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SPECTRUM PRIVATIZATION:
REMOVING THE BARRIERS TO TELECOMMUNICATIONS COMPETITION

by
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EXECUTIVE SUMMARY

Spectrum management must be modernized for the 21st century. This paper offers a detailed plan for aligning spectrum management with the bedrock principle of the digital eraCa bit of information is the same, regardless which spectrum frequency is used for transmission. The cornerstone of the plan is the privatization technique used by over 100 nations world-wide to return nationalized assets to the market. An interdepartmental Steering Committee (FCC, NTIA, OMB and Treasury) should be charged to oversee the 10 year de-zoning and mass transfer of spectrum to the private market. The plan is technologically neutral: it simply creates a level playing field, permitting the market to determine what technologies are available.

In Phase One, spectrum will be Ade-zoned.@ Service classifications, block allocation and technical use restrictions will be phased out in an orderly and sequenced process. Spectrum holders will be freed to use the spectrum that best serves their customers, business plan, and shareholders. De-zoned spectrum will be coordinated and managed by expanded use of existing private frequency coordinators (PFCs).

In Phase Two, the Steering Committee will return the now de-zoned spectrum to the market and public through mass privatization. The goal is to remove the government as the arbiter of its use. Based on lessons from New Zealand's spectrum privatization experience, the plan goes beyond proposals for government to permit Aflexible use.@ Specifically, bandwidth not reserved for public safety, national defense, emergency services and limited civilian governmental use will be made available to the market in a sequenced Aroll out.@ Title to spectrum will be granted in fee simple to applicants. Spectrum auctioned since 1994 will be quick-deeded and transferred to the bidder. Should competing applications be tendered for a portion of de-zoned spectrum, auctions will be held.

Finally, in Phase Three, a property-based spectrum management system for the de-zoned and privatized spectrum will be created. Owners will obtain the ability to sell or transfer spectrum as with any other property right, subject to a title filing with a newly created spectrum registry. Title holders to spectrum will be subject to the current property-based common law systems, including the right to quiet enjoyment, protection from trespass/interference, etc. Coordination and initial resolution of interference issues should be resolvedCas they are currentlyCat first instance through the PFCs and arbitration. Should litigation be necessary, the PFCs will be able to assist the courts as the ultimate arbiters of the property rights.

Mass privatization of all the nation=s spectrum could generate long-term revenues to the federal government of between $100 billion and $300 billion, which could be applied to reducing the national debt. Such revenue is at best a secondary benefit from spectrum reform. The long-term benefits from job creation and new products and services will eclipse these sums.

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I. INTRODUCTION

The telecommunications revolution is without doubt a salient event of the modern era, embodying dynamic change.[1] From the advent of the telegraph in 1844, technological advances have reshaped old market structures to create new industries and companies.[2] The wireless sector is the most active portion of the industry.[3] One in six new subscribers for a telephone world-wide now selects a mobile, wireless connection. Revenues for U.S. wireless service providers grew 39 percent in 1994, and 42 percent in 1995Cfaster than any other segment of the telecom industry.[4] The number of cellular telephone users worldwide will double (to 200 million) in the next four years. By the year 2001, the wireless equipment market is predicted to total $67.5 billion.[5] Combinations of cellular telephony, two-way

[1] While it may yet to be seen if A[t]he effect of telecommunications on society at large may turn out to be as significant as the invention of the printing press, there can be little doubt that societal structures currently organized around hierarchical information flows will undergo substantial changes.@ J.P. Linnartz, *Narrowband Land-Mobile Radio Networks 2* (1993); see also I. Lebow, *Information Highways and Byways: From Telegraph to the 21st Century* (1995); J. Thorne, P. Huber and M. Kellogg, *Federal Broadband Law*, ' 1.1 p. 2 (1995) (telecom innovations will transform society more than printing press).

[2] See G. Brock, *The Telecommunications Industry: The Dynamics of Market Structure*, 4 (1981), describing dynamic change theory and market structure. The premise is that technological changes can be discerned and drive the structure of industry, regulatory and legislative frameworks. As Brock notes, if dynamic change is not accepted as a model, legislation must be based on a static Asnapshot@ of industry at any given moment. *Id.* at 21B54. It was the static snapshot of analog technology taken in the 1920s which continues to govern telecommunications to this day.

[3] See, e.g., M. Lander, AAn Aerial Assault on the Wired Nation,@ *New York Times*, February 26, 1996 at D1 (noting the massive commitment of wireless resources to by-pass the copper local loop).

[4] *Telecommunications Industry Revenue: TRS Fund Worksheet Data,* FCC Common Carrier Bureau, Industry Analysis Division, 1996.

[5] *Wireless Products Markets*, Killen & Associates (1996).

messaging/pagers, wireless local area networks, and direct broadcast satellites provide new services, options and choice for consumers.

The wireless industry is a subset of today's convergence toward ubiquitous computing.[6] The microprocessor is the agent of change. This device processes signals in binary form that could include telephony, text, or video/image on a given frequency. By contrast, older analog technology entailed separate devices: a radio, TV or telephone could only receive a signal intended for that device. Digitization means that all information can be accessed in any order and transmogrified between mediaCfrom text to voice, etc. Telephone, cellular and paging companies, TV and radio broadcasters, cable companiesCall are now in the computer industry, broadly defined, whether they know it or not.[7] The provision of Internet servicesCincluding Acybercasting@ of radio and TVCover telephone or cable networks to a mass consumer audience only foreshadows the change ahead.

6 The ability of the Internet to carry long-distance and international telephone calls at the nominal cost of a local call is merely the tip of the iceberg of developments to come. Companies such as Vocaltec provide software that enables any PC to call around the world with voice for the price of a local call. Bill Gates of Microsoft summed it up: AI=m not sure what the Internet is good for commercially, but I don=t know why you would want to be in the long distance market with that thing out there.@ *The Economist*, September 30, 1995 Telecommunications Survey at p. 8.

7 The number of Aradio@ stations broadcasting on the Internet is growing exponentially. As IBM recently predicted, the low cost of setting up a Web Page means the future is not 500 channels, but 50 million. ACheap Stations Already Profiting on InternetCAnd TV Is On The Way,@ *Comm. Daily*, March 11, 1996 at p. 3. Of course, these stations do not have to buy FCC licenses, can Abroadcast@ world-wide as easily as next door, and can be set up in a basement over a weekend.

Today's spectrum management is based on the analog era of separate devices for separate functions. Accordingly, it focuses on allocating spectrum in large service blocksCfrequencies were set aside by the Federal Communications Commission (FCC) for FM radio or for VHF or UHF television broadcasts. Telecommunications observers have offered Congress the suggestion of Aflexible use@[8] of spectrum made possible by relaxing the rigidities of the block allocation system. Such concepts are improvements but miss the essence of the post-analog era. Microprocessors eliminate the economic and technical rationale for spectrum segregation into service classifications. Any portion of the spectrum, whether classified by the government as trunked radio, television broadcast, telephony, data, etc. can carry digital signals including data, voice, video or text messages to be processed by a single device, a microprocessor. Digital handheld devices can now roam and transmit signals over different spectrum such as PCS, analog cellular, etc. The signals can be voice, fax, or e-mail. The consumer does not care what spectrum is used. All that is important is that the message gets through.

The systemic pressures for change in spectrum management are immense and will only increase. Hence, Aflexible use@ proposals that loosen but do not replace the existing regulatory burdens on spectrum only postpone the inevitable. Microprocessors historically follow the well-known maxim of the computer industry, Moore's Law. Named after Gordon Moore of Intel fame, the law states that microprocessors double in power approximately every 18 months. The price of computing power decreases with each iteration, making digital wireless devices cheaper, smaller, more flexible and increasingly available for widespread consumer devices and applications.[9]

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8 Flexible use has many different definitions, depending on any given proponent. For purposes here, flexible use is the right to use assigned spectrum for any service and the right to transfer spectrum within a given spectrum block.

9 Computers have been digital from almost the beginningCeven when using the old vacuum tubes. The tubes represented 1s and 0sCwhen on a 1, when off, a 0. In digital terms, the number 1 is represented as a 1, the number 2 as 10, number three as 11, etc. The same process applies to letters or pictures, colors, shapes, etc. Vacuum tubes are unreliable, bulky and generated enormous heat. The first computer, ENIAC was fragileCone tube failing caused problems. To combat the staggering heat, ENIAC=s technicians wore bathing suits. SemiconductorsCas exemplified by the transistorCcreated reliability and lower heat. Transistors and semiconductors were the bridge between the large vacuum tubes and the microprocessor. Lebow, *supra* note 1, at p. 151B152. It is the microprocessor, however, introduced in 1971, which makes connected computing and consumer digital devices available. Consider the Sony Playstation, a video game machine available in most toy stores. It can process digital information at 200 MIPS (millions of instructions per second). Its rivals, the Sega Saturn and the 3DO M2, are similar. Newer devices are already planned to make these obsolete. These $300 toys have more power than an old million dollar mainframe. Moore=s Law has proven to be accurate two decades after he made it popular. In 1987, a desktop microprocessor ran at 2 MIPS. By 1994, the same type of desktop featured a microprocesor running at 256 MIPs. By 1998, a desktop microprocessor will run over 2 billion MIPsCor 2 billion instructions per second. *See* M. Kellog, J. Thorne & P. Huber, *Federal Telecommunications Law*, pp. 50B51 (1992) (noting the impact of Moore=s Law on microchips, performance and digital convergence in telecommunications) [hereinafter FTL].

