Comments to the FCC on Docket # 04-113

NPRM on Unlicensed Operation in the TV Broadcast Bands and Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band

John Laprise
j-laprise@northwestern.edu

Table of Contents

Introduction

The FCC in its NPRM 04-113 has announced its intent to expand the availability of unlicensed spectrum by making available unused television spectrum. This measure would be highly beneficial to consumers of communications and data services and also encourage the continued growth of unlicensed wireless services and technologies. Combined, these benefits would result in a greater level of competition in telecommunications and data services by adding yet another choice to the current regime of satellite, wireline, and cellular communications. Moreover, as Voice over Internet Protocol (VoIP) becomes more common, unlicensed services hold the potential to vastly reduce the cost of communications to the consumer and realize the FCC's dream of universal service for both voice and data services. Finally, the availability of unlicensed spectrum enriches and enhances the variety of free speech available in the market by allowing individuals greater accessibility to communications without the mediation of a spectrum license holder.

There is some concern that this NPRM is being introduced at a transitional time as television makes the change from analog to digital transmission. Broadcasters suggest that they are concerned about interference and interaction effects between digital broadcasts and unlicensed spectrum users which might impede consumer adoption and raise technical deployment costs with respect to digital broadcasting. However, I would suggest that broadcasters are very concerned over spectrum allocation. As digital broadcast requires less spectrum, broadcasters fear that the FCC may expand NPRM 04-113 in the future to permit unlicensed usage of the spectrum held by active broadcasters that would become unused once analog broadcasting ceases. This fear of broadcasters is

based, however on an understanding of spectrum scarcity that ignores technological innovation. Spectrum at present is a scarce and valuable commodity, but new compression technology will make it possible to fit more information into a narrower slice of spectrum. Ten years from now, broadcasters will find themselves with an embarrassingly large amount of spectrum of minimal value as unlicensed users will have continued to develop more complex wireless encoding schemes and better utilize the existing unlicensed spectrum.

The FCC's present course of action in 04-113 comes at a critical time. The data encoding schemes that will reduce the problem of scarcity are now emerging from engineering laboratories. The impact of these new technologies is not apparent to established, licensed spectrum users and they do not anticipate the changes that this technology will bring. Presently, it is important to "prime the pump" by increasing the availability of unlicensed spectrum to innovators and entrepreneurs seeking to offer new services and old services in new ways to better interconnect our society, encourage competition, and support free speech.

Wi-Fi and Innovation

Unlicensed wireless services have enjoyed explosive growth since 1991. The earliest service standards such as Wi-Fi, RF Home and Bluetooth all sought to use unlicensed spectrum to link electronic devices over short distances. Wi-Fi has proved to be the most successful over time in part due to its origination with the IEEE as an open standard and the large audience of skilled "techie" users. Wi-Fi users and electronics

hobbyists, as in the early days of broadcast radio, were quick to see other potential uses of the standard. This is exemplified by the "Cantenna" and the practice of "warchalking".

The "Cantenna" is a jury rigged directional antenna created by Wi-Fi users in Seattle Washington based on an amateur radio antenna.[1] Incorporating a Pringles can and minor, easy to obtain electronic components, and costing less than ten dollars, Wi-Fi enthusiasts eager to avoid the high costs of early Wi-Fi equipment built these cantennas to enable Wi-Fi access. Moreover, this innovation also allowed the formation of "Hot Spots" referring to the wireless footprint of a Wi-Fi antenna. With a directional antenna, users could aim at a known antenna to receive a signal and gain broadband access for their computers.

Discovering the location of hot spots came to be a game of sorts named warchalking.[2] Individuals and groups would canvass cities with handheld signal detectors to identify Wi-Fi hotspots and create maps. Hobbyists thus obtained inexpensive broadband service by piggybacking on unsecured Wi-Fi hotspots. While the owners of some of these sites eventually secured access to stop this broadband freeloading, others left their networks open and fostered communities of Wi-Fi users. Both phenomena encouraged innovation, built community, and fostered open discourse.

Unlicensed Spectrum and Broadband Competition

While the cantenna and warchaulking were spontaneous consumer technological innovations, it did not take long for individuals to adapt Wi-Fi technology for business. Wireless Internet Service Providers (WISPs) are the primary example of this approach.

