

# The Coming Spectrum Explosion— A Regulatory and Business Primer

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Wireless communications capacity, long considered a scarce resource, will soon become much more abundant in the United States. Enough new spectrum may become available by 2006 to completely change industry economics, especially for popular mobile telephony and wireless Internet services. This decade's spectrum explosion, like the fiber-optic boom in the last, will trigger major changes in the way services are priced and marketed, leading to the demise of old business models and the rise of new ones.

Although prices will tend to fall, not all spectrum is alike and licenses for frequencies with the most desirable propagation characteristics (e.g., mobile services or broadcasting) will continue to have value. Within a decade, the spectrum explosion will have a profound economic impact, the speed and scope of which will depend significantly on how service providers and investors react.

This article offers an introductory regulatory and business primer to this new reality. First, it examines the sources of the spectrum explosion. Second, it discusses the accelerating trend toward private sector spectrum management. Third, it sketches some consequences of these changes for various industry players. Finally, it presents various legal and political hurdles to regulatory action.

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For simplicity, throughout this article we refer to "spectrum" in its common usage as a finite resource. However, as the FCC's Spectrum Policy Task Force stated last year, it is *access* to wireless communications capacity that is the critical bottleneck, not the amount of spectrum itself. Some of the changes we describe even call into question the need to ration spectrum by allocating fixed blocks of frequencies through a traditional "command-and-control" regulatory process.

## *Sources of New Spectrum*

More spectrum will enter the market from four main sources. First, the FCC will license additional spectrum. Second, much new spectrum will become available on an unlicensed basis. Third, the FCC decided in May 2003 to permit many incumbent licensees to lease and perhaps ultimately resell or trade their spectrum via secondary markets. Finally, the federal government is exploring novel approaches to free more spectrum.

## *Licensed Spectrum*

The expansion of licensed spectrum, most of which will be auctioned to the highest bidder for flexible use, reflects various factors, such as TV stations' transition to digital transmission and the licensing of several new satellite, video, and Internet access services. In all, FCC actions to expand licensed spectrum may increase the available spectrum for video services by over 1500 MHz—enough to distribute hundreds of new channels of TV programming. During the same period, spectrum for mobile wireless services may increase by at least 300 MHz with ten or more new terrestrial licenses available in most areas.

## *Mobile Wireless Spectrum*

Between 1985 and 2000, the FCC licensed approximately 195 MHz of spectrum for analog cellular telephony, digital PCS, and commercial dispatch services, known as Specialized Mobile Radio. Licensees in these bands now offer virtually the same

suite of mobile services with six national operators (Cingular, Verizon, AT&T Wireless, Sprint PCS, T-Mobile, and Nextel) controlling most of the spectrum. Together with various regional providers, these carriers serve over 140 million subscribers.

Since 2000, the booming demand for mobile communications has spurred the FCC to add approximately 300 MHz of new spectrum for cellular and 3rd Generation (3G) Advanced Wireless Services. That is six times the spectrum initially licensed for cellular telephony in the 1980s.

The bulk of the new 3G spectrum—120 MHz—stems from two hotly contested decisions regarding spectrum in the 1.7 and 2.1 GHz bands. Another 130 MHz (or more) of spectrum is now available for broadband mobile services in the 2.5–2.7 GHz band as a result of the FCC's 2001 decision to authorize existing wireless cable or Multichannel Multipoint Distribution Service (MMDS) and instructional TV (ITFS) licensees to use all of their spectrum to serve mobile devices as well as fixed locations.

## *Satellite Services*

Between 1999 and 2001, the FCC authorized more than a dozen new high-powered satellite systems to use at least 500 to 1000 MHz of spectrum for broadband video and data services in the Ka band (at 17.7–20.2 GHz). In 2004, the FCC is expected to auction four new Direct Broadcasting Satellite (DBS) licenses, mostly covering the western United States, with a total of approximately 100 new satellite program channels, each of which can carry up to ten video services. The FCC has also allocated 40 MHz of spectrum in the 2 GHz band for a new mobile satellite service.

Over the next few years, U.S. consumers will also have access to a substantial pool of additional satellite spectrum as the FCC continues to authorize foreign licensed satellite operators to use their spectrum to offer mobile and broadband services in the United States.