The digital era now confronts a roadblock: the 60-year old spectrum management structure built when AM radio and vacuum tubes represented cutting-edge technology. The limits of proposals that urge government regulation of spectrum to be Amore flexible@ become clear. Why should we petition the government to be more Aflexible@? In a post-analog era, the best government role is to permit markets to function properly through the enforcement of existing antitrust laws. Government control over spectrumCno matter how benignCis no longer tenable. The pace of technical change will supersede incremental improvements such as Aflexible use.@

Better to do reform right the first time.

II. EXISTING SPECTRUM MANAGEMENT: Prometheus Bound

It is now commonplace to criticize the existing spectrum management regime as obsolescent and in need of significant reform. Different premises adopted in analyzing its flaws will, however, lead to different outcomes. The discussion below focuses on how the existing regime was adopted to accommodate the technology of the dayCanalog radio. Understanding this conceptual foundation will help clarify why current digital technologies and those to come require a significantly different governmental role.

The existing inefficient spectrum management system costs the American economy tens of billions of dollars each year in lost economic activity. Cellular telephony for consumers, for example, was first demonstrated on Capitol Hill in 1973. Over a decade later, the industry was still in embryonic form due to regulatory delays. The cost to the economy of this 10-year delay is estimated to be $85 billion.[10] Moreover, the FCC=s policy of limiting cellular providers to two entities per market, a duopoly, fostered artificially high prices and delayed creative service introductions. The six-year delay in bringing PCS technologies to the market is similarly estimated to have cost another $9 billion in lost economic activity.[11]

A. The Analog Anchor Of The Spectrum Management System

The radio frequency spectrum is the continuum of electromagnetic energy (radio and light waves) transmitted in the form of oscillating electric and magnetic fields at the velocity of light (see Table 1). A frequency is a particular and pre-determined number of oscillations per second (cycles per second, or Ahertz@). The range of these frequencies is referred herein as Aspectrum@ and the specific frequency as a Aband.@ A user of spectrum is an entity which establishes a channel of communication by use of a particular frequency.[12]

Table 1: Spectrum Allocation and Propagation

Frequencies	Band	Characteristics	Services
3 Hz-30 kHz	ELF, VLF	High atmospheric noise, antennas are inefficient.	Submarine, navigation, sonar, long-range navigation.
30-300 kHz	LF	High atmospheric noise, ionosphere absorption.	Long-range navigation beacons.
0.3- MHz	MF	High atmospheric noise, good groundwave propagation.	AM broadcasting (535B1705 kHz), maritime communication, navigation.

10 Rohlfs, Jackson and Kelly, *Estimate of Loss to the United States Caused by the FCC=s Delay in Licensing Cellualt Telecommunications*, 4 (National Economic Research Associates 1991).

11 *The Telecomm Revolution: An American Opportunity*, Progress and Freedom Foundation (1995).

12 Rau, AAllocating Spectrum by Market Forces: The FCC Ultra Vires?,@ *Cath. L.Rev.*, vol. 37 no. 2, p. 149 (1987) (describing basic definitions of spectrum and its users).

3-30 MHz	HF	Moderate atmospheric noise, sensitive to solar flux density, ionosphere provides long-distance links.	International shortwave, amateur radio, ship to shore, telegraphy.
30-300 MHz	VHF	Propagation basically line of sight; ionosphere reflection at low range.	Television, FM broadcasting, air traffic control, radio navigation aids.
0.3-3 GHz	UHF	Line of sight propagation.	Television, radar, mobile radio, satellite communications.
3-30 GHz	SHF	Line of sight propagation, ionosphere absorption at upper frequencies.	Radar, microwave links, land mobile communications, satellite links.
30-300 GHz	EHF	Line of sight propagation, extremely susceptible to ionosphere absorption.	Radar, secure military communication, satellite links.
300- and up.	IR-optics	Line of sight propagation, very susceptible to ionosphere absorption.	Optical communications, fiber optic links.

Spectrum is therefore an infinite resource in one sense. Unlike water, petroleum, or land, spectrum is always there. The radio frequencies used currently were in existence 100 years ago, 1,000 years ago and will be in another 1,000 years. It is impossible Ato use up@ spectrum. How we use spectrum and who gets to use it, however, are different matters. Our existing spectrum management regime was adopted over 60 years ago to address those questions.

The U.S. adopted a centralized and regulated spectrum management structure by government statute, the Communications Act of 1934[13] and its predecessor, the Radio Act of 1927.[14] The essentials of this regime are largely unaltered by the Telecommunications Act of 1996 some 62 years later. Both the 1934 and 1927 laws embrace the limits and capabilities of analog technology from the 1920s. The FCC, created by the 1934 Act, supervises nongovernmental spectrum use in Athe public interest.@ (The National Telecommunications and Information AgencyCNTIACformed in 1978, coordinates the government=s spectrum use.) The government, not the consumer, decides who uses spectrum and on what basis.[15] Licenses and administrators answer Lenin=s famous dictum, AWho, whom.@

The FCC and NTIA divided what they considered to be the usable spectrum (0-300 GHz) into 800 frequency bands and allocated the bands to 34 separate services (fixed, land mobile, broadcasting, satellite, etc.). The 1934 Act authorizes the FCC to regulate spectrum under Title III consistent with Athe public interest, convenience and necessity.@ There are no definitions or limitations on what constitutes Athe public interest.@ It is essentially what the five FCC commissioners define it to be. FCC decisions regarding the public interest are granted Asubstantial judicial deference.@[16]

1. Block Allocations: Administrative Links in the Chain

The current basis for FCC spectrum management continues to be *block allocation*. Spectrum is divided into various services. Each service has Ablocks@ of spectrum, with each block divided into channels.[17] In the 1930s, the technical

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13 Act of June 19, 1934, ch. 652, 48 Sts. 1064, 47 U.S.C. (1982).

14 Act of Feb. 23, 1927, ch. 169, 44 Stat. 1162.

15 As noted economist Alfred E. Kahn stated, AThe essence of regulation is the explicit replacement of competition with governmental orders as the principal institutional device for assuring good performance.@ A. Kahn, 1 *The Economics of Regulation: Principles and Institutions*, 20 (1970).

16 Edles and Nelson, *Federal Regulatory Process: Agency Practices and Procedures*, 688 (2d ed. 1992).

17 A Ablock@ is defined as contiguous band of frequencies dedicated to a particular service. The FCC estimates the appropriate amount of spectrum for a specific communications service and allocates a block of frequencies for the service's use. See Robinson, *Spectrum Management Policy in the United States: An Historical Account*, Federal Communications Commission, Office of Plans and Policy Working Paper No. 15 (1985).

limitations of the AM radio band, ease of administrative burdens, and regulatory simplicity made this system workable.

In essence, the FCC still attempts to guess the public's need for particular communications services. The FCC locates spectrum most technically suitable for the particular radio service. Factors in the decision-making include the degree to which the technology employed may cause or receive undue interference with other spectrum users. Each service classification and the individual blocks are governed by intricate FCC-created rules and technical regulations.[18] Over the years, the spectrum management system from the 1930s congealed into a five-tier hierarchy: 1) international restrictions and agreements; 2) government use (NTIA after 1978); 3) FCC service classification; 4) FCC user classifications; and 5) the technical limitations imposed upon a particular bandwidth. Administrators currently pick technological winners and losers. Administrative decisions replace market signals.

2. The Exaggeration of Spectrum AScarcity@: an Excuse for Government Control

The spectrum management system rests on one major premise: Aradio spectrum is [allegedly] a scarce resource.@[19] Repeated so often by so many, the phrase is often relegated to a truism. So, too, is its corollary, that government involvement in spectrum allocation is necessary to prevent Ainterference.@ Both are overstated. What both assertions mask are *a priori* assumptions about the need for government to make decisions for people.

Why is spectrum said to be scarce? The National Association of Broadcasters first warned of an impending spectrum shortage in 1925. At that time, 2 MHz was the highest usable frequency. Despite more spectrum becoming available for use with advances in technology, the scarcity claims linger. Why? In essence, spectrum is not available in sufficient quantities to allow users to have as much as they would like *at a zero price*. Obviously, at a zero price more people desire the few FCC licenses that are issued than have them.

In fact, every productive resource is scarceClabor, land, even investment capitalCif the criteria used are (a) if it is given away, people would want more than the quantity that exists, and (b) if we had more of it, there would be an incremental value to the economy. From sodas, to dance records, compact discs to whole factoriesCthe same analysis suggests that each resource is Ascarce@ and if sold on the market, would command a price.[20]

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18 It is perhaps natural that the State would control spectrum management. After all, the U.S. Navy single-handedly created the U.S. wireless industry. After managing the nationalized wireless infrastructure for World War I, the Navy sought to create a U.S. industry rather than become dependent on Great Britain and its Marconi corporation. After significant encouragement from the government, General Electric purchased Marconi=s U.S. subsidiary, and renamed it Radio Corporation of America (ARCA@). The Navy also brokered patent settlements among Westinghouse, AT&T and General Electric regarding the vacuum tube, an essential development in the lauch of the U.S. wireless industry.

The results were as spectacular as the PC industry in the 1980s. From sales of $60 million in 1922, radio sales skyrocketed to $358 million in 1924, and by 1928, penetrated to over 7.5 million homes. See generally *Lebow*, supra note 1, at pp. 96B98.

