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Wireless Technology and Spectrum Demand: Advanced Wireless Services

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Summary

Advances in wireless telecommunications technology are converging with Internet technology to foster new generations of applications and services. Presently, the United States and other countries are moving to third-generation (3G) and fourth-generation mobile telephony. The defining feature of these technologies is that transmission speeds are significantly faster than prevailing technology, making it possible to provide services such as high speed access to the Internet and to receive broadcast television programs.

A related trend is the growth in use of Wi-Fi (wireless fidelity) and WiMAX (an industry designation for a specific broadband standard). Wi-Fi uses local wireless networks for high-speed mobile access to the Internet. WiMAX has a broader range of distance. 3G could be described as bringing Internet capabilities to wireless mobile phones; Wi-Fi as providing wireless Internet access for laptop computers; and WiMAX as expanding networks with wireless links to fixed locations. The technologies are seen by some as competing for customers and by others as complementary — providing a broader base and greater choice of devices for wireless communications and networking. From the perspective of spectrum management, a significant difference in the technologies is that 3G and WiMAX services operate on designated, licensed frequencies, while Wi-Fi shares unlicenced spectrum with other technologies. As the markets for Wi-Fi and WiMAX develop, wireless carriers have become concerned about the competitive impact on their businesses when municipalities offer wireless broadband services. In the 109th Congress a bill to restrict municipal communications services, H.R. 2726 (Representative Sessions), and a bill that would guarantee the right of local governments to provide advanced communications services (S. 1294, Senator Lautenberg) have been introduced. The Broadband Investment and Consumer Choice Act (S. 1504, Senator Ensign) contains a provision that would require states or localities to submit plans to offer communications services to competitive bidding. The Digital Age Communications Act of 2005 (S. 2113, Senator DeMint) would bar states from engaging in unfair competition with commercial providers of communications services. S. 2327 (Senator Allen) and S. 2332 (Senator Stevens) would allocate new frequencies for unlicensed use, notably wireless broadband. This report will be updated.

Wireless Technology: Development and Demand

In order to deploy advanced wireless technologies, telecommunications carriers, network operators, and their suppliers are seeking effective strategies to move to new standards, upgrade infrastructure, and develop software for new services. This migration path includes decisions about using spectrum.

Radio frequency (RF) spectrum is used for all wireless communications. It is managed by the Federal Communications Commission (FCC) for commercial and other non-federal uses and by the National Telecommunications and Information Administration (NTIA) for federal government use. International use is facilitated by numerous bilateral and multilateral agreements covering many aspects of usage, including mobile telephony.[1] Spectrum is segmented into bands of radio frequencies and typically measured in cycles per second, or hertz.[2]

Spectrum bandwidth is a finite resource that is infinitely re-usable. Commercial wireless communications typically rely on bandwidth below 3 GHz because of limitations in current technology. American competitiveness in advanced wireless technology may be constrained by the limited amount of exploitable bandwidth that is available. This constraint is both specific, in the inherent finiteness of useful spectrum, and relative, in comparison to the amount of spectrum available for commercial use in other countries. Developments in technology have in the past facilitated the more efficient use of bandwidth within a given portion of the spectrum. New technologies, such as Software-Defined Radio (SDR) and "smart" antennae for terrestrial wireless, are being explored and implemented to increase the efficiency of spectrum and to expand its usable range. Nonetheless, there is persistent demand for spectrum to carry new services.

Mobile Telephony. Mobile communications became generally available to businesses and consumers in the 1980s. This "first generation" technology, still in use, is analog, the prevailing telecommunications technology of the time. Second generation (2G) wireless devices are characterized by digitized delivery systems that provide qualitatively better delivery of voice and small amounts of data, such as caller ID. The next major advance in mobile technology is referred to as the third generation (3G) because it represents significant advances over the analog and digital services that characterize current cellular phone technology. A dramatic increase in communications speed is the most important technical feature of 3G.[3] Fourth-generation (4G) networks in development are expected to deliver wireless connectivity at speeds up to 20 times faster than 3G.