The United States agreed to provide market access to satellite telecommunications services licensed by the World Trade Organization member states as part of its commitment under the 1997 WTO Basic Telecom Agreement.

Citing the need for more competition, the FCC recently went even further by authorizing the use of two Canadian satellites to provide new DBS services in the United States even though such services are not now covered by the WTO agreement.

### **Wireless Cable and Video Distribution Services**

The FCC has taken steps to spur new investment in two other large blocks of licensed spectrum, to provide broadband data and video services, such as pay TV and Internet access. Most significantly, perhaps, in April 2002, the FCC affirmed its decision to authorize a terrestrial Multichannel Video Distribution and Data Service on the 500 MHz of Ku band spectrum (12.2–12.7 GHz) currently used by the DBS service. The FCC said that this new service, primarily intended for point-to-multipoint, high-speed video systems, would not interfere with existing DBS operators and could be used, like a wireless cable network, to distribute multiple TV channels.

In March 2003, the FCC proposed a new band plan to facilitate more extensive use of the 190 MHz of spectrum already allocated to the MMDS and ITFS. Current MMDS operators believe that a new generation of plug-and-play receivers that do not require a clear line of sight to the base transmitter will make the wireless cable offerings of MMDS a real competitor to other multichannel video distribution networks (such as cable TV and DBS).

### **Satellite Radio**

To create the Satellite Digital Audio Radio Service (SDARS), a comparatively small amount of spectrum (12.5 MHz) was awarded to each of two licensees, now known as XM Radio and Sirius. Both companies began to roll out service in 2002. With each MHz of SDARS spectrum able to deliver at least ten channels of CD quality music across the United States, the radio business will be transformed.

### **Broadcast Spectrum**

The approaching shift of local advertiser-supported TV broadcasters from an analog to a digital transmission format will augment the increase in licensed bandwidth for satellite and terrestrial pay TV systems. Under current legislation, specifically § 309(j)(14) of the Communications Act, TV broadcasters are required to begin digital TV (DTV) broadcasts on a core group of 6 MHz channels (2–51) in 2002 and 2003. The law requires analog programs to be phased out by January 1, 2007, or the date on which 85 percent of viewers have access to digital signals, thus freeing the existing UHF channels (52–69) for other services. Although the total amount of spectrum occupied by local broadcasters will shrink, the digital transmission standards adopted by the FCC create the potential for a 400 percent increase in the program-carrying capacity of the remaining spectrum—that is, each new DTV channel may be able to multicast up to five channels of standard TV programs or two high-definition TV streams.

Once the transition to DTV is complete—and it could extend well beyond 2006 in some markets—a city with five or six local TV outlets could have access to twenty or more additional over-the-air program services. Some of these new channels may be offered only on a subscription basis. In addition, consumer access to some new DTV services may be limited because most TV viewers now receive local broadcast channels via cable or DBS, and the FCC has yet to decide upon the obligations, if any, these systems will have to retransmit all local DTV program service.

In 2000 and 2001, the FCC reallocated 84 MHz of spectrum in the 700 MHz band now used by television UHF channels 52–69. Incumbent broadcasters are to be relocated to channels 2–51 as part of a congressionally mandated transition to digital transmission for all TV stations. The auction of lower 700 MHz licenses began in 2002, but bidding was light, except for rural areas, because of the Communications Act. In the absence of a voluntary band-clearing agreement, as noted above, the law permits UHF broadcasters to continue using their existing channels until January 1, 2007, or until 85 percent of the viewers in their local service area have sets that can receive digital TV signals.

### **Unlicensed Spectrum**

Perhaps no area of communications has attracted more interest over the past two years than unlicensed wireless. Much of the spectrum dedicated for unlicensed devices has been available for years. Until recently, though, it was generally used for rather mundane applications (cordless phones, medical sensors). WiFi—a trade name for the IEEE 802.11 technical standards for wireless local networks—enables unlicensed wireless high-speed data connections within approximately 300 feet of an inexpensive access point. Since 2000, the market demand for wireless local area network equipment has been extraordinary. In response, the FCC has launched several new dockets to expand the spectrum available for unlicensed uses, with additional proposals under active consideration.