At its inception in the 1920s and 1930s, the block allocation system met little opposition from the then new wireless industry. Major players in the industry, particularly AM radio equipment manufacturers such as RCA and Westinghouse, relied on the government to create stable and defined markets in which they could sell radios. Segregating markets and awarding licenses based on administrative considerations also served the interests of broadcasters. Barriers to entry for new competitors were raised not by competitive but by regulatory advantages. Everyone arguably benefited at the time, including the public.

19 See Attachment to Testimony of Larry Irving, Assistant Secretary for Communications and Information, U.S. Department of Commerce, National Telecommunications and Information Administration on Federal Management of the Radio Spectrum before the House Subcommittee on Telecomunications and Finance (September 7, 1995) (ARadio spectrum is scarce resource...@). In his actual testimony, Irving went further, adding ASpectrum is a precious and finite national and international resource...@). Courts have also endorsed the notion that spectrum is a finite and scarce resource. *See FCC v. National Citizens Comm. for Broadcasting,* 436 U.S. 775 (1978); *CBS v. Democratic Nat'l Comm.*, 412 U.S. 94, 103B114 (1973); *Red Lion Broadcasting Co. v. FCC*, 395, 367, 388B389 (1969).

20 See T. Krattenmaker, *Telecommunications Law and Policy*, 38 (1994) (noting that the scarcity claims as a basis for governmental regulation are analytically imprecise because markets are used in the U.S. to allocate scarce resources all the time).

Advocates of the status quo argue that spectrum is different because of inherent physical waveform characteristics which make centralized control necessary to prevent Ainterference.@ [21] For example, if Party A wishes to broadcast a signal in a particular area, and Party B is already using that same frequency, one would expect interference in the signals. In any given area, there are likely many other Parties who might wish to broadcast on that frequency as well. Sometimes, even Party C on a different frequency can interfere with either Party A or B. In fact, the potential for Achaos@ in the airwaves is frequently cited by courts and commentators as a basis for government=s centralized control over bandwidth.

Yet consider a chair. Party A wishes to sit down. So does Party B. AInterference@ occurs because both seek to use the chair at the same time. We do not have a Federal Commission of Furniture to allocate the scarce resource of desk chairs. Facetious? Yes, but the point is that any resource is subject to interference if simultaneous use is attempted. For this reason, governments long ago established property rights and the ability to transfer explicitCand exclusive useCin a marketplace. The real question to be asked is whether issues of spectrum bandwidth usage are so *sui generis* as to make a traditional property approach infeasible. The answer is no, and technology is making that more clear each year.

3. Technology Reduces Interference and the Need for Exclusivity

Technology plays a key role in shaping our perceptions of scarcity. The analog origin of the block allocation system therefore is a critical element in considering meaningful spectrum reform. One cannot separate the technology from the regulatory scheme. Licensing became the first line of defense against interference because technology could not supply an answer. In a digital era, the key concept is that Aa bit is a bit.@ Microprocessors can not only use the same spectrum to carry a variety of bits with more than one type of content, they can process the bits to permit communication by multiple users with minimal interference.

[21] There are, in the main, three types of interference. First, there is Aco-channel interference@Ctwo transmitters broadcasting the same frequency. AAdjacent interference@ results from transmitters broadcasting on adjacent frequenciesCchannel 2 and channel 3, for example. The FCC does not allocate adjacent channelsCthis does not refer to numbers on our TV sets, but the actual frequencies. Channels 4 and 5, for example, do not use adjacent frequencies. AIntermodulation,@ the third type of interference, is a rare occurance when one frequency transmission by a third broadcaster causes one of two previous broadcasters to interfere with each other.

Digital microprocessors do more than increase dramatically the efficiency of older analog techniques.[22] Certainly, through digital efficiencies, existing spectrum can be utilized more efficiently. This alone will have significant implications for the cant of Ascarcity.@ Even the NTIA estimates that digital technologies promise at least a tripling of spectrum usage efficiency. Those with less stake in preserving the status quo suggest increases of 10-20 times efficiency[23] over existing analog technology.[24]

Digital radio permits technology to accomplish what licenses did before: remove interference as a justification for government to allocate spectrum. One technique is spread spectrum,[25] an approach originally developed for the

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22 Analog trunking, introduced in the 1970s, permits one user to transmit on a channel for the duration of a broadcast. When that channel is busy, another caller is routed to another, unused channel. Digital microprocessors transform the single trunk channel into a number of time slots or frame. Each user is assigned one or more time slots, thereby permitting many users to share a single channel. When the microprocessors handle slots at speed, each user perceives an exclusive use of the channel. This process's known as time division multiple access (ATDMA@). G. Calhoun, *Wireless Access and the Local Telephone Network*, pp. 325B334, (1992). The efficiency of analog cellular techniques, the foundation for most commercial cellular telephones, are also improved with digital microprocessors. More users can be multiplexed onto a given slice of bandwidth. Early generation digital cellular networks offered three-fold increases in efficiency. I. Brodsky, *Wireless: The Revolution in Personal Telecommunications*, 52 (1995). More recent digital designs can permit a ten-fold increase in spectrum efficiency. Microprocessors allow compression of signals. Redundant information is subtractedCpossible because the signal is in the digital form of 1s and 0s. Transmission can be accomplished at a lower bit rate. Such a signal in turn uses less bandwidth. Digital channels can be spaced closer, letting more users operate in a given frequency band.

23 G. Calhoun, *supra* note 24, at 580B581 (estimating that baseline digital efficiency factors are probably on the order of 15, with potential for 20).

24 Analog signals in the 1970s adopted two innovations to increase efficiency, trunking, and cellular re-use. Both represent the limits of analog technology. Not coincidentally, both innovations are wholly compatible with the existing spectrum management system. Trunking represents a splicing of existing channels into subchannels. Users on a group of channels share channels through contention. When one channel is in use, the system detects an available channel and directs a transmission to it. Cellular architectures, actually known as space division multiple access (SDMA), permit re-use of the same channels over a given geographic area. To accomodate more usage of a given slice of spectrum in a particular geographic area, more cells are installed. Analog cellular is essentially Aa brute-force attempt to build out really large systems using FM.@ *Id.* at p. 242.

25 I. Brodsky, *supra* note 24, at pp. 37B72.

military to overcome Soviet radar and signal jamming. There are two main types of spread spectrum approaches: direct sequence spread spectrum (DS-SS) and frequency hopping spread spectrum (FH-SS). Under DS-SS, users are not segregated into distinct channels or time slots. This is a dramatic departure from analog=s requirement of putting users in separate channels (the existing FDMA approach) or transmitting digital signals in specific time slots (the TDMA approach). Instead, multiple users are simultaneously on the same wideband channelCa process known as code division multiple access (CDMA). The signal is spread over a wide bandwidth, many times that required by the actual signal. An embedded code in the signal permits the receiver to decode the transmission and separate it from the surrounding white noise.

The other form of spread spectrum, frequency hopping (FH-SS), uses traditional signals but jumps these signals to different frequencies, avoiding interference. In essence, the microprocessors skip to different frequencies very quickly, thereby ensuring that in any given slice of time, the spectrum is free from interference. The same access to spectrum by many parties is thus permitted, with each user simultaneously exchanging places within a given bandwidth.[26]

The potential of digital radio, and CDMA in particular, has led some observers such as Eli Noam and George Gilder to opine that the future of spectrum management should lie with Ashared access.@ In Noam=s construct, spectrum will be much like a public highway or Aopen entry spectrum exchange@Cmade possible by digital technology. Such regimes, we are advised, will have the added benefit of removing oligarchical dominance.[27] Not only will spectrum be abundant, but access will be open to all based on their actual needs and uses.[28]

The future of CDMA in the market, particularly for PCS use, is a much-debated topic. Digital technologies already in use todayCwithout CDMA and FH-SSCdramatically reduce the perception of Ascarcity@ by: 1) massively increasing efficient use (even NTIA concedes this); and 2) permitting multiple (i.e., nonexclusive) use of the same frequency in channels. CDMA and Aopen access,@ if proven feasible, will be icing on the cake.

Why do so many persist and still maintain that spectrum is so scarce? The culprit is the block allocation system itself. As a former FCC chief economist once quipped, A[t]he only way you can waste spectrum is not to use it.@[29] And the FCC has wasted enormous amounts of spectrum. It is a classic vicious cycle: spectrum is scarce, so FCC regulation is necessary, and FCC regulation ensures that spectrum stays scarce. A few brief examples will suffice. Consider the *nationwide* block allocation[30] of 470B806 MHz for UHF television, channels 14 through 69. (Channel 37 is reserved exclusively for radio-astronomy nationwide.) Under the block allocation system, this spectrum is allocated under the service classification of UHF television broadcast. The channels assigned to each UHF station

26 Currently, the FCC permits spread spectrum to be used up to 1 watt for unlicensed uses, subject to Part 15 of its rules. Examples of unlicensed uses include digital cordless phones, wireless PBXs, and inventory control systems. The Commission still regulates this unlicensed use. In the 915 Mhz band, for example, the Commission=s rules require 50 channels for a FH-SS system. Some companies believe that 25 channels is sufficient. Again, centralized management attempts to dictate a regime in a constant state of innovation and change. Part 15 devices were intended by the FCC to cover two types of devices: incidental and unintentional radiators. Incidental examples include machines like small dc motors, etc. that produce radio signals when they function. Unintentional devices include PCs, microwaves, etc. Part 15 devices operate in the industrial, scientific and medical (AISM@) band and are subject to priority use by the licensed user. A full 10 Mhz was set aside for unlicensed PCS use. But spread spectrum can do so much more. Current CDMA technology will permit operation on top conventional radio broadcasts, in some cases generating relatively low increases in background noise levels. In other words, CDMA now can permit two parties (or more) to use the same frequency without interference even if the parties are using different technologies.