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[1] The International Telecommunication Union (ITU), part of the United Nations, is the primary organization for coordinating global telecommunications and spectrum management.

[2] One million hertz = 1 megahertz (MHz); 1 billion hertz = 1 gigahertz (GHz).

[3] The FCC identifies key service attributes and capabilities of 3G as the following: capability to support circuit and packet data at high bit rates; interoperability and roaming; common billing and user profiles; capability to determine and report geographic position of mobiles; support of multimedia services; and capabilities such as "bandwidth on demand." [http://www.fcc.gov/3G/]. Viewed January 3, 2006.

Wireless communications services have grown significantly worldwide, and explosively in some countries. Consumer demand for wireless telephony in the United States has soared in recent years, totaling over 201 million mobile phone subscribers by the end of 2005.[4] In approximately the same time frame, use of the Internet has expanded dramatically from an arcane tool for specialized research to a popularized, user-friendly service providing near instant access to information and entertainment. Wireless Internet and other broadband applications are widely expected to redefine how computers are used in the future. 3G technologies bring the wireless Internet revolution to cell phones. Business and consumer demand for new, advanced wireless services — including 3G and Local Area Networks (LANs), such as those using Wi-Fi (wireless fidelity) — is considered by many to be an engine for future growth in American and global economies. The Internet Corporation for Assigned Names and Numbers (ICANN) has approved the creation of a ".mobi" domain to join more familiar Internet address extensions such as ".com" and ".net." The new extension will be used at first to designate Internet material that has been specifically formatted for viewing on a mobile device.[5]

Third-generation and future developments in wireless technology will be able to support many services for business and consumer markets, such as: enhanced Internet links, digital television and radio broadcast reception, high-quality streaming video, and mobile commerce (m-commerce) — including the ability to make payments. Future generations of technology will be able to carry more data, and carry it farther and faster than is available in services today. Better technology makes mobile communications more mobile. As the ability to send high-grade signals greater distances improves, so does the opportunity to tap new markets, with less investment in supporting infrastructure, such as towers.[6]

Wi-Fi and WiMAX. Wireless Local Area Networks (W-LANs) operate on unlicenced spectrum, using radio frequencies in the free 2.4 GHz and 5.4/5.7GHz spectrum bands. A group of standards for frequency use in these bands is known as the 802.11 family. The 802.11b standard is currently the most widely used and is commonly referred to as Wi-Fi, for wireless fidelity. Wi-Fi provides high-speed Internet access for personal computers and Personal Digital Assistants (PDAs) and is also widely used by businesses to link computer-based communications within a local area. Links are connected to a high-speed wireline (landline) either at a business location or through HotSpots. HotSpots are typically located in homes or convenient public locations, including many airports and café environments such as Starbucks. Another standard for wireless Internet is Bluetooth, which has a shorter range than Wi-Fi but works well in cell phones. Bluetooth handles both voice and data; Wi-Fi is mostly data but also supports Voice over Internet protocol (VoIP) calls, sometimes known as VoWiFi.

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[4] Statistic updated regularly at [http://www.ctia.org/].

[5] "ICANN Concludes 23rd Annual Meeting with Action on Domain Name Security and Global Addressing Policy" at [http://www.icann.org/announcements/announcement-18jul05.htm], dated July 18, 2005. Viewed January 3, 2006.

[6] For an in-depth study of wireless broadband, see *Connected on the Go: Broadband Goes Wireless,* Wireless Broadband Access Task Force, Federal Communications Commission, February 2005 at [http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-257247A1.pdf]. Viewed January 3, 2006.

