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Wireless Technology and Spectrum Demand: Third Generation (3G) and Beyond

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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 a third generation (3G) of mobile telephony. The defining feature of 3G technology is that transmission speeds are significantly faster than prevailing technology.

A related trend is the growth in use of Wi-Fi (wireless fidelity); these are localized wireless networks providing high-speed access to the Internet. Whereas 3G could be described as bringing Internet capabilities to wireless mobile phones, Wi-Fi provides wireless Internet access for portable computers and handheld devices, such as Personal Digital Assistants. The two 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 between the two technologies is that 3G services operate on designated frequencies licensed by the Federal Communications Commission (FCC), while Wi-Fi shares unlicenced spectrum with other technologies. Providers of the two technologies share in common the concern that there is insufficient spectrum available for their services to be developed to full market potential.

Industry experts have noted that more efficient uses of spectrum must be developed to meet future demand. The U.S. Congress and federal government departments and agencies are examining the impact that new technology will have on bandwidth demand and spectrum allocation, prompting Congress to review the policies and laws that guide spectrum management. Legislation, supported by the Administration, has been introduced that would make it easier for government agencies to relinquish spectrum to private wireless carriers for use in providing 3G and other services (H.R. 1320, Representative Upton and S. 865, Senator McCain).

This report will be updated.

Wireless Technology: Development and Demand

In order to deploy third-generation (3G) and other advanced wireless technologies, telecommunications carriers 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. Spectrum is segmented into bands of radio frequencies and typically measured in cycles per second, or hertz.[1]

Spectrum bandwidth is a finite resource that is infinitely re-usable. Commercial wireless communications currently rely on bandwidth within a narrow range.[2] 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.

Technology Development. 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]

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 164 million mobile phone subscribers in

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

[2] The FCC limits consideration of bandwidth available for 3G to frequencies below 3 GHz.

[3] The Federal Communications Commission (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." 3G speeds are: 144 kilobits per second at vehicular traffic speeds; 384 kilobits for pedestrian traffic; 2 megabits or higher for indoor traffic, [http://www.fcc.gov/3G]. (Visited May 27, 2004.)

May 2004.[4] In approximately the same time frame, use of the Internet 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 is 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.

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, mobile intranet/extranet, mobile commerce (m-commerce)—including the ability to make payments—"always on" capabilities, high-quality streaming video and location-identification. In the United States, location-finder technology for existing cellular phones is being introduced through the nationwide wireless enhanced 911 (E911) program.[5]

Public Policy and 3G

International Agreements on 3G. International agreements that coordinate and enable global telecommunications are negotiated under the aegis of the International Telecommunication Union (ITU), a specialized agency of the United Nations. Delegates to the ITU World Radio Conference in 2000 (WRC-2000) agreed that harmonized worldwide bands for advanced commercial wireless services were desirable in order to achieve global roaming and economies of scale. Resolutions voted by delegates of WRC-2000 encouraged nations to make available some part of one or more of the three spectrum bands identified in committee (806-960 MHZ, 1710-1885 MHZ, and 2500-2690 MHZ) for use as harmonized spectrum. In the United States, most of the frequencies within these bands had been allocated for other uses, requiring reassignment and relocation in order to provide harmonized spectrum to meet WRC accords.

Harmonized Spectrum. The applications of wireless technology are tied to spectrum. Infrastructure, such as towers, relay stations, and handsets, must be able to provide communications along pre-designated frequencies. A benefit of harmonization is to provide common bands of spectrum dedicated to 3G technology worldwide. This makes it easier for carriers to cover large geographical areas and for the telecommunications industry to develop 3G hardware and software. Many industry observers, however, believe that WRC-2000 did not evaluate the practical considerations of achieving global roaming capabilities and economies of scale through harmonization. They argue that countries like China and Brazil are using spectrum to develop 3G technology in bandwidths not covered by the WRC-2000 resolution, and that global roaming exists today without the benefit of harmonized spectrum.