27 Testimony of Eli Noam before the Senate Committee on Commerce, Science and Transportation, July 1995.

28 Noam, *supra* note 23.

29 AFCC En Banc Session Told Spectrum is Wasted, TV Bands Underutilized,@ *Communications Daily*, March 6, 1996 at p. 2 (remarks by Dr. Thomas Hazlett).

30 In FCC parlance, television channels are Aallocated@ to services, Aallotted@ to communities and Aassigned@ to individual stations.

require transmission of a television broadcast over 6 MHz. The same amount of spectrum is reserved for UHF television channels 14B69 in Boise, Idaho or Nome, Alaska as in New York City or Los Angeles.

Of course, even in the largest metropolitan areas, less than a handful of UHF stations actually broadcast. Additional FCC rules require that stations on the same channel be separated by approximately 155B205 miles. Moreover, broadcasts of two, three, four, seven, eight, fourteen and fifteen channels apartCAtaboo@ separationsCmust be 25 to 75 miles apart. The FCC also, in Afairness,@ allots specific channels to specific communities.[31] The result? Nationwide, the majority of channels 14 through 69 are vacant. Tuning in to them reveals the famous Asnow@ static, declaring no broadcast. Is this efficient use of spectrum?

To centralized frequency planners relying on block allocation schema, the 336 MHz are allocated and thus Ain use.@ To the real world, the situation is quite different: vast amounts of prime spectrum nationwide is idle, vacant and underutilized. It has been estimated that loosening the technical and other regulations for television alone would permit the same signals and services to be accomplished with 1/10 the spectrum.[32] The same situation can be found elsewhere in various service classifications. Block allocation also creates the obverse: administrative miscalculation of enormous and intensive demand for spectrum in an allocated band resulting in overcrowding, interference and delays. The frequencies from 500 kHz to 30 GHzCthe most desirable for the physical characteristics of waveform/ propagation purposesCare therefore allocated, thus scarce.[33] But scarcity often exists on paper only.

Frequency planners are not oblivious. Even the NTIA suggested modest relaxation of the block allocation scheme in its landmark 1991 study.[34] The system is retained despite its shortcoming for a number of reasons. The first is convenience: creating broad service classifications and blocks eases administrative duties. Block allocation also simplifies control. Spectrum can be dedicated to desirable ends, such as fostering a centralized vision of new technology (e.g., interactive television, which flopped in a massive display of the limits of central planning). Today, the FCC is continuing to Areserve@ spectrum for new technologies that it might choose to promote. In 1970, the FCC managed to Afind@ 120 MHz for cellular, SMR and other uses by releasing Areserved@ spectrum at the upper UHF TV bandwidth. It continues to husband spectrum.

4. Why is the Existing System Supported?

Support for the block allocation system is often expressed quietly and away from the public discourse. The truth is the system protects incumbents and is a barrier to entry for competitors. The essence of the artificial spectrum scarcity is that most spectrum, according to charts, is already allocated. Innovators and entrepreneurs are faced with burden of identifying available spectrum for their enterprise. If none is available, they must embark upon a lengthy petition process with the FCC for re-allocation of the spectrum. New spectrum allocations require changes in FCC Rules. Such changes can be initiated by the FCC but more often are initiated by a company or interested party.

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[31] 47 C.F.R. 73.606(b).

[32] Comm.Daily, *supra* note 29, at p. 2.

[33] I. Brodsky, *supra* note 22, at p. 17.

[34] National Telecommunications and Information Agency, *U.S. Spectrum Management Policy: Agenda for the Future*, p. 55 (February 1991).

Should the FCC decide that a petition is worth attention, it issues a ARequest for Comment@ and AReply Comments.@ Afterwards, the FCC issues a ANotice of Proposed Rulemaking@ or ANotice of Inquiry.@ More comments are solicited from the public. Finally, if the FCC agrees with the NPRM, it issues a AReport and Order.@ Should it decline the petition, it does so in a AMemorandum and Order.@

Petitions require expensive lawyers, but more importantly, can *take years.* In a digital era, when product life cycles are typically three years or so, such a delay in even launching a business can be fatal. Hewlett Packard=s revenues typically come from products that did not exist the year before. The average consumer electronics device *has a commercial lifespan of two months.*[35] As noted previously, delays in cellular telephony cost the economy $85 billion, and PCS delays cost the economy a further $9 billion. The point here is that start-up companiesCthose which are the source of innovation and new technologiesCfrequently cannot wait the years required in the regulatory quagmire. More damning, even if a start-up or other party were to persevere, a proceeding at the FCC may result in a company emerging with permission to introduce obsolete technology. The formal technical regulations, published still later, lock the older technology in place for years and restrict adoption of new, less expensive and more capable alternatives. Nothing could be more anathema to the digital economy and dynamic change.

The upshot is that, as Noam writes, the wireless market is essentially oligarchical. Wealthy telephone, cable and media companies control most of the valuable spectrum made available. Incumbents, however, are not limited to the private sector. The greatest incumbent and most wasteful user of spectrum is the U.S. government itself. Government use is not necessarily about defense and national security issues, although such concepts are prominent in NTIA descriptions of governmental spectrum needs.[36] In addition to legitimate security issues (Department of Defense, FBI counter-intelligence and law enforcement, the intelligence community, Secret Service, etc.), the Departments of Agriculture, Commerce, Energy, Federal Emergency Management Agency, General Services Administration, Interior, Health and Human Services, NASA, Transportation, Treasury, U.S. Information Agency, Veterans Affairs, etc. all lay claim to reserved spectrum.

Beyond national security issues, civilian governmental use of spectrum is massive, uncoordinated and wasteful. Each department, bureau or group frequently operates on different frequencies, even for the most mundane matters. There is little or no incentive to be efficient about governmental spectrum use. Technically, the government frequently uses antiquated and spectrally inefficient equipment. The spectrum management system rewards inefficiency.

Table 2: Spectrum Allocation Between Public and Private Sectors

Band	Exclusive		Shared	
	Federal Government	Private Sector	Accessible to Private Sector	Not accessible to Private Sector
30,000 MHz and below	3,177 MHz (10.6%)	10,449 MHz (34.8%)	9,834 MHz (32.8%)	6,542 MHz (21.8%)
Above 30,000 MHz	2,000 MHz (0.7%)	7,600 MHz (2.8%)	22,000 MHz (8.1%)	238,400 MHz (88.3%)
Total	5,177 MHz (1.7%)	18,049 MHz (6.0%)	31,834 MHz (10.6%)	244,942 MHz (81.6%)

Source: FCC Rules.

Table 2 indicates that the bulk of spectrum is ostensibly available to nonexclusive federal and private use, i.e., it is Ashared.@ Shared spectrum is nominally accessible to private sector. On paper, therefore, the private sector has

[35] D. Tapscott, *The Digital Economy*, 63 (1995).

[36] A NTIA publication, *Federal Spectrum Management: How the Federal Government Uses and Manages the Spectrum* (August 1995) begins its description of the government=s use of spectrum with a 5 page description of the Department of Defense, Air Force, Army, Navy and Marine Corps= need for spectrum.

access to about 90 percent of the spectrum below 30 GHz. Not so. For one category of shared spectrum, the FCC and NTIA have yet to promulgate a complete set of rules about use by nongovernment agencies. Until such time, the government retains exclusive use of large portions the spectrumC6,542 MHz. Moreover, the public does not know how much of this Ashared@ spectrum is currently being used by the federal government, and if so, how efficiently. A second category consists of spectrum that is actually shared by the government and private users, which consists of approximately 9,834 MHz. The private sector shares this with the government on a secondary basisCi.e., the private sector must defer to governmental use. The government is under no obligation to inform the public (or even the FCC, which regulates the private sector) how intense the spectrum use is, how efficient it could be, or the technologies being used by the governmental incumbents. Such uncertainty has a significant impact on commercial development.

The cost of this hoarded spectrum to the economy is beyond easy measure. In February 1995, the NTIA issued a Spectrum Reallocation Final Report, responding to a direction from Congress two years earlier in 1993 to make 200 MHz of government-used spectrum available to the private sector. The Report is a compendium of many interested parties= contributions. The FCC asked to issue regulations on this spectrum in 1996, with at least a decade to come before it is fully available for use.

Comments by private-sector companies indicate that spectrum now reserved for the government could be easily deployed into commercially desirable services and products. If the PCS example is a viable analogy, such cleared spectrum will gravitate to higher-valued uses. The lost value to the economy by this hoarded spectrum would be equivalent on an equal bandwidth basis with the $1.5 billion annual cost incurred by delays in PCS services. Clearly, NTIA and the FCC could alleviate much of the pressure for more spectrum by promulgating rules for the portion of shared spectrum to permit private-sector use.

