Order Code RS20993
Updated April 2, 2007

CRS Report for Congress

Wireless Technology and Spectrum Demand: Advanced Wireless Services

Linda K. Moore
Analyst in Telecommunications and Technology Policy
Resources, Science, and Industry Division

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 (4G) mobile telephony. A related trend is the growth in use of Wi-Fi (wireless fidelity) and WiMAX (an industry designation for a type of broadband standard). Wi-Fi uses local wireless networks for high-speed (broadband) mobile access to the Internet. WiMAX uses broadband wireless to link fixed points and also supports mobile devices.

From the perspective of spectrum management, a significant difference in the technologies is that 3G, 4G, and WiMAX services operate on designated, licensed frequencies, while Wi-Fi shares unlicenced spectrum with other uses. From the perspective of spectrum policy, a key difference between licensed and unlicensed use is that the market for services over licensed frequencies is developed by the license-holder whereas demand for services on unlicensed frequencies is developed by the manufacturers of the devices. As the markets for Wi-Fi and WiMAX develop, policy issues before Congress include the competitive impact on commercial wireless carriers when municipalities offer wireless broadband services, promoting the development of broadband wireless access, and assuring the availability of appropriate spectrum. One proposal being suggested to the Federal Communications Commission and members of Congress is a national, wireless, broadband data service that would be built by M2Z.

Legislation includes S. 234 (Senator Kerry) and its companion bill H.R. 1597 (Representative Inslee), providing terms for the release of spectrum for unlicensed use in "white space"; S. 337 (Senator Sununu), providing terms for the release of spectrum for unlicensed or licensed use and addressing authority over the use of the spectrum in white space; and H.R.1320 (Representative Rush) prohibiting unlicensed devices of any kind in white space in rural areas until after February 17, 2009 and mobile devices until at least three years later. S. 291 (Senator Smith) and S. 315 (Senator Warner) are almost identical bills to strengthen the national digital and wireless infrastructure by supporting investment by certain minority-serving institutions; H.R. 694 (Representative Towns), would also establish these technology programs at minority-serving institutions.

Wireless Technology: Development and Demand

In order to deploy advanced wireless technologies, telecommunications carriers, broadcasters, cable companies, content providers and others are seeking effective strategies to move to new standards, upgrade infrastructure, and develop new services and content. This migration path includes decisions about acquiring and using spectrum. Spectrum 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]

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. Although developments in technology increase the efficiency of spectrum and expand its usable range, there is persistent demand for spectrum to carry new services as other technologies reach the market. New developments in wireless technology 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.

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. Third generation (3G) mobile technology 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 and 4G, and this increases capacity for broadband applications that include video and mobile (transportable) television.[3] Because they can transmit at high speeds, these leading-edge technologies support multi-function devices, such as the BlackBerry and the IPhone.

---

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

[2] Electromagnetic radio waves are usually identified by frequency. Standard abbreviations for measuring frequencies include kHz — kilohertz or thousands of hertz; MHz — megahertz, or millions of hertz; and GHz — gigahertz, or billions of hertz.

[3] Broadband refers to the capacity of the radio frequency channel. A broadband channel can transmit live video, complex graphics and other data-rich information as well as voice and text messages whereas a narrowband channel might be limited to handling voice, text and some graphics. 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 11, 2007.

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 230 million mobile phone subscribers in January 2007.[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. Advanced technologies bring the wireless Internet revolution to cell phones. Business and consumer demand for mobile services is considered by many to be an important engine for future growth in American and global economies. The Internet Corporation for Assigned Names and Numbers (ICANN) has approved the creation of a "dotmobi" domain to join more familiar Internet address extensions such as ".com" and ".net." The new extension designates Internet material that has been formatted for viewing on a mobile device.[5]

Wi-Fi and WiMAX. Wireless Local Area Networks (WLANs) 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 802.11 standards are commonly referred to as Wi-Fi, for wireless fidelity. Wi-Fi provides high-speed Internet access for personal computers and devices such as Personal Digital Assistants (PDAs) and is also 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.

WiMAX (Worldwide Interoperability for Microwave Access) refers to both a technology and an industry standard, the work of an industry coalition of network and equipment suppliers[6] 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 used 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.[7] 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 or used include 700 MHz, 1.9 GHz, 2.3 GHz, 2.5 GHz and

---

[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 12, 2007.

[6] 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/].

[7] A global standard for mobile WiMAX, 802.16e has been established by the IEEE 802.16 Working Group; documentation is at [http://www.wimaxforum.org/technology/documents/]. Viewed January 4, 2007.

2.7 GHz. Not later than January 28, the FCC must hold auctions of 60 MHz of spectrum at 700 MHz.[8] The technologies and services chosen for this spectrum by the winning bidders could have a significant impact on for mobile devices in the United States.

Transportable Television. Some technologies use terrestrial links to bring broadcast television transmissions from satellites to cell phones. Frequencies that are being used include 1.5 GHz, 2.2 GHz and 2.5GHz. In the United States, Qualcomm and Intel are among the companies developing 4G technologies that include TV broadcasts to mobiles. Qualcomm provides a proprietary technology called MediaFlo that is being incorporated into next-generation mobile services from AT&T and Verizon Wireless. U.S. standards that would support broadcasting to mobile or handheld TV are A-VSB and — being developed by ATSC[9] — a standard based on digital TV. In Europe, handset manufacturer Nokia supports the mobile TV standard DVB-H, which uses broadcast spectrum.