WiMAX (Worldwide Interoperability for Microwave Access) is both a technology and an industry standard, the work of an industry coalition of network and equipment suppliers[7] that have agreed to develop interoperable broadband wireless based on a common standard (IEEE 802.16) for point-to-point transmissions. WiMAX technology can transmit data over distances of up to 30 miles and is being tested in the United States as a "last mile" technology, that is, a means to provide fixed wireless service to locations that are not connected to networks by cable or high-speed wires. Mobile WiMAX is still in the early stages of development.[8] WiMAX uses multiple frequencies around the world in ranges from 700 MHz to 66 GHz. In the United States, frequencies where WiMAX is being tested include 700 MHz, 1.9 GHz, 2.3 GHz, 2.5 GHz and 2.7 GHz.

Municipal Deployment of Broadband

The Telecommunications Act of 1996 was intended, among other purposes, to foster and encourage competition among providers of telecommunications services. In the act, Congress barred states from "prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service."[9] Responding to lobbying efforts by telecommunications companies, several states have passed laws prohibiting or limiting local governments' ability to provide telecommunications services. An effort to challenge such a law in Missouri by municipalities offering local communications services in the state was heard before the U.S. Supreme Court in 2004.[10] The Court ruled that "entity" was not specific enough to include state political divisions; if Congress wished specifically to protect both public and private entities, they could do so by amending the language of the law. This decision and the steady improvement in broadband communications technologies that municipalities wish to have available in their communities have provided fuel for a policy debate about access to broadband services. The central debate is whether municipal broadband services are part of essential infrastructure — like electrical power or water — with many benefits, including stimulus to the local economy, or whether they provide unfair competition that distorts the marketplace and discourages commercial companies from investing in broadband technologies.

The two main broadband technologies that are particularly attractive to communities, in part because they support existing community services such as Internet access for schools and communications for public safety, are fiber-optic cable networks and wireless access — WiFi today, possibly WiMAX in the future. The spread of wireless services such as access to the Internet and anticipated advances in wireless technology are

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[7] Founding members of the WiMAX Forum include Airspan, Alvarion, Analog Devices, Aperto Networks, Ensemble Communications, Fujitsu, Intel, Nokia, Proxim, and Wi-LAN. For additional information, see [http://www.wimaxforum.org/].

[8] A global standard for mobile WiMAX, 802.16e has been established by the IEEE 802.16 Working Group; for a detailed discussion of standards see "Fixed, nomadic, portable and mobile applications for 802.16-2004 and 802.16e WiMAX networks," November 2005 at [http://www.wimaxforum.org/news/downloads/Applications_for_802.16-2004_and_802.16e_WiMAX_networks_final.pdf]. Viewed January 3, 2006.

[9] 47 U.S.C. 253 (a).

[10] U.S. Supreme Court, Docket Number 02-1238.

modifying the business case for broadband. Networks that depend on a fiber-optic cable backbone are capital-intensive and usually most profitable in high-density urban areas. A number of rural communities have used their resources to install fiber-optic broadband services in part because they were too small a market to interest for-profit companies.

The technologies for Wi-Fi and WiMAX today cost less and have a wider geographic reach than cable, broadening the size of potential markets for broadband. Therefore, although the arguments pro and con about the municipal provision of broadband apply generally to all types of broadband services, it is the long-term profit potential of Wi-Fi and its successor technologies that are apparently spurring commercial wireless service providers to lobby against municipal competition. In particular, the fact that urban areas are creating Wi-Fi networks and providing, among other services, free wireless links to the Internet is viewed as a threat to commercial companies and a form of unfair competition. Municipalities around the world have installed free Wi-Fi zones. Cities in the United States that have Wi-Fi zones include New York and Chicago; Philadelphia and San Francisco are implementing plans for citywide coverage. The cities argue that generally available access to the Internet through wireless connections has become an urban amenity, arguably a necessity in sustaining and developing the local economy. Municipal Wi-Fi also provides the opportunity to improve social services and Internet access in disadvantaged communities that often are not served by fiber optic networks. The debate about public-sector provision of what some consider to be a private-sector service is expected to continue. Increasingly, Congress can expect pressure from advocates from both sides to clarify the language of the Communications Act or to take some other action that addresses the issue.