[1] http://www.netscum.com/~clapp/wireless.html#history
[2] http://www.warchalking.org/

WISP's began providing "virtual T-1" service in the early 1990's. Employing unidirectional antennas and buying wireline broadband access from CLECs, WISPs provided low cost broadband service. The service did have limitations. Wi-Fi requires a direct line of sight and has a maximum range of seven to ten miles. Nonetheless, it offers service comparable to the T-1 service offered by telephone companies at half of the price. Moreover, WISPs are ideally suited for rural areas as the service does not rely upon an existing wireline infrastructure. The advent of WISPs began to bring competitive pressure to bear upon cable and telephone companies offering broadband service at relatively uncompetitive prices.

WISPs and hot spots began to enter urban areas in the 2000's. While lacking the range of rural WISPs owing to obstructions to transmission, the increasingly wireless business community was eager to exploit the new technology and technology producers were more than willing to assist. In 2002, Intel introduced a notebook computer chipset that incorporated wireless technology in its design. Intel has further restructured itself to focus on network and wireless communications.[3] This reorganization recognizes ongoing market research that suggests that 95% of notebook computers sold in 2006 will be equipped with Wi-Fi and that 90% of business travelers anticipate using Wi-Fi in the future.[4]

With consumers and manufacturers both seeing Wi-Fi in their future, service providers began offering Wi-Fi service in airports, truck stops, coffee shops, and hotels in an effort to attract and retain business customers. Many such providers are affiliated or owned by wireless telephone companies which see Wi-Fi as an inexpensive intermediate

[3] Intel Corporation, SEC 10-Q, 5/3/04
[4] http://siliconvalley.internet.com/news/article.php/3082991

step towards the 3G service which they anticipate offering in the future over their cellular telephone networks. Moreover, Wi-Fi is an inexpensive technology for cellular telephone companies to provide as Wi-Fi antennas can be mounted along with their existing network of cellular antennas.

As providers, consumers, and manufacturers began to push Wi-Fi, another group also saw the potential of the new technology. Inexpensive and easy to install, Wi-Fi allowed building owners to easily upgrade their buildings' telecommunications infrastructure. Rewiring older buildings can be an expensive and time consuming proposition for management companies. However, Wi-Fi offered a way to upgrade old buildings for the twenty-first century by blanketing them with broadband access for residents. Institutional users such as medical facilities, government, and educational institutions are major consumers of such products.

Wi-Fi is but one use of unlicensed spectrum. Over the past fifteen years, Wi-Fi has become a multibillion dollar industry, providing goods and services to businesses and consumers. The economic benefits of unlicensed wireless through a single service have extended to individual consumers and businesses, creating whole new industries in the process. Moreover, it has been executed between the cracks of the current spectrum regulatory regime, having relied upon small, preexisting unlicensed pieces of spectrum. Furthermore, Wi-Fi is contemplating another leap in its utility with the emergence of VoIP.

Wi-Fi Voice Competition and VoIP

Convergence of communication into a digital format has been occurring at a steadily increasing pace since the advent of the computer. Today, digital media formats are driving their analog predecessors into obsolescence. Digital music, photographs, and movies are outselling their analog equivalents. Moreover, while presenting significant intellectual property concerns, reproduction costs of digital media are dramatically lower than analog media. One of the last bastions of analog data transmission is the wireline telephone system.

Even here, however, digitalization is making its mark. VoIP technology is creating new competitive pressure upon telephone companies. Digitalization is, like other media content forms, creating new capacity by compressing information into narrower pipes which in turn is improving efficiency and lowering costs. Moreover, the different regulatory regimes governing cellular, wireline, and cable telephony industries and the difference between voice and data services have combined to give consumers a range of new inexpensive choices for voice communications. VoIP's infrastructural neutrality allows it to be adapted for non-traditional infrastructure such as Wi-Fi.

The combination of VoIP and Wi-Fi create the potential for local wireless communications in the absence of an external infrastructure provider, either wireless or wireline. The internal PBX systems of a large company could be completely managed by software and off-the-shelf (OTS) equipment. Voice could be conveyed between corporate locations over the company's own VPN, negating the need for a traditional internal switchboard. By making available additional unlicensed spectrum, the FCC encourages additional competition not only for broadband use, but also for basic voice services.

Wireless Innovation

This powerful combination of Wi-Fi and VoIP is made possible by the existence of a minimal amount of unlicensed spectrum. This however is not the full extent of innovation brought about by the existence of unlicensed spectrum. Other technologies for networking like mesh networks[5] are already being deployed or like the WIMAX standard[6] are in development. These new communications technologies and the services that will harness them are yet to be fully realized. The availability of further unlicensed spectrum would catalyze innovation by inventors struggling to find spectrum.