Broadband Wireless Access to the Internet

As demand for Internet services grows, policymakers at all levels of government are seeking ways to make access (especially broadband access) to the Internet available to all. As wireless technologies have improved, they have become a popular option for deploying municipal broadband, especially to disadvantaged sectors of a community. Successive Congresses have seen the introduction of bills supporting programs to bridge what is often called the digital divide, the inequality of access to the Internet because of technical or economic constraints.[10]

Municipal Deployment of Broadband. 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 modifying the business case for choosing a broadband technology. Networks that depend on a fiber-optic cable backbone are capital-intensive and usually more 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. Increasingly, communities are looking at wireless technologies to support their networks.

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.[11] In the Telecommunications Act of 1996t, Congress barred states from "prohibiting the ability of any entity to provide any interstate or intrastate

---

[8] P.L. 109-171, Sec. 3o03 (a).

[9] Advanced Television Systems Committee, Inc., at [http://www.atsc.org/guide_default.html].

[10] For further information, see CRS Report RL30719, *Broadband Internet Access and the Digital Divide: Federal Assistance Programs*, by Lennard G. Kruger and Angele A. Gilroy.

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

telecommunications service."[12] 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 with many public 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. 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 installing free Wi-Fi zones often contend 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 Federal Trade Commissions' Internet Access Task Force has published a report discussing many aspects of municipal broadband implementation and related issues.[13]

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. New technologies that can use unlicensed spectrum without causing interference are proposed for vacant spectrum designated to provide space between the broadcasting signals of digital television, known as white space. On September 11, 2006, the FCC announced a timetable for allowing access to the spectrum so that devices could be developed and ready for retail sales by February 2009.[14] One of the potential uses for white space is wireless broadband to support access to the Internet.[15]

M2Z Networks. Another approach for using wireless technology to provide broadband has been proposed by M2Z Networks. The company is petitioning the FCC to cede 20 MHz of unpaired spectrum[16] in unused spectrum at 2.155 GHz so that it can build a national wireless network that would offer basic access to the Internet for free.[17]

---

[12] 47 U.S.C. 253 (a).

[13] At [http://www.ftc.gov/opa/2006/10/muniwireless.htm]. Viewed January 23, 2007.

[14] FCC, *First Report and Order and Further Notice of Proposed Rule Making*, ET Docket No. 04-186, released October 18, 2006.

[15] "Tech Firms Push to Use TV Airwaves for Internet," by Charles Babington, *The Washington Post*, March 13, 2007.

[16] Paired spectrum provides separate frequencies for transmitting and receiving. Unpaired spectrum uses a single frequency.

[17] See [http://www.m2znetworks.com/].

Fair Access. In recent Congresses, bills have been proposed to improve access to the Internet that have focused on overcoming technological or economic barriers that excluded some sectors of the population. In the 109th Congress, the policy debate expanded to include the concept of net neutrality. In general, net neutrality is the principle of non-discriminatory access by all website providers to all Internet users, with no artificial barriers.[18] The role of wireless technologies in enhancing competition or side-stepping regulations governing the Internet is an aspect on the net neutrality debate that has not been fully engaged by Congress. Some observers are asking if there should be a "wireless exception" in net neutrality laws and regulations or whether net neutrality laws can be written that apply to wireless services. One proposal to develop network neutrality regulations or laws for wireless networks argues that requirements for neutrality are essential for wireless services, which are often linked to proprietary technologies.[19]

Bills in the 110th Congress

Bills to increase the availability of unlicensed spectrum for community broadband are H.R. 1597, S. 234 and S. 337. The Wireless Innovation Act of 2007 (S. 234, Senator Kerry) would require the FCC to complete Docket 04-186 and issue a final order, among other requirements, within 180 days of the bill becoming law. H.R. 1597 (Representative Inslee) is a companion bill. The White Spaces Act (S. 337, Senator Sununu) would provide terms for the release of white space spectrum for unlicensed or licensed use, prohibit the FCC from banning the marketing of technologies that work on the white space, and address uncertainty stemming from legal proceedings regarding authority over the use of the spectrum, among other uses. The Interference Protection for Existing Television Band Devices Act (H.R. 1320, Representative Rush) would prohibit the use of unlicensed devices of any kind in white space in rural areas until after February 17, 2009 and of mobile devices until at least three years later. In particular, unlicensed devices would not be allowed to operate on channels already in use by low-power auxiliary television broadcast devices and the FCC would be required to seek additional way to protect these broadcasts from interference by unlicensed devices.

Bills to improve access to digital and wireless services are S. 291, S. 315 and H.R. 694. All three bills would provide grants to strengthen the national digital and wireless infrastructure by supporting investment in minority-serving institutions. S. 291 (Senator Smith) and S. 315 (Senator Warner) would establish a new office within the National Science Foundation. Similar goals for technology programs appear in H.R. 694 (Representative Towns), but would be achieved by adding a program to existing technology programs at the Department of Commerce (15 U.S.C. 3704).

---

[18] A discussion of net neutrality and issues facing the 110th Congress is provided in CRS Report RS22444, *Net Neutrality: Background and Issues,* by Angele A. Gilroy.

[19] Wireless Net Neutrality: Cellular *Carterfone* on Mobile Neyworks, by Tim Wu, February 2007. At [http://papers.ssrn.com/sol3/papers.cfm?abstract_id=962027]. Viewed February 27, 2007.