### **Two Classes of Unlicensed Devices**

Prior to 2002, the FCC had authorized two broad classes of unlicensed devices. Under Part 15 of the agency's rules, intentional radiators may operate anywhere in the radio spectrum except where prohibited for security or other public-interest reasons. Such devices must operate with such low power that they cannot interfere with licensed services. This limits them to short-range, low-bandwidth applications, but that still includes a substantial market for devices such as garage door openers, cordless phones, wireless microphones, and retail antitheft sensors.

The second category of unlicensed devices is limited to defined frequency bands, but within those bands, Part 15 allows more flexibility for higher-capacity services. In this category are the spread-spectrum bands in the 900 MHz and 2.4 GHz range, the Unlicensed—National Information Infrastructure (U-NII) bands in the 5 GHz range, unlicensed PCS bands at 1.9 and 2.3 GHz, and millimeter wave bands at 57–64 GHz.

### **New Technologies and Services**

The phenomenal growth in the market for unlicensed devices since 1999 has largely occurred not because the government has allocated new spectrum, but as a result of business-driven technical innovation. WiFi devices take advantage of the preexisting spread-spectrum and U-NII rules for the 2.4

and 5 GHz bands. Through a combination of standardization, rapidly falling costs, and market demand resulting from the proliferation of the Internet and broadband networks, WiFi devices have become a major success story. WLAN sales rose to \$2 billion in 2002, with a majority of that being WiFi gear, and growth continues at a rapid pace. By 2005, for example, 95 percent of laptop computers will likely have built-in WiFi connections.

The WiFi market is also diversifying. A new group of carrier-class service providers such as Boingo, Wayport, and Cometa are deploying local hot spots in high-traffic areas (airports, hotels, and cafes) or providing seamless connections between them. Cometa alone promises 20,000 hot spots by the end of 2004, which it will wholesale to carriers, and Verizon recently began to deploy hot spots on pay phones throughout New York City. Vendors are building antennas and switches that magnify WiFi's effective range and capacity.

The IEEE is ratifying new technical standards, including 802.11a and 802.11g, to allow for additional capacity and service opportunities. Beyond wireless LANs, a new IEEE standard (802.16a) known as WiMax will provide for long-range metropolitan-area connections, tying together local WiFi nodes across areas of several square miles. Some 2,000 wireless Internet service providers already operate in the United States, primarily in rural areas, and many are deploying unlicensed gear from vendors such as Motorola, Proxim, and Alvarion.

The success of WiFi has spurred other innovative wireless companies, such as Mesh Networks, LocustWorld, Omnilux, and SkyPilot, to build networking devices that simultaneously act as receivers and routers. Such meshed networks have the ability to reroute or switch traffic and thus can multiply the usable spectrum in an area because each mobile user acts as a virtual cell site or base station switch for every other user.

Technologies like meshed networks may ultimately be used to expand the spectrum options in licensed as well as unlicensed bands, but today the opportunity for experimentation in unlicensed bands is stimulating the development of many new technologies. Unlicensed spectrum is governed by a set of ground rules favoring robust devices that can

coexist effectively with other users. This is perhaps the most exciting element of the unlicensed commons approach to spectrum management.

Bandwidth constraints, technical requirements, and preexisting users still limit what can be accomplished with the existing spread-spectrum and U-NII bands. The FCC has therefore taken additional steps, discussed below, to foster unlicensed devices.

#### **Recent FCC Actions: UWB and 5 GHz**

Two recent FCC decisions regarding unlicensed spectrum deserve particular mention. First, in February 2002, the FCC authorized limited use of ultrawideband (UWB) technology, which can underlay other services by using extremely low power over very wide swaths of spectrum. UWB devices can offer a very high bandwidth service, 100 Mbps or more over short distances, without interfering with other systems in the same bands.

The second FCC decision, in November 2003, allocated an additional 255 MHz of spectrum in the 5 GHz range to U-NII devices, subject to technical restrictions to protect military and weather radar systems in the same band. This increases by 80 percent the amount of unlicensed spectrum available at 5 GHz.