III. DIGITAL SPECTRUM: Prometheus Unbound

A. The Digital Economy And The Morphology Of Freedom

Two distinct and heretofore separate market structures are converging at the close of the 20th century, linked by the microprocessor: the computer and telecommunications industries. A third, representing the multimedia content, is joining to create a new digital economy. More Americans today are involved in manufacturing computers than automobiles. More Americans make semiconductors than construction equipment, and more work in data processing than in petroleum refining.[37]

Today's computer industry features: 1) low barriers to entry by new competitors, with premiums placed on technical innovation, customer service and price; 2) market-based allocation mechanisms with minimal government role and interference; 3) increasingly Aflat@ architectures, distributing more power to the end-user, as from mainframes of the 1970s to today's PCs, or from client-server to peer-to-peer networks; 4) unprecedented flexibility available to the individual end-user; and 5) technical regulations and standards determined by markets, not governmental bureaucrats.[38]

The interaction of these characteristics makes Moore=s Law a reality for consumers: every year, computers and digital devices are more powerful, smaller and available at lower prices. Prices for RAM chips are not set by

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[37] D. Tapscott, *supra* note 35, at p. 9.

[38] There is a distinction between Acompetition@ and Amarket forces.@ The FCC has used competition as a regulatory tool, such as its policy of Aduopoly@ for awarding cellular and other licenses. Market forces substitute the public's decision-making through purchasing power for the FCC's administrative determination of what is best for the public. Fowler & Brenner, *A Marketplace Approach to Broadcast Regulation,* 60 Tex.L.Rev. 207, 209 (1982).

government regulation. Prices are set by market factors. Consumers have choice of brand and features. Industry standards such as DVD, MPEG[39] and PCI bus interfaces as well as operating systems are not imposed by government. The computer industry transformed the Internet into a genuine phenomenon in less than 2 years. New companies such as Netscape and Pixar command premiums for investment, setting standards for new jobs and economic growth. Older telcos such as MCI and AT&T seek to join this trend and are all offering retail Internet services to their customers. Cable companies, as well as television networks and broadcasters, are trying to react and adopt Internet strategies and alliances. Those that survive will be in the business of connected computing.

[39] The Motion Pictures Expert Group (AMPEG@) is a standards committee composed of people from the motion picture industry and the computer industry. The MPEG standard allows video playback on PCs, game consoles such as 3DO and Nintendo, etc. Microsoft includes MPEG in Windows >95, licensed from MediaMatics, a small MPEG developer. A voluntary standard for digital television has also been adopted by the private sector by the U.S. Advanced Television Systems Committee.

In contrast to this digital free market, government intervention and regulations in telecommunications created a static structure featuring: 1) few, large and entrenched market monopolies, such as broadcasters, phone companies and cable companies protected by barriers to entry[40] due to high market entry costs and by the government itself through regulations; 2) administrative judgments rather than market signals to determine resource allocation; 3) rigid, hierarchical network architectures and data flowsCbroadcast from point to multi-point (TV, radio) or the elaborate copper-based twisted pair infrastructure of telephony; 4) lack of individual consumer choice and flexibility; 5) rigid stratification of industries, such as broadcast, cable, telephone, etc.; and 6) government-imposed technical standards.[41]

The reform plan set forth below implements the steps needed to transform the wireless industry into the digital era and beyond. The plan is couched in terms friendly to digital technologies, but its reliance on market forces and freedom to transfer resources with minimal restrictions and encumbrances is actually technologically neutral. Any technologyCanalog, digital, photonic or their successorsCcan be accommodated within this framework. The key point is that none are handicapped as is currently the case. The plan introduces reform in a measured, sequenced step to allow markets and industry time to adapt and allocate resources in the most efficient and responsible manner.

B. Real Reform To Make A Difference

Spectrum reform is a perennial topic in policymaking circles, but little actually has been accomplished. Reforms focused on improving distribution methods, such as the 1993 introduction of auctions for licenses to use bands of spectrum, address symptoms, not the underlying pathology.[42]

Auctions are more efficient than administrative hearings or lotteries. But their overall impact on improving the spectrum management system is slight, because government retains centralized control over which bands can be used for which purposes. The government *does* raise revenues via auctions. It extracts large payments from auction bidders for the privilege of being subject to government regulation.

Meaningful reform requires re-thinking the *purpose* and *mechanism* for government-determined spectrum allocation. Dynamic change undercuts its rationale and viability. Real reform also requires moving beyond releasing government-imposed encumbrances on spectrum service classifications, block allocations and accompanying

40 Barriers to entry are costs imposed on a new entrant to a market that is not imposed on those already participating. Theoretically, barriers to entry can be actions taken by an individual private-sector firm. In this industry, they almost all derive from government laws, rules and regulations.

41 For example, for decades the FCC made it illegal for a consumer to own his or her telephone or connect an answering machine to a telephone line. The FCC, through its allocation process, discussed *supra*, vastly miscalculated VHF allocation and limited consumers to three networks.

42 *Omnibus Budget Reconciliation Act of 1993*, Pub.L. No. 103-66, 107 Stat. 312 (1993). While one need not go so far as Noam to claim that the auctions are a Atax@ on the American consumer, certainly, auctions do not address fundamental problems of restrictions on spectrum use.

technical regulations. Government control no longer serves a valid purpose. The block allocation system should be abolished, not made over into a Akinder, gentler@ governmental usurpation of markets. Market signals are a better mechanism to decide which services are to be offered over which portion of spectrum.

Meaningful reform recognizes and indeed celebrates the truism that technology is no longer stable. Analog FM radio, the basis for broadcast as well as analog cellular telephony, lasted 40 years as a durable standard. Technology today offers discontinuity: a breakthrough. The very substance of a digital signal, the binary 1s and 0s, is qualitatively different from analog waveforms. The opportunities are not analog=s Amore, better, faster,@ but radically new services, products and industries. As digital technologies are eventually succeeded by yet still more advanced technology, the trend will continue.

C. A Sequenced Program of Change

Real reform aims at transforming the current regulatory regime into a market-oriented framework for the 21st century. Reform not only addresses statutory and regulatory issues in Washington, D.C. but will create the environment for the redistribution of capital in the industry to reflect real competitive capabilities, not regulatory advantages. Bluntly stated, the market capitalizations of major telephone and cable companies which now enjoy the advantages of being incumbents in the FCC=s protected regulatory world will be affected. New, innovative companies desiring to participate in spectrum-related markets likely will also experience fluctuations in capitalization.

To implement a reform program creating market signals, attention must be paid to both the end desired and the role of markets in arriving there. Accordingly, the model envisions an orderly, sequenced introduction of programmatic change to permit markets to anticipate the direction of change and its impact. Information should be as transparent as possible to the public, allowing informed decisions about investment and participation.

The privatization program envisioned here requires Congress to establish a streamlined interdepartmental group with direct responsibility and authority for the privatization. It must be a closely coordinated team effort. Participants should include representatives from the FCC and NTIA, as well as others such as Treasury and OMB (collectively, the Steering Committee). The experience of other nations teaches us that such a group is instrumental for success. The Steering Committee should be vested with the explicit authority for the sale and transfer of ownership interests in spectrum. Reporting to the Steering Committee should be inter-disciplinary working committees organized along functional lines, each committee having the responsibility for achieving specific tasks such as supervising the privatization (including, but not limited to auctions), creating the new Spectrum Registry, and facilitating the expansion of the private frequency coordinators system.

Privatization experience in Eastern Europe, the former Soviet Union, the United Kingdom, Latin America and New Zealand shows that it is essential at the outset to operate from a clear timetable for privatization.[43] A realistic timetable establishes and helps maintain the momentum and discipline necessary to consummate the program. Moreover, a timetable permits regular review of the progress of the Steering Committee and the impact of such progress on achieving the overall goals. The privatization program is composed of three distinct phases, each lasting three years. Together with the initial year of coordination and organization, the program envisions transition to a market-based system in ten years. Each phase is timed to permit both capital markets and the corporate participants in the process to adjust to the transition and anticipate the most desirable means of allocating capital and investment.

Real reform begins with Phase One, in which the government will dismantle and phase out the block allocation system. In Phase Two, four years into the plan, the Steering Committee will begin the mass privatization of

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[43] For a good overview of a recent experience, see The World Bank, *Implementing Reforms in the Telecommunications Sector: Lessons From Experience*, ed. B. Wellenius, P. Stern (1994), pp. 411B483.

spectrum. Finally, in Phase Three, the Steering Committee will establish a national title registry system for spectrum, under which registrants will be free to use, transfer or commit their spectrum.

IV. MAKING THE TRANSITION

A. Phase One: Transition From Block Allocations

The first task before the Steering Committee is to begin the process of removing the encumbrances on spectrum inherent in the block allocation system. At stake is tens of billions of dollars in *annual* lost economic activity due to inefficient, regulated use of spectrum.[44] The FCC itself has studied these costs and the benefits that would accrue with flexible spectrum use based in part upon a recommendation of its Office of Plans and Policy.[45] The FCC considered whether a limited market should be permitted to develop, with spectrum owners able to determine the type of service to be adopted within a narrow bandCin this case, the 6 MHz allocated to particular UHF channels. This proposal, considered innovative at the time, merely hints at the potential for de-zoning spectrum.

De-zoning will unleash massive and immediate economic benefits. In 1992, the FCC=s Evan Kwerel and John Williams of the Office of Plans and Policy examined what de-zoning would mean for the economy.[46] The report examines the impact of releasing a single UHF licensee in Los Angeles to switch from television broadcast to provision of cellular telephony. Net economic benefits from a single television station having the freedom to chooseCafter accounting for transition costs and lost economic activity associated with television broadcastingCis estimated to total almost $1 billion. De-zoning spectrum on a nationwide scale will generate external benefits massively exceeding this local example.