Policy Decisions in the United States. Following WRC-2000, President Clinton directed the Secretary of Commerce to work with the FCC, in coordination with the NTIA, to prepare studies on allocating bandwidth for harmonized spectrum. In

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

[5] See CRS Report RS21028, *Emergency Communications: Wireless Enhanced 911 (E911) Issues Update*.

response, the NTIA and the FCC issued reports, respectively, on 1710-1850 MHZ and 2500-2690 MHZ use.[6]

FCC Actions. The report provided by the FCC covered spectrum used primarily by Fixed Service operators for Multipoint Distribution Service (MDS), Multichannel Multipoint Distribution Services (MMDS) and Instructional TV Fixed Service (ITFS). As part of the effort to provide additional spectrum for 3G and other new wireless technology, the FCC subsequently adopted a First Report and Order and Memorandum Opinion and Order[7] adding a mobile allocation to the 2500-2690 MHZ range. In March 2003, the FCC announced a Notice of Proposed Rulemaking that will probe alternative uses for underutilized portions of this spectrum. One of the announced objectives of the proposal is to promote broadband wireless.[8]

In line with the actions of the 3G planning group, the FCC allocated new spectrum for advanced wireless services, a category that includes but is not limited to 3G.[9] The spectrum bands are two blocks of 45 MHz each of contiguous spectrum at 1710-1755 MHz and 2110-2155 MHz. The 1700 MHz band spectrum is used primarily by federal agencies, including the DOD. Plans are for a rapid relocation of federal agencies other than the DOD from the 1710-1755 MHz band, with a slower relocation plan for frequencies used by the DOD. The speed and efficacy of this relocation will be impacted primarily by the ability to fund the costs of relocation. As part of its plan for relocation within the 2100 MHz band, the FCC is also looking at other bandwidths that might be freed for advanced wireless services.[10]

NTIA Actions and the Department of Defense. In its report, the NTIA divided the band into two segments: the 1710-1755 MHz band, already scheduled to be made available for commercial use,[11] and the 1755-1850 MHZ band occupied by the Department of Defense (DOD) and 13 other government agencies. In particular, the report addressed the issue of reallocating spectrum now used by the DOD. The DOD also issued a report on the subject with different conclusions than those of the NTIA.[12] The

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[6] "The Potential for Accommodating Third-generation Mobile Systems in the 1710-1850 MHz Band," Final Report, March 2001, U.S. Department of Commerce, NTIA [http://www.ntia.doc.gov/ntiahome/threeg/33001/3g33001.pdf]; and "Spectrum Study of the 2500-2690 MHz Band," Final Report, March 30, 2001, FCC, [http://www.fcc.gov/3G].

[7] FCC 01-256, September 6, 2001, September 24, 2001.

[8] Action by the FCC on March 13, 2002, by Notice of Proposed Rulemaking and Memorandum Opinion and Order (FCC03-56), FCC News Release, "FCC Initiates Proceeding to Facilitate Wireless Broadband in the 2500-2690 MHz Bands," March 13, 2003 [http://www.fcc.gov].

[9] FCC, *Second Report and Order*, ET Docket No. 00-258 (2002).

[10] FCC, Third Report and Order, *Third Notice of Proposed Rulemaking and Second Memorandum Opinion and Order*, ET Docket No. 00-258 (2003).

[11] The Omnibus Budget Reconciliation Act of 1993 (47 U.S.C. 927) directed the FCC to allocate frequencies from the 1710-1755 MHz band on a "mixed-use" basis.

[12] "Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band," 9 February 2000, DOD.

NTIA, DOD and others continue to study and debate Defense's use of spectrum and possible plans for migration from the 1755 - 1850 MHz band to other spectrum ranges.