In November 2002, the FCC also issued a landmark report by a staff-level spectrum task force. It provides an important new framework for the future of spectrum policy. The task force labeled the FCC's primary method of spectrum allocation as "command-and-control," meaning that licenses are granted by government fiat to specific users for specific frequencies and specific purposes, with little flexibility. Ninety-three percent of the spectrum below 3 GHz has been allocated under this model. The task force suggested that two alternate models—exclusive use and commons—should be adopted more widely, except for cases involving public safety, national security, or other compelling reasons. *Exclusive use* means giving licensees service flexibility, as is the case for the PCS and MMDS bands today, and ultimately the right to lease or resell their spectrum as a property owner. *Commons* means unlicensed use, perhaps with even fewer restrictions than exist today in the spread-spectrum and U-NII bands.

#### **TV Band Notice of Inquiry**

In December 2002, the FCC issued a notice of inquiry seeking comment on the possibility of allowing unlicensed devices to operate in the television broadcast bands below 900 MHz and in newly available spectrum at 3.6 GHz. The broadcast bands are among the oldest, most valuable allocations in the radio spectrum. Because broadcast television is such an important and pervasive service, these bands have long been off-limits for any other uses.

However, as the FCC noted, in any given region significant portions of these bands lie fallow. For example, Channel 3 is vacant in New York because it is occupied in Philadelphia. This type of channel allocation plan was arguably necessary for interference-free reception of high-powered local stations (e.g., Philadelphia's Channel 3) by 1950s-era TVs. But, with today's technology, it should be possible to authorize "smart" unlicensed devices to scan the local spectrum environment and adapt their power and frequency so as to operate in those portions of the TV spectrum that are currently unused.

#### **Extremely High Frequencies**

In October 2003, the FCC also adopted rules to bring 13 GHz of spectrum into service at frequencies above 70 GHz. An unlimited number of nonexclusive, nationwide licenses will be issued for these millimeter wave bands that have never been available before for commercial use. At such high frequencies, propagation loss is quite substantial, making short-range or directional applications the most likely use. It is unclear when affordable chip sets and radios can be built to make use of those frequencies. Yet, the history of radio spectrum use has seen higher and higher frequencies become usable over time and the sheer amount of spectrum the FCC has now made available in these bands—some 13,000 MHz—should ultimately draw considerable industry interest.

#### **Other Possibilities**

Beyond the proceedings listed above, the FCC's spectrum task force report suggested additional possibilities for unlicensed uses that underlay existing services. The report proposed a new standard for determining occurrences of harmful interference based on

interference temperature. The FCC would define noise floors, potentially on a band-by-band basis, below which unlicensed uses would be permissible. Because these floors would be higher than the current Part 15 limits, they could have the effect of allowing new underlay services to develop. In November 2003 the FCC began a formal proceeding to write new interference temperature standards into its rules.

The task force report also suggested that time should be a dimension of spectrum allocation. Cognitive radios could find short-duration holes in the licensed frequency bands at any given location and transmit there, jumping to another frequency when another transmitter appeared. Such devices could expand the scope for spectrum underlays as proposed in the television band proceeding. Most such equipment is now at the laboratory stage, but some systems are being commercialized through efforts such as the Pentagon's Joint Tactical Radio System procurement and the XG program at the Defense Advanced Research Project Agency. According to the FCC's staff, a cognitive radio notice of inquiry is under development for release by early 2004.

### **Spectrum Leases and Secondary Markets**

A third mechanism for unlocking large amounts of spectrum is to allow current licensees to lease or resell their spectrum rights. Many economists have long urged the FCC to authorize such secondary markets in order to encourage current licensees to put their spectrum to the best use.

Allowing private actors to trade or lease spectrum also would get the FCC out of the impossible task of deciding ahead of time what spectrum is worth and how it should be used. Today, licensees that leave their spectrum fallow or employ it for relatively low-value uses have little incentive or even ability to change. The adoption of a liberal secondary market policy by the FCC could trigger a chain of new transactions that would significantly reshape the spectrum landscape.

Although some types of limited spectrum leases have been authorized for years (e.g., capacity leases by MMDS/ITFS licensees), the FCC began to explore a much wider scope for sec-

ondary markets in a 2000 rulemaking proposal. That proposal led to an initial order in May 2003 allowing licensees for most two-way wireless communications services, including cellular mobile and PCS providers, to lease some or all of their spectrum. The order adopts rules for short- and long-term leases on either a spectrum manager basis (where the licensee maintains de facto control and prior notice to the FCC is the only requirement) or a de facto transfer leasing basis (requiring prior FCC approval). The new rules were released in October 2003 and are expected to become effective by January 2004. Thereafter, assuming the FCC's legal power to authorize such expedited transfers of spectrum rights is upheld, the secondary markets order could radically reshuffle how spectrum is used across the United States without new spectrum auctions or any changes to the FCC's formal service-by-service spectrum allocation plans.