1. The Voluntary Allocation of Radio Spectrum

In Phase One, spectrum will be Ade-zoned@ through almost all 800 bands. The Steering Committee would be authorized by statute to direct the staggered removal of government-imposed service classifications on spectrum. In practice, this means the end of dividing spectrum and suballocating it to groups based on a stated purpose or function. There will be no more spectrum ghettos based on identities and labels.

Removing government spectrum classifications will stimulate the development of new coordination and management assets. Real reform removes government=s role and strengthens industry collaboration. This is already happening and will increase by expanding the role of existing private frequency coordinators (PFCs). Starting in 1986, the FCC initiated a series of rules to enlist PFCs and certify them as competent to manage spectrum. The system works well and can be expanded to be the foundation for a private property-rights-based approach to spectrum management.[47]

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44 *The Telecom Revolution: An American Opportunity*, The Progress & Freedom Foundation at p. 26 (1995).

45 The proposal effectively permitted land mobile users to Abuy out@ UHF spectrum and would establish a market in spectrum, pitting land mobile users against broadcast owners. It is not a pure market system because the FCC would continue to issue licenses.

46 Evan Kwerel and John Williams, *Changing Channels: Voluntary Reallocation of the UHF Television Spectrum*, FCC Office of Plans & Policy (OPP) Working Paper No. 27, 1991.

47 In 1996, a user seeking a license for certain services must provide technical coordination or evidence of prior coordination with existing spectrum users before approaching the FCC for a license. The private sector through PFCs typically provide this service. Applicants seeking new licenses or modification of existing ones send their application to a PFC appointed to manage a particular slice of spectrum. The PFC, after checking the application for completeness with existing rules and regulations, recommends the spectrum frequency most appropriate for the application. The FCC reviews the PFCs recommendation. In reality, the Commission routinely approves the requests and rarely overrules the PFCs. The applicant typically pays a fee for the service.

In Phase One, the PFCs will assume greater responsibilities over de-zoned spectrum.[48] PFCs now will serve all users of the spectrum bandwidth assigned to the coordinators by the Steering Committee. Their role will be considerably broader than serving spectrum ghettos of particular industries or users such as railroad companies, utilities, etc.

For a user, this system opens new possibilities unavailable currently. Consider a user requiring more bandwidth because of a rapid increase in business volume. The first option would be to consult with its assigned PFC to determine availability of more spectrum within the bandwidth assigned to the user=s PFC. Additional spectrum may or may not be available. Now, however, the user will have another option. Because spectrum is de-zoned, the user may consult with other PFCs which manage different portions of the spectrum. Other regions of the frequency bandwidth are available. There may be technical, economic or business reasons which might make a different portion of the bandwidth more or less desirable. Users seeking access to spectrum are thus able to work with coordinators across the entire bandwidth and identify the most suitable spectrum for their needs. Egregious examples of current wastage, such as the massively fallow spectrum of the current UHF TV block allocation, will be eliminated. The PFCs will coordinate and ensure that noninterference requirements are met.

The NTIA (or its successor, such as a PFC) will serve the same function for the nondefense/national security functions for the government. Classifications of government land-mobile services according to agency will be abolished. The government civilian agencies will share spectrum and, through recourse to a PFC-type entity, will have the same ability to work with the regime as the PFCs perform for private-sector entities. Public safety spectrum (such as law enforcement, fire, ambulance/health care), radio astronomy, transportation, and national defense/security spectrum will be reserved and exempt from this process and Aretained as is.@

The Steering Committee inevitably will encounter opposition, particularly from existing industry incumbents and regulators. Warnings of Achaos@ and Aunmanageability@ during Phase One are to be anticipated. The claims will be overstated. The FCC is already slowly moving in this direction. The recent PCS auctions provide relatively unencumbered bandwidth. Phase One simply extends this trend to the rest of the radio spectrum. Choice and flexibility are inherently untidy to a central planner and always will be. Major industry incumbents also can be expected to oppose Phase OneCat least, at first blush. After all, they already have their spectrum. They are already making money. Incumbents will not easily forego the years and money spent on lawyers to fight for regulatory advantages and hobble opponents. Yet all will benefit from de-zoned spectrum. Flexibility of use will enable all to pursue their business plans to their fullest extent. Eventually, all will see that de-zoned spectrum will permit those with the best strategic planning and business models to prosper and win.

2. The Removal of Technical and User Regulation Completes De-zoning

In addition to ending the block allocation according to service classification, de-zoning spectrum ends the state-imposed technical standards on each band of spectrum. Currently, the government instructs users and equipment manufacturers on the specifications needed to design their networks. Compliance is mandatory to operate in a particular band of frequencies. The regulations are detailed, including power radiation specifications, antennae and tower rules, etc. Some regulations even refuse to allow spectrum to be used for mobile devices, etc. These restrictions can be conceptually classified as Ainteroperability/compatibility@ rules, Ainterference and efficiency requirements@ and Aperformance@ standards.

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[48] The NTIA in its 1991 study confirmed that frequency coordination by private-user groups or clearinghouses was widely supported in industry. NTIA Study, *supra* note 34, at p. 43.

Spectrum in a post-analog era must be free of such onerous, mandatory regulatory restrictions. Government regulation impedes technical innovation. In principle, standards can be a desirable baseline benchmark and can be considered efficient. But a fast-changing digital economy (Moore=s Law) makes promulgation of technical rules in the Code of Federal Regulations untenable. Codification locks those standards into semi-permanence.

One should anticipate the argument that lack of government-led standards will result in confusion, signal interference and the like. But if standards are necessary, the computer industry demonstrates that private industry, not government, should set them. Interoperability standards in particular are best left to the market. Fortunately, the government did not impose CP/M and the Zilog Z-80 on industry in the early 1980s. Nor did it mandate computers to use UNIX, MS-DOS, Windows, OS/2 Warp or MacIntoshes. In fact, the Antitrust Division of the Justice Department was concerned that Microsoft might be frustrating competition by setting de-facto standards! Consumers chose the systems and software best suited for their needs. Compatibility issues did not require government intervention. The FCC itself has moved slowly in this direction,[49] but more remains to be done.[50]

In Phase One, the government will get out of the business of dictating signal-to-noise ratios, minimum field strength requirements for television transmitters, and minimum standards for FM broadcasters, etc. In place of the myriad rules will be a simple framework: noninterference. The model to be utilized is based on the six years of experience gained by New Zealand=s privatization of the radio spectrum described below. Essentially, the PFCs will have the initial task of coordinating spectrum use. Parties wishing to broadcast may do so upon certification to the applicable PFC that the technology and use intended will not interfere with existing use of the neighboring bandwidth. In the event of interference or disagreement, the parties are subject to mandatory arbitration in a manner similar to that adopted in the Telecommunications Act of 1996 with respect to interconnection negotiations. The New Zealand experience confirms that arbitration is a valuable and useful requirement. As with the 1996 Act, the parties may appeal an arbitration decision, in this case to the courts if necessary.

De-zoning spectrum also alleviates controversies such as allocating digital spectrum to so-called Advanced Television (ATV, *nee* HDTV). In Phase One, those broadcasters desiring to broadcast digitally over their existing analog spectrum may do so. Moreover, those broadcasters wishing to make two separate broadcasts, one analog and the other digital, can do so. The standards for digital broadcasts developed by the so-called Grand Alliance simply

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[49] The FCC itself has attempted to curtail some of its technical rulemaking activities in favor of market forces. It opened many of its technical standards to public scrutiny in the mid-1980s through a *Technical Regulation Inquiry. Re-Examination of Technical Regulations*, Notice of Inquiry and Proposed Rule Making, 48 Fed.Reg. 14,399 (1983); Report and Order (1984).

[50] Technical burdens nonetheless remain. Some regulators such as the NTIA still argue that the government has role in determining certain technical standards such as emission limits on transmitters or receiver susceptibility, etc. See e.g., NTIA Study, supra note 34, (urging a more relaxed but essentially unchanged continuation of the spectrum management system). The NTIA relies on an interesting technique in its study, citing industry responses to its NPRM announcing the spectrum study. What the NTIA does not delve into, however, is the fact that incumbents supported maintaining the existing system precisely because it is a barrier to entry to competition. Moreover, one should not expect industry to openly criticize the FCC in such a public fashion while remaining subject to the FCC=s administrative control.

direct broadcasters which portions of spectrum to secure through applications and/or auctions in Phase Two. ATV will flourish or fail not because of government diktat, but through the market and the existence of a viable business plan for such a service. Certainly, the government will not Aaward@ spectrum to broadcasters.

3. De-zoning Hastens ASpectrum Efficiency@

Freedom from service, technical and user restrictions will usher in a new era of relative spectrum abundance. Its foundation will be that users now will have incentives to adopt more efficient digital technologies. Moreover, de-zoning and its accompanying incentive for technical upgrades will have a significant impact on how the de-zoned spectrum may operate in a private market of property rights. This alone will yield efficiency. Consider that many of the original Ataboo@ separations in the television bandwidth, for example, were established when analog receiver and broadcast technology and antennae mandated particular channel separations. Technologies have long since made reception and discrimination more sophisticated, but there has been little incentive to manufacture televisions and receivers to be more efficient. The spectrum was there and no business use could be made from efficiency. Such artificial Ainterference@ issues may be significantly reduced if incentives are made available through efficient use of spectrum to upgrade the existing analog plant and infrastructure.

B. Phase Two: Mass Privatization of De-Zoned Spectrum

Phase One is anticipated to last three years. This period of time will be required to acquaint many users accustomed to the command economy of the analog past to the new regime. Moreover, PFCs must be strengthened and familiarized with their expanded scope of duties and responsibilities.