While Wi-Fi is an excellent example of an existing technology using unlicensed wireless spectrum, new technologies are also relying upon spectrum availability that do not rely upon Wi-Fi. One such exemplar is that of Radio Frequency Identification (RFID). RFID technology utilizes short range radio transmission to interrogate small programmable chips that allow the collection of information. This technology is being implemented by the US Government[7] as well as retailers in the private sector such as Wall-Mart[8]. Both seek to use the RFID technology to help them control inventory and streamline purchasing. RFIDs have developed in an environment where the future of unlicensed spectrum was uncertain. In spite of this uncertainty, the inherent value of the technology has propelled it forward through development and into deployment. By expanding the array of available unlicensed spectrum, the developmental risks and costs incurred by such innovation would be reduced.

[5] http://www.meshnetworks.com/#
[6] http://en.wikipedia.org/wiki/WiMAX
[7] http://www.aimglobal.org/technologies/rfid/resources/articles/dec03/DoD.htm
[8] http://www.infoworld.com/article/03/11/21/46OPreality_1.html

Free Speech and Unlicensed Spectrum

Early Wi-Fi enthusiasts also exemplify another attribute of unlicensed spectrum; its capacity to encourage and enrich free speech. The cantenna and warchaulking phenomena are both made possible by the exchange of information between enthusiastic hobbyists on the Internet. One of the early incentives to these hobbyists was that Wi-Fi was seen as an escape from the control of ISPs. Wi-Fi access was a liberating mode of connection and exchange.

The simple phrase "Unlicensed spectrum" connotes a lack of oversight to the general public. While this is patently false as the FCC observes the actions taking place across the spectrum, it is certainly true that corporate interests are weaker within unlicensed spectrum as they lack the control that a license proffers. This public perception of a lack of oversight even though the truth is one of degrees still creates a freer and richer communications environment.

Furthermore, the volume of speech is has also increased due to the availability of unlicensed spectrum. Truck drivers who had limited opportunities to access the Internet through kiosks at specially equipped truck stops are now able to work from within their truck with their notebook computer.[9] Travelers in airports are likewise able to work and communicate to a degree unthinkable in days past.

Unlicensed spectrum enhances public access to venues of discourse and creates an environment that is perceived to be more liberated from control. The FCC by freeing up additional spectrum for unlicensed use will continue to nurture spaces that encourage free

[9] http://www.cnn.com/2004/TECH/internet/05/07/wi.fi.trucking.ap/

speech. The existence of such spaces promotes the creation of communities such as those associated with the Wi-Fi movement that underpin free and open public discourse.

Spectrum Scarcity

Despite the common perception that spectrum is scarce, there is reason to believe that it is a commodity that will be less scarce due to further technological innovation. This will fundamentally change the nature of wireless and broadcast business models which have relied upon spectrum's scarcity and resultant value. As scarcity declines, so will the value of spectrum held by licensees. Moreover, because spectrum scarcity will decline through more efficient use of spectrum, current license holders will find themselves with an abundance of spectrum and few potential buyers.

The IEEE notes that technological improvements are increasing the carrying capacity of signals towards their theoretical limits. In practical terms, this would improve the carrying capacity of broadcast signals by an order of magnitude.[10] These theoretical improvements are now being designed into the products of telecommunications equipment suppliers including Lucent, Motorola, and Cisco and will be deployed in the coming years.

The deployment of this new equipment will allow existing spectrum to be used more efficiently. Current license holders will have more spectrum than they require to provide their current level of service. Moreover, their licenses would seem to appreciate because of the added capacity of their spectrum allotment. However, this appreciation is illusory due to the scale of the capacity growth. Rather, all spectrum users will come to find themselves with an abundance of spectrum. Moreover, license holders will fear that

[10] IEEE Spectrum 3/04

their underutilized spectrum will be reallocated by the FCC. Companies that have paid large fees at spectrum auctions will find themselves having overpaid for devalued spectrum.

Freeing up underutilized spectrum at this time therefore is unlikely to burden licensed spectrum holders over the long term as spectrum capacity will increase globally. At the same time, making additional unlicensed spectrum available now will help unlicensed wireless users, while spectrum scarcity is still a factor and over the long term as the freed up spectrum is used for an ever increasing range of products and services.

Digital Television

One concern that has been raised by both the broadcast industry and by the commissioners is in the implementation of this order simultaneously with the widespread deployment of new digital television technology. It appears there is a belief that the concurrent implementation of these orders will be problematic. Significant concerns have specifically been lodged as to the identification of underutilized spectrum and potential interference issues.