The FCC also adopted a notice of proposed rulemaking in May, seeking comment on additional secondary market mechanisms. Notably, two senior FCC staff economists have issued a working paper calling for a "big bang" transition of 438 MHz of spectrum to full flexibility for resale in less than two years. This would be a stepping stone to a more comprehensive transition of spectrum allocation from administrative to market mechanisms. As radios become more frequency agile and as antenna technology continues to improve, it may also be possible to make spectrum available in a spot market with providers negotiating for capacity on a real-time basis, much as occurs today in the spot markets for electricity and natural gas. Advocates of the commons model and unlicensed underlays envision similar real-time scenarios, but without charges for each transaction.

### **Government Spectrum Review**

The results of the Bush administration's year-long, top-to-bottom review of government spectrum use announced in June 2003 will also affect the scale of the coming spectrum explosion. A high-level task force led by the Commerce Department will recommend ways to stimulate more efficient radio frequency spectrum use by government users. This could have a dramatic impact. Two-thirds of all spectrum in the beachfront

bands of 300 MHz-3 GHz, which, as noted, have particularly desirable propagation characteristics, is either controlled or shared by government users. Over 20 percent of the spectrum (more than 600 MHz) is dedicated to exclusive government use. If some of that spectrum is made available for private use, either licensed or unlicensed, it would further add to the quantity of new spectrum on the market.

The Bush administration has not announced specific areas of consideration for the task force, but its primary focus will be on enhancing government use of spectrum rather than transferring that spectrum to the private sector. Nonetheless, if government uses its spectrum more efficiently, it may be able to perform essential functions either with less spectrum or by purchasing services from the private sector. A full analysis of government spectrum needs and uses might also lay the groundwork for considering the relative value of dedicating spectrum bands to private or governmental uses.

### **Planning for Change**

Government policy initiatives and new technologies will make more spectrum available in the next few years than in any comparable period in U.S. history. Magnifying the change, spectrum will be used for a rainbow of different services and adaptable in ways spectrum never has been before. As a result, access to spectrum will soon become more like a commodity.

Most of the drivers of change discussed above involve direct government actions to allocate or assign spectrum for new uses. However, with every increase in the supply of spectrum, the private sector gains more options, and service providers and consumers become less dependent on the government as the nation's spectrum gatekeeper. Not only does the FCC acknowledge this but many of the agency's proposed spectrum reforms appear designed to accelerate that trend by letting markets and users have a much greater say in how spectrum is managed in the future.

### **Winners and Losers**

Although it may be too early to identify specific winners and losers, some general observations can be made about the

impact of a post-scarcity regime. See the table on page 28. The table focuses on the market sectors most likely to be affected in the near term by the changing spectrum environment; other types of companies, including broadcasters and satellite providers, will see their businesses change as well, although the scope and timing of those changes are more difficult to divine.

Some of the key points outlined in this table include the following:

- The FCC's reallocation and auction of new spectrum will almost certainly devalue the existing spectrum portfolio of incumbent mobile operators. Licensed operators, especially those offering 3G services, also face competition from unlicensed devices. But there are several offsetting factors: e.g., as spectrum prices decline, the market may place a higher value on an operator's customer base vis-à-vis its spectrum portfolio; and revenues from unlicensed services alone (e.g., hot spots) are unproven. For new entrants, both legal and economic barriers to entry will fall dramatically. However, new entrants will be joining hypercompetitive markets where incumbents have equally low incremental spectrum costs and will have already amortized the bulk of their spending on network construction and billing systems.
- As spectrum becomes a commodity, competition in the mobile sector will become even fiercer, resembling the personal computer (PC) industry more than traditional communications markets. In the PC business, a few companies, such as Dell, thrive by being efficient, low-cost providers, but downward price pressure threatens everyone else. Sprint PCS, AT&T Wireless, and T-Mobile have already seen their profit margins erode through a vicious cycle of price reductions. Nextel has enjoyed relatively good performance thanks to the unique push-to-talk feature of its handsets. Like Apple Computer, though, this differentiation has tied it to proprietary hardware, and other service providers are beginning to offer similar features.