Phase Two begins the de-nationalization of spectrum. The Steering Committee will have one overriding goal and measurement of performance: how much spectrum has been turned over for private use. Many economists and policy advocates have urged the creation of property rights model for spectrum allocation for decades.[51] The plan incorporates the best aspects of international experience with privatizing spectrum. Title to spectrum, accordingly, is awarded in fee simple absolute, subject to a noninterference standard and other common law applicable to property.

A property model, using market forces, requires four elements for implementation: 1) defining *exclusive* rights that are unambiguous and take into account the special properties of spectrum; 2) an enforcement mechanism for those rights; 3) an exchange mechanism permitting efficient transfer of the property; 4) and freedom of contract for use of the spectrum.

1. Learning from New Zealand's Spectrum Privatization

The New Zealand model is particularly instructive here. In 1989, New Zealand=s Labour government enacted the Radiocommunications Act (the AAct@) which provided for the mass transfer of radio spectrum to the private markets. When the Act was passed, a property-rights spectrum management scheme was unique in the world. New Zealand granted rights to spectrum in two tiers: 1) management rights to bands of nation-wide spectrum lasting 20 years with the possibility of reverter back to the government at the end of that period, and 2) within any band, rights to specific bandwidth identified by geographic or area locale.

[51] A.S. DeVany et al., *A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering*, 21 Stan.L.Rev. 1499 (1969); Hazlett, *The Rationality of U.S. Regulation of the Broadcast Spectrum*, 33 *Journal of Law and Economics*, 133, 136 (1990); Mueller, *Technical Standards: The Market and Radio Frequency Allocation*, Telecommunications Policy 43 (1988); Felker and Gordon, *A Framework for Decentralized Radio Service*, Federal Communications Commission, Office of Plans and Policy (1983).

Six years after the Act, the Ministry of Commerce issued a preliminary report in December 1995 commenting on the successes of the Act and areas for improvement.[52] The Ministry noted two overarching principles which it urged be considered for adoption in an amended Act. Our plan incorporates theses lessons. As will be seen, the overall conclusion to be drawn from the New Zealand experience is that half-measures will not yield the expected results.

First, the Ministry noted that the finite term on property rights was undesirable and limited the ability of a market to function properly. The Ministry concluded the relatively disappointing number of applications for band management are attributable to the limited (20-year) duration of the property rights granted. The Ministry also noted that there are no technical or other reasons for a fixed term. Accordingly, they suggested that no limits be established. Our plan reflects this experience by granting title to spectrum in fee simple absoluteCi.e., with no duration or similar restrictions.

Second, the Ministry noted that the Act encumbered spectrum more than was necessary with fairly technical restrictions, including floors on radiated power, and inflexible requirements on resolving noninterference. The Act requires negotiation of interference issues or enforcement in the courts based on the Afirst in time@ principle. Under this approach, the party first using the spectrum had priority with respect to interference. The Act specified the areas of flexibility and negotiation permitted band managers and prevented many options from being available to partiesCsuch as an interfering party being permitted to broadcast subject to reimbursement or other agreement with the interfered-with party. The Ministry urged that the band managers be given greater flexibility, with technical restrictions removed or relaxed, and arbitration in the event of disputes. Such a requirement for flexibility will be essential for spread spectrum and other digital approaches.

Our plan incorporates these lessons. The de-zoning of spectrum in Phase One contributes to the flexibility of spectrum transfer. Title is not of limited duration. Moreover, the establishment of a simple noninterference standard is more flexible than the current New Zealand regime. For example, under this plan, should a party desire to transmit at a given location and at a certain power level, there may be interference with another party=s spectrum. Under the plan, in the process of certifying noninterference to the PFC, the parties may agree to permit the broadcast provided reimbursement or other compensation is made. Noam=s AOpen Access@ regime, if and when CDMA arrives as a consumer technology, can be accommodated without change. Flexibility is the rule.

Two other aspects of New Zealand=s experience warrant further comment as well. The Ministry and observers noted that the Act did not address issues of Awarehousing@ spectrumCi.e. the purchase of spectrum to remove it from market without utilization. Combined with major market power, such activity could pose a major constraint on competition. An example of this is Telstra=s purchase of a cellular concession for approximately NZ10 million, which as of this writing, is still undeveloped. Our plan agrees with the Ministry=s assessment that privatization under the plan requires vigorous enforcement of existing antitrust law.

More importantly, however, the Ministry=s concerns highlight the need for combining de-zoning spectrum with a privatization plan. Without de-zoning, privatization still may create bottlenecks. A party=s use of spectrum (or lack of use), for example, would not be a major problem in the United States because other spectrum could rapidly be deployed to fill market demand for service. Warehousing simply is not attractive from either a tactical or strategic point of view when anyone else can use their spectrum as needed by the market.

A second matter raised in New Zealand is intriguing for the future and the evolution of digital technology. The Act=s granting of exclusive licenses, the Ministry noted, may have an effect on the use of digital technologies

[52] *Radio Communication Act Review: Preliminary Conclusions*, Ministry of Commerce (Wellington, December 1995).

which, through CDMA or FH-SS, may be able to utilize Ashared access@ regimes. In other words, the Ministry asked if the Act is compatible with Noam=s public highway model or Gilder=s elegant description of the Awide and weak@ spread-spectrum future. In New Zealand, the Act grants exclusive title to all licenses, which have typically been defined in analog narrowcasting fashion. The basis of CDMA and FH-SS technologies are that they require wide bandwidth and broadcast at low power. The decision to adopt a digital or an analog network is a fundamental and often irrevocable choice. Will privatization on an exclusive basis prove to be as great an obstacle to a digital future as the existing block allocation system?

Our plan anticipates these concerns. First, the plan permitsCbut does not requireCcreation of wideband property rights through aggregation. The de-zoned essence of spectrum assists this process. In addition, the title accorded is fee simple. The titleholder can offer shared access areas to users in any fashion, as a highway as Noam envisions, or in some other manner. Any applicant for spectrumCcommunities, libraries, industry groups, etc. can decide how to utilize it. It is not clear, however, that specific Adigital ghettos@ for spread spectrum are necessary. The ability of CDMA to exist in an overlay mode with other frequenciesCshould it prove viable in a commercial environmentCwill simply be a basis for negotiations among interested parties and PFCs. All will have both incentives and means to be flexible. The point is that this plan permits the marketCnot the governmentCto determine how these technologies are to be used. As Thomas Hazlett has cautioned, it would be as much of a mistake to create a regime specific to CDMA (let alone variants of CDMA) as it was to do so for analog radio. There is no need for industrial policy.

2. Obtaining Title to Spectrum

As a matter of law, the 1934 Act must be be revised to explicitly authorize the Steering Committee to create and distribute the property rights in spectrum.[53] The mechanism to be employed by the Steering Committee is simple. The tranches of spectrum as de-zoned in Phase One will be announced as available for application for the presumptive granting of title to spectrum. One of the essential working groups affiliated with the Steering Committee will be charged with the task of identifying the scope of the spectrum footprints to be offered to the public.

Winners of previous spectrum auctions (who are in good standing with respect to payment and interest) will be quick-deeded title to their spectrum. All other existing and new users will have an opportunity to submit a sealed application(s) for remaining spectrum. In this sense, it is essentially a bottom-driven approach. In the event that an applicant is the sole entity requesting the spectrum, the applicant is granted a title in fee simple. It now owns the spectrum. In the event of multiple applicants, auctions will be held to determine the most efficient allocation of the spectrum. This system is relatively neutral between incumbents and new or potential users of spectrum. On the one hand, incumbent users of spectrum have a valid basis for determining the value of the spectrum based on their existing business model. Moreover, incumbents now will have an incentive for using spectrum efficiently, thereby making more spectrum available for new entrants. On the other hand, new entrants are granted a level playing field with the incumbents. Both have an equal opportunity to gain access to spectrum.

One argument advanced in spectrum debates against including incumbents in auctions is the large number of license transfers in the secondary markets (see Table 3). Under this reasoning, broadcasters, for example, are said to have already paid for spectrum when they purchased the company.

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[53] 47 U.S.C. ' ' 301, 304, amended by the Telecommunications Act of 1996, 104th Cong. 2d. Sess. (1996).

In these transactions, the assets such as transmitters, cameras, buildings and the like comprise a small portion of the valuation. The remaining value, according the FCC Office of Policy and Plans, can be attributed to the value of the operating license to use the spectrum.

Table 3: Broadcast TelevisionCSample Transactions		
KTLA Los Angeles	1985	$510 Million
WWOR New Jersey	1991	$300 Million
WNYC New York	1995	$207 Million
KTTY San Diego	1995	$ 70 Million

Source: Broadcasting and Cable [October 1995]

The reality is that the broadcasters are extracting profits from a monopoly position.[54] The essence of the digital era is to remove artificial barriers to entry such as regulatory advantages. By de-zoning spectrum and making it available for noninterfering use, competition is strengthened. The valuation of businesses will be in accordance with traditional cash flow and earnings per share techniques based on the health of the underlying business. Moreover, by applying for and if necessary bidding for spectrum, each of the businesses would be free to continue broadcasting as well as explore other uses and business opportunities.

3. *Valuing the Spectrum*

Phase Two envisions using existing auction mechanisms to distribute spectrum in the event of competing applications. Congress approved auctions as a distribution mechanism in 1993 after considerable debate. Auctions conducted by the FCC, beginning in 1994, provide a few data points to enable speculation on what a mass privatization program might generate in terms of revenue.