Unlicensed Spectrum

Unlicensed spectrum is not sold to the highest bidder and used for the services chosen by the license-holder but is instead accessible to anyone using wireless equipment certified by the FCC for those frequencies. Among the advantages of unlicensed spectrum is the opportunity to test new technology directly with consumers instead of going through spectrum license-holders. One of the disadvantages of unlicensed spectrum is the possibility of interference among the transmissions of the various users, both within the assigned bandwidth and with other bandwidths. Currently, there are no commercial applications for WiMAX using unlicensed spectrum. The cost of developing WiMAX applications for unlicensed use could impact its adaptation by municipalities seeking to provide wireless broadband services.

Some advocates for unlicensed spectrum would like to see spectrum set aside in the 700 MHz band, where channels will be released by television broadcasters as they move from analog to digital transmission. An alternative proposal for providing unlicensed spectrum as part of the DTV transition is to designate so-called "white spaces" among the new digital TV channels. To avoid interference among TV station broadcasts, channels are assigned in one market area and left vacant in adjoining areas. For example, channel 7 is used in the New York City area and in the Washington, DC area, but not in Baltimore. In Baltimore, spectrum designated for channel 7 is vacant and could be used for unlicensed purposes. Beginning in May 2004, the FCC requested comment on proposals for considering the use of spectrum in television broadcast bands (Docket No. 04-186) but has yet to reach a decision. Representatives of the televison broadcast

industry have filed comments containing engineering studies that suggest harmful interference would occur; other studies suggest no significant interference would occur.

Policy Considerations in the 109th Congress

The continued growth in demand for bandwidth for private and public sector use is one of the factors prompting Congress to review the policies and laws that guide the allocation and management of spectrum. A number of bills have been presented in the 109th Congress that deal with wireless broadband and spectrum use. The Preserving Innovation in Telecom Act (H.R. 2726, Representative Sessions) would amend the Communications Act of 1934 to prohibit states and local governments from providing telecommunications, information services, or cable in any geographic area in which a similar service is offered by a private sector company. The Community Broadband Act of 2005 (S. 1294, Senator Lautenberg) would amend the Communications Act to specifically permit local governments to provide advanced telecommunications access. The Broadband Investment and Consumer Choice Act (S. 1504, Senator Ensign) is a broad-based bill that addresses the impact of new technologies, such as broadband, on telecommunications competition. It includes a section (Section 15) that would require a stringent competitive bidding process for state and local governments seeking to provide communications services. Public notice would be required for proposed projects that would include such components as the cost, services, coverage, and any advantages that would accrue to the government sponsor, such as free access to rights-of-way or preferential tax treatment. Non-governmental entities would be able to submit competitive bids that would benefit from the same advantages allowed government bidders. The Digital Age Communications Act of 2005 (S. 2113, Senator DeMint) is one of several bills oriented toward telecommunications law reform. In addition to addressing issues such as the Universal Service Fund and state franchises of cable and other video services, the bill would bar states from engaging in unfair competition with commercial providers of communications service. It would empower the FCC to establish the criteria for determining unfair competition and to enforce the rules.[11] A bill (S. 2332, Senator Stevens) would amend the Communications Act to provide that certain "unused television broadcast spectrum" could be used for unlicensed purposes, "including wireless broadband devices;" the bill specifies that the spectrum covered are available channels in 72 - 698 MHz, except for channels within 608 - 614 MHz. The bill, the American Broadband for Communications Act, also specifies the rules that the FCC would establish to prevent interference to licensed (TV) channels. S. 2327 (Senator Allen), the Wireless Innovation Act, would require the FCC to complete Docket No. 04-186 and, at a minimum, permit unlicensed use of unassigned channels in 54 - 698 MHz and establish the rules to prevent interference between licensed and unlicensed users.

[11] S. 2113, Sec. 102 et seq.