- Manufacturers may see the greatest stimulus from the new spectrum environment. If nothing else, lower entry barriers mean more service provider customers and demand-stimulating price reductions. In particular, makers of chip sets and network equipment will benefit from fast-growing unlicensed markets, new licensed operators, and demand for greater capacity and features. For mobile phone handset vendors, new customer opportunities will be balanced against greater competition from personal digital assistants, wireless-equipped laptops, and mobile entertainment devices. For all manufacturers, as spectrum becomes cheaper and applications expand, the expense of new equipment can be amortized across significantly larger user bases and a wider range of networks.
- Investment banks and financial intermediaries are also likely to see substantial new business, especially if secondary market opportunities (e.g., for off-peak spectrum leaseholds and refinancing) develop as we expect. In addition, market structure changes always provide arbitrage opportunities for savvy financiers to exploit. Eventually, significant increases in mergers and acquisitions and competitive entry will generate substantial need for capital and advisory services. Finally, spectrum will itself begin to look like a tradable commodity, much like other natural resources such as oil, electricity, and natural gas.

Though the table does not include them, content providers, notably for video programming services, games, and rich media, also will benefit from the spectrum explosion. Operators and end users will be looking for new services. Greater capacity will allow experiments and novel programming concepts to come to market. Cable television created twenty-four-hour news and home shopping, plus a raft of specialized channels, while DBS brought season-pass sports packages and pushed cable to haster digital and on-demand offerings. Portable multimedia terminals will also be hungry for information services along with software to manage the deluge of ad hoc content (e.g., camera phone images, and MP3 clips).

### **Legal and Political Hurdles**

Any prediction about regulatory action must include explicit caveats. Just because the FCC is moving forward or has made a decision does not mean the result will be clear-cut. Regulators can abandon or delay their plans in response to opposition from the general public or powerful interest groups. Congress may also choose to step in and overrule the FCC. With the FCC, in particular, the courts are a major potential stumbling block. Finally, the FCC could do a poor job of designing rules such that expected markets do not emerge. That was the case with the little-used ITFS and unlicensed PCS bands.

Handicapping these risk factors can be difficult. The spectrum explosion is being driven by so many factors and collectively has such broad-based momentum that the main trend is highly unlikely to be blocked by the courts or Congress. Nonetheless, those affected should consider the legal strengths and weaknesses of any relevant decision.

FCC actions regarding the allocation and use of licensed spectrum probably are on the soundest legal footing, if only because the agency's authority is clearest in this realm, and most of the proposals described above have generated an extensive public interest record. The FCC has been allocating and reallocating bands of spectrum for seventy years. Nonetheless, for some allocations and auctions, delays are still possible. Incumbents concerned that their spectrum portfolios will be reduced or devalued may raise legal or political objections. With the growing significance of wireless services and the growing interest in unlicensed devices, Congress has become more involved in spectrum policy. It could intervene on any given decision if it so desires as it did, for instance, in delaying the auction of upper-band UHF spectrum to be vacated by the DTV transition and in scaling back the FCC's proposed expansion of low-power FM radio. Opposition from other federal agencies, especially the military, could also have an impact.

The FCC's actions on unlicensed spectrum may face tough objections. Almost all incumbents, both private sector and government, are worried about potential interference. The FCC's decision to authorize UWB services was the result of a four-year proceeding that involved hundreds of comments

and elicited great concern from, among others, the military and the aviation industry. The outcome was a compromise FCC order that allowed the UWB industry to emerge from the development stage, but another FCC proceeding will be needed to fully liberalize the rules for this promising technology. On the other hand, where there is a strong demand for more unlicensed spectrum and the parties negotiate directly, as was the case with the proposed addition of 255 MHz of U-NII spectrum, which was proposed in May 2003 and adopted in November 2003, FCC action can be swift and dramatic. Still, some observers question the FCC's right to unlicense so much spectrum absent express congressional authority.