Spectrum Relocation.[13] In October 2001 the NTIA announced that a new plan for the selection of 3G spectrum would be prepared with the FCC, the DOD and other Executive Branch agencies.[14] After receiving this and other interagency assessments, the FCC announced the allocation of additional spectrum for advanced wireless services.[15] In mid-2002, the Department of Commerce circulated draft legislation that proposed the creation of a Spectrum Relocation Fund. This would make it possible for federal agencies to recover relocation costs when they are required to vacate spectrum slated for commercial auction. Previously, the Strom Thurmond National Defense Authorization Act of 1999 (P.L.105-261) authorized agencies to accept compensation payments when they relocate or modify frequency use in order to accommodate non-federal users. It authorized the NTIA and FCC to develop procedures for this. The NTIA subsequently ruled that agencies must submit detailed estimates of costs. The FCC suggested that these estimates be included in the auction process for the relevant spectrum; in effect, commercial bidders would be covering the costs of relocation. The Communications Act of 1934 would need to be modified to permit the agencies access to auction funds, even if part of the proceeds have been earmarked for their use. A bill (H.R. 1320, Commercial Spectrum Enhancement Act) introduced in the House on March 18, 2003 called for the creation of a Spectrum Relocation Fund. It was approved by the House Committee of Energy and Commerce on April 30 with an amendment to clarify that federal spectrum could be transferred for non-commercial uses, such as public safety, and for uses where spectrum is not now auctioned, such as unlicenced spectrum. The bill was passed by the House on June 11, 2003. The bill was passed, with an amendment, in mark up by the Senate Committee on Commerce, Science and Transportation on June 26. The addition of a controversial amendment that could benefit Northpoint Communications reportedly could harm the bill's chances for passage by the Senate.[16] Reportedly, the Acting Director of the NTIA, Michael Gallagher, has written to Vice President Richard B. Cheney suggesting that the passage of the Commercial Spectrum Enhancement Act would spur the development of 3G. He is quoted as saying in the letter that the NTIA "would not support such an action until identification of alternative frequencies for the affected federal systems has been completed."[17]

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[13] See also CRS Report RS21508 *Spectrum Management: Special Funds.*

[14] An Intra-Government 3G Planning Group (IG3GPG) was created, comprising the NTIA, the FCC, DOD, the Office of Management and Budget, the Office of Science and Technology Policy, and the Department of State.

[15] FCC News Release, "FCC Allocates Spectrum for Advanced Wireless Service and Proposes Licensing and Service Rules," November 7, 2002 [http://www.fcc.gov].

[16] National Journal's CongressDaily (AM Edition), "Administration Disapproves of Northpoint Funding Language," November 11, 2003.

[17] "Gallagher Recommends Govt Actions to Forward 3G Deployment," TELECOM A.M., (Today's News), April 23, 2004.

Wi-Fi

Wireless Local Area Networks (W-LANs) operate on unlicenced spectrum, using radio frequencies in the free 2.4 GHz and 5.4 GHz 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 small area. The current operating radius for Wi-Fi is 300-350 feet. 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 only, with some use of Voice over Internet Protocols (VoIP). Many industry experts predict that Wi-Fi and its successor technologies will be the primary link for wireless Internet, while 3G mobile phones and Bluetooth-enabled PDAs will provide other services.[18] Legislation was introduced in the 108th Congress (S. 159) that would require the FCC to allocate "not less than an additional 255 megahertz of contiguous spectrum" in the 5 GHz band. In response, the FCC has provided 255 MHz of spectrum between 5.47-5.725 GHz, adjacent to one of the frequency bands now used by Wi-Fi.[19]

Conclusion

The continued growth in demand for bandwidth for private and public sector use has prompted Congress to review the policies and laws that guide the management of this resource. Some future legislative initiatives regarding spectrum policy might be influenced by the formation of a Spectrum Policy Initiative by President George W. Bush.[20] Among the issues are consideration of the law, policies and rulings for spectrum allocation that will best meet the sometimes conflicting objectives of protecting consumers, fostering new technology, encouraging efficiency, bolstering international competitiveness, and promoting competition, fairness, and access in domestic markets.

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[18] Financial Times, "Wi-Fi and 3G; cheaper, faster and actually here," March 12, 2003.

[19] FCC, "Revision . . . of Rules to Permit Unlicenced . . . Devices in the 5 GHz Band," Docket No. 03-122, released November 18, 2003.

[20] By Executive Memorandum, June 5, 2003 [http://www.whitehouse.gov/news/releases/2003/06/20030605-5.html]. (Viewed May 27, 2004.)