Digital television technology has already been implemented at many large market television stations. In 2000, 62 % of television stations had already upgraded to digital television.[11] It thus appears that the primary barrier to the elimination of analog broadcast will be the FCC's decision that consumers' adoption should reach 85%. With two years yet to go, inference concerns should be addressed rather easily in the intervening time. Industry's concern that digital broadcast which uses less bandwidth than an analog

[11] http://www-royaltv.pp.asu.edu/lunch2000.htm

broadcast, could be interfered with by unlicensed usages appears to be an administrative stalling tactic.

Having upgraded their systems to digital broadcasting, television stations now find themselves in possession of more spectrum than they can effectively use. The FCC's action in this NPRM leads them to believe that the spectrum to which they hold license may be vulnerable to reallocation by the FCC. While digital television has brought television stations efficiencies of spectrum use, it has also raised the specter that they might lose what they consider to be a valuable commodity.

As previously outlined, this belief is likely to be turned on its head within the next ten years. Just as stations play for time with which to try and negotiate advantageous terms and transactions on portions of their spectrum licenses, the value of that spectrum will plummet due to technological innovation. Moreover, by striving to delay the FCC's potential action in reallocating their underutilized spectrum at some indeterminate future point, they are reducing any compensation they might receive from the government in exchange.

Future Action

Indeed, the FCC should be looking towards further spectrum reallocation and broadcast signals are a likely location. Digital transmission requires less spectrum for broadcast. Moreover, improved transmission techniques have made it possible to reduce the guard bands for channels and stations.

Furthermore, spectrum auctions for licensed spectrum will also require serious reevaluation. The technological revolution that is inverting the spectrum scarcity

problem will have a dramatic effect on future spectrum auctions. The FCC has experimented with a number of different methods of allocating spectrum. It has granted licenses in the public interest, it has given them away in lotteries and, most recently has held auctions. With the decline of spectrum scarcity, auctions will no longer command the hundreds of millions of dollars that have been the rule in recent past.

I suggest that unlicensing the spectrum might be not only technically feasible but also an effective way to utilize resources in the future. Encoding technologies presently allow signals to be transmitted within the same area without interference. As encoding technologies improve, it will be possible to make more efficient use of spectrum and allow market forces free rein in communications services.

For instance, from my notebook computer I have access to five separate Wi-Fi networks within signal range. Some of these are private and some are public. By paying for access on the private system, I gain greater quality of service, speed, and security, while the public systems offer me free access and a more advertisements. Nonetheless, all of these networks are competing within the same spectrum for subscribers. Unlicensed spectrum is another way in which the FCC can allocate spectrum for public use while upholding its mandate to steward spectrum use.

Conclusions

The FCC's intention to make available additional spectrum for unlicensed use is eminently sound policy. The availability of unlicensed spectrum has acted as a technological catalyst for the communications industry resulting in the emergence of whole new industrial technologies. These technologies such as Wi-Fi and RFID have embraced consumers and businesses. Moreover, the pace of innovation is not slowing

despite the dearth of unlicensed spectrum currently available. By releasing additional unlicensed spectrum, the FCC will further lower the barriers to innovation within the telecommunications sector.

Unlicensed spectrum has also proven to be successful in providing economical broadband service to underserved populations and thus enhancing the competitive environment for telecommunications service providers. The availability of additional unlicensed spectrum and technologies such as VoIP provide the means by which to continue to drive competition by forcing prices and costs lower in the realm of voice. Enhanced access to voice and data services will also encourage free speech to flourish by making it easier for mobile Internet users and individuals in underserved areas to communicate.

While some concerns do exist over the logistics of implementing the proposed rule with regard to interference, it seems that these hurdles are easily surmountable. Moreover, these concerns are likely put forward by broadcasters who fear that one of their most valuable assets will be arbitrarily taken from them. Because digital broadcasting requires less spectrum, broadcasters fear additional future spectrum reallocations will come at their expense. They fail to realize that technological innovation is even now eroding the value of their licensed spectrum as it becomes possible to compress more information over smaller pieces of spectrum.

This lesson should not be lost upon the FCC in guiding its future decisions on spectrum allocations. Previous modes of allocation such as auctions may become unfeasible as the scarcity of spectrum declines. Moreover, advanced encoding schemes may make it possible to steadily delicense the spectrum as guard bands become narrower

or even superfluous. The FCC should be cognizant of the fact that the regime of licensed spectrum may be undermined by technological innovation and begin to think about what kind of regulation will function in such an environment.