The FCC's proposals for an underlay in the television broadcast bands, an interference temperature standard, and authorization of cognitive radio are all likely to test the agency's process for spectrum reform. Each initiative could provoke political opposition and court challenges by licensees whose spectrum would be affected. Because underlays take spectrum-sharing to a new level, they will also raise legal issues of first impression (e.g., does an FCC license confer rights below the interference temperature floor?). Similarly, many supporters of secondary

markets oppose further unlicensed allocations, and vice versa, fragmenting the proponents of reform.

Secondary markets for spectrum create their own set of legal questions. Licensees historically must maintain direct control over the transmission equipment operated on their assigned frequencies. Under the Communications Act, the FCC must review and approve any change of licensed spectrum control. This obligation, which mandates FCC review of most communications industry mergers and broadcast station transfers, is a long-standing bedrock of FCC responsibility. The FCC has attempted to accommodate the Act in its secondary markets order by providing expedited review procedures for de facto transfer leases and authorizing leases without review if de facto control nominally remains with the licensee. Yet, given the novelty of this mechanism and the stakes involved, undoubtedly the courts or Congress will decide whether the FCC has been successful in fulfilling its mandate.

### Conclusion

A presumption of scarcity has been the hallmark of U.S. spectrum policy since its inception. The growing demand for wireless communication and broadcasting

services has only reinforced that mindset. When access to spectrum is constrained, service providers and their advisors must focus all their energy on acquiring and husbanding spectrum resources. If spectrum access becomes less and less encumbered, as we suggest it will over time, then investors will begin to shift their funds accordingly from those that are best at acquiring spectrum to those that are best at using it. Likewise, economic power will begin to shift from companies with licenses to companies, licensed or not, that can offer the most popular wireless devices, content, and service packages, and from spectrum gatekeepers (the FCC and its staff) to consumers.

This will not happen overnight, not everywhere, nor for all services. The kinds of markets that develop will depend on several factors, including the relative availability of licensed versus unlicensed spectrum, the propagation characteristics of the band, adjacent uses, and the restrictions on each allocation. Yet, the direction of change is now clear. The spectrum explosion will affect virtually every wireless service provider as well as the manufacturers, content providers and financial intermediaries that serve them. Now is the time to prepare for this new world.

Sector	Opportunities	Dangers
<b>Incumbent Mobile Radio Licensees (PCS, Cellular)</b>	Lower costs for spectrum needed to expand coverage, launch new services (3G), and reduce congestion. Spectrum leases provide new revenue and financing options. Hybrid service opportunities with WiFi hot spots. M & A costs may fall.	More downward pressure on prices; lower entry barriers (e.g., via WiFi, leased spectrum). If stock market caps of incumbents fall with spectrum prices, more sector consolidation is likely.
<b>New Mobile Service Providers</b>	Multiple new entry options (via spectrum auctions, leases, and unlicensed bands). Drastically lower price points for spectrum licenses and network infrastructure. Ability to capitalize on new multiservice, multi-band handsets/PDAs.	Low entry barriers mean hypercompetitive pricing. Customer acquisition costs may rise as raw spectrum prices fall. Differentiation may be difficult.
<b>WiFi/Unlicensed Networks</b>	Low entry barriers with terminal costs absorbed by customers. Enterprise and municipal providers may best capture externalities. Urban spectrum underlays and unused areas may also provide service test beds.	Business models unproven. Stiff competition from incumbents, which can bundle licensed services. Low entry barriers make differentiation difficult; potential interference and security questions.
<b>Equipment Manufacturers</b>	Competitive entry increases addressable service provider markets. Lower prices and new services boost consumer demand, especially for multiband (e.g., PCS/WiFi) devices. Consumer devices less tied to specific service providers, especially for unlicensed networks.	Diversity of bands and standards to support. Standards issues delay integration of WiFi/PCS/cellular services. Uncertainty regarding interference potential and standards stalls demand for unlicensed services.
<b>Investment Banking/Financial Services</b>	Falling spectrum prices increase M & A activity and financial restructuring. Spectrum leasing and new auctions spur demand for innovative banking services and financing for market intermediaries (brokers, clearinghouses).	Consolidation impairs existing banking relationships. Price declines impair lenders' security. Legal challenges delay or restrict secondary markets and financing of new leaseholds. New market structures undermine proven business models.