with rural operators to date, we find the only concerns expressed to be similar to *Motorola's*, that "higher operating powers may prove counter-productive as the limited bandwidth available in the band could quickly be impacted by multiple 'high-powered' unlicensed broadband transmitters operating in the same area."⁶ Indeed, one of the most promising applications to date of unlicensed spectrum has been low-powered ad hoc "mesh" networking and the groups currently experimenting with these networks would not be able to utilize additional spectrum in the 3650-3700 MHz band if this were reserved for high-powered operation only.

NATURE OF COMMENTOR

Dr. Christian Sandvig is an assistant professor at the University of Illinois at Urbana-Champaign where he studies communication technology and public policy.⁷ He holds the PhD in Communication from Stanford University and has served as a Markle Foundation Information Policy Fellow in the Programme for Comparative Media Law and Policy at Oxford University, where he remains a research associate. Sandvig's current work is funded by the National Science Foundation and the Economic and Social Research Council (ESRC) of the United Kingdom. Sandvig is also a computer programmer with industry experience in a

⁶ *Reply Comments of Motorola, Inc.* (August 27, 2004) at 2.

⁷ For additional information, see: <http://research.niftyc.org/>

Fortune 500 company, a regional government, and a San Francisco Bay Area software start-up. In 2000 Sandvig received the top student paper award at the Telecommunications Policy Research Conference for a portion of his dissertation. In 2002 Sandvig was named a “next-generation leader in science and technology policy” in a junior faculty competition organized by Columbia, Rutgers, and the American Association for the Advancement of Science.

Respectfully Submitted,

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