To date, the FCC has conducted several auctions: (i) interactive video and data services (IVDS); (ii) regional narrowband personal communications systems (PCS); (iii) national narrowband PCS; (iv) broadband PCS; (v) specialized mobile radio (SMR); (vi) multipoint microwave distribution systems (MMDS); and (vii) digital broadcast satellite (DBS) licenses. Actual data points are now available to determine what nominal valuation is placed on certain spectrum licenses (see Table 4).

Table 4: Values of Auction Bids for Spectrum

Spectrum Use	Number of Licenses	Available Spectrum (MHz)	Auction Revenue	Unit Price ($/MHz-Pop)
IVDS	594	0.5	$249 million	$1.99

[54] Consider the case of WNYC in New York. Its equipment and assets total approximately $11 million, leaving the spectrum to be priced at $196 million. In fact, ITT, which offered to buy the station, also owns the Knicks basketball team as well as the world famous Madison Square Garden complex in Manhattan. The business plan of ITT is said to include, among other things, turning WNYC into another so-called Superstation. By necessity, the real presence of WNYC will therefore not be broadcast over the limited spectrum license in New York, but in placement on basic tier cable offerings nation-wide. The value of the spectrum is in fact secondary. The real value is derived from the artificial monopoly position accorded to broadcasters, this case WNYC, through the regulations.

Regional PCS narrowband	30	0.45	$395 million	$3.51
National PCS narrowband	10	0.7875	$617 million	$3.13
Broadband PCS (A and B blocks only)	102	60.0	$7.736 billion	$0.52

Source: FCC

The Commission also carried out its first satellite auctions on January 26, 1996. MCI bid $682.5 million for 28 frequencies at 110 west and Echostar DBS Corp. bid $52.3 million for 24 frequencies at 148 degrees west. The C Block, SMR and MMDS auctions have not been completed as of this writing. Nonetheless, to date, the C Block bids have totaled over $10 billion on a gross-up basis[55].

No estimate of revenues to be generated from auctions can be definitive. In fact, the revenue to the government is actually not the essential point or purpose of the exercise. Secondary markets will over time reflect the true value of the de-zoned spectrum. Initial auction prices recorded to date for IVDS and PCS reflect both the bidder's valuation of the amount of spectrum offered and the service, technical and use restrictions imposed by the existing block allocation system (as well as the lack of a fee simple property right). In other words, auction valuations are distorted by the Azoning@ of spectrum. Different zoning of spectrum results in different valuations, even for the same amount of spectrum. This typically becomes more clear in the secondary markets, as more objective analysis of the potential for spectrum use and profits becomes more evident.

A number of assumptions must be made about the amount of spectrum available under Phase Two for auction. The more spectrum available for auction, the lower the price the auction will raise on a $/MHz-pop[56] basis. This is simple supply and demand economics. The Steering Committee=s goal is to privatize spectrum as rapidly as possible rather than dribble portions of spectrum out to the market to maximize revenues for the government. In other words, mass privatization in Phase Two actually intends to drive the price of spectrum to be as low as possible. This will reduce the barrier to entry posed by the prodigious sums required to buy into it now. The amount of spectrum available for auction, however, will be determined by demand and the number of competing applications. (Recall that spectrum already distributed by auctions will not be available for bidding but quick-deeded to the original bidder.)

Given these parameters, the spectrum closest in form and function to the de-zoned spectrum of Phase One is the broadband PCS offerings. The amount of service, technical and user restrictions imposed upon PCS are relatively relaxed compared to other spectrum. A baseline use of broadband PCS prices as an initial proxy for auctioned de-zoned spectrum suggests that the 300 kHz to 3 GHz range used by AM, FM, VHF and UHF as well as other mobile

55 The C-block, particularly for Aentrepreneurs,@ permits parties bidding on spectrum to receive a discounted payment schedule. The actual revenue to the Treasury will be somewhat lower.

56 The $/Mhz.-pop ratio is a standard formula that divides the amount paid by the product of the Apops@Cthe number of consumers in a given MSA, BTA, etc. and the amount of spectrum purchased. As with any statistic, its use should be viewed with caution, as the type of service permittedCpaging, telephony, etc. C will have a dramatic impact on the ultimate value and rationality of a given ratio.

services could generate $300 billion in auction revenue. This figure is reached by using the 0.52 cents per MHz-pop ratio of PCS and applying it to the amount of spectrum being offered to the market. A composite Abasket@ of all existing auction results for IVDS, NPCS and broadband PCS on a $/MHz-pop basis confirms that an auction could generate over $300 billion.

Are these numbers realistic? No one knows. *Wired* magazine estimates that auctioning just the broadcast spectrum would generate over $100 billion in revenues.[57] The FCC Office of Plans and Policy informed the Senate that auctioning off the rights to 120 MHz of digital ATV spectrum and its analog spectrum pair could yield anything from $11 billion to $132 billion.[58]

The fundamental issue is that spectrum valuation depends on the business model being applied by any given applicant or potential applicant. [59] Compounding the matter is that de-zoning spectrum inherently will affect valuation, because the premium paid for PCS flexibility will now be obtainable across the entire bandwidth. The current $/MHz-pop price ratios available for analysis are therefore less than an optimal means of speculating on spectrum values.

Efforts to look at secondary markets to Aback out@ assets of existing business by examining transactions and estimating spectrum value are also likely not to be accurate. NTIA estimated in 1991, for example, that the entire 400 plus MHz of the broadcast spectrumCAM, FM, broadcast televisionCwould be worth more than $13 billion.[60] Experience with the much more limited PCS 30 MHz A, B and C auctions, which raised over $17 billion in bids among them, indicate the problems with this approach.[61]

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57 *Wired,* March 1996 at p. 115 (basing estimates on FCC auctions completed to date).

58 *Comm. Daily*, May 24, 1995, p. 2.

59 Estimates are merely indications that spectrum auctions can generate significant revenue. Of course, to avoid false precision, proper valuation of spectrum requires familiarity with the various business plans of existing and new market entrants. Such business plans must anticipate the competitive environment, and make assumptions about penetration rates in the wireless markets based on the Atake rate@ and/or substitution rate of competitive offerings. In the case of service providers such as cellular and alphanumeric paging/messaging companies, for example, penetration rates and thus the overall capital expenditure structure of a business will be affected by developments in PCS, two-way paging, little LEOs, analog cellular, SMR and data services. All compete for a finite amount of discretionary spending by the end user. Each service likely will cannibalize a portion of others.

60 NTIA Study, *supra* note 34, at p. 91.

61 The Congressional Budget Office has suggested that digital TV spectrum alone is worth about $12 billion. Here, the analysis compared existing analog uses and revenue flows to estimate what parties might be prepared to bid to keep their spectrum. The

The essential point is that Phase Two auctions will yield considerable revenue to the government. The $0.52 per MHz-pop figure for PCS (which will no doubt be higher once C Block bidding is closed)Cused above to estimate $300 billionCis open to many variables. The more spectrum available, the lower the price. Moreover, not all spectrum will be available for auction. Under the Phase Two model, auctions occur only if there are competing applications for spectrum use. Many portions of the spectrum, particularly above 3 GHz, may therefore be made available to applicants seeking to create Agreenfield@ and Aspectrum commons@ for innovative uses such as wireless Internet (the WINFORUM ASuperNet@, for example), educational and other innovative measures. It is likely that in Phase Two, significant portions of bandwidth will not be contested as vigorously as the PCS auctions, thus lowering the overall revenue to the government. For that reason, a discount factor will be appropriate.

Receipts of $100 billion to the federal government through a mass privatization of spectrum is both a feasible and possibly conservative Afloor estimate.@ De-zoned spectrum under the plan is closest to the PCS digital spectrum. The PCS figure of $0.52 per Mhz.-pop, applied to the analog broadcast spectrum alone, should easily yield this sum. A mathematical Aceiling@ to potential bids can be roughly estimated by applying the same mechanism to the spectrum now available for private sector use, approaching $300 billion. While Congress has correctly noted that spectrum auctions are not driven by budgetary policy needs, it should be confident that mass privatization will yield significant initial revenues, as well as additional revenues from the resulting economic growth and job creation.

C. Creating A Property Rights Management System

Once Phase Two has accomplished the mass privatization of spectrum, a system is required to protect the newly established property rights. The New Zealand experience confirms the desirability of a centralized registry to record spectrum ownership and transactions. The 1934 Act should be amended to establish a Spectrum Registry (SR) to record title and other deed-related information on spectrum.

The revised 1934 Act must make clear that federal pre-emption of state law is a necessary condition to create a national market in specific instances. Attempts to place local regulations and encumbrances on spectrum or other attempts to interfere with the national market established in spectrum property should be pre-empted. In American jurisprudence, the general responsibility to oversee property interests, however, lies with the states. Trespass, breach of contracts, false and deceptive advertising, and local zoning issues with respect to transmitter towers and the like are to be handled by state judicial systemsCjust as states today handle all other property issues.

An observer may question the role of state courts in the plan. The reality is that state law governs property rights in the United States. The American legal system is flexible. In the event of a dispute, parties are first required to enter arbitration with the PFC. Federal courts, under the Federal Arbitration Act, and state courts as well, will enforce this requirement. The New Zealand experience is that arbitration is more valuable and efficient than recourse to the courts.

Should an arbitration fail or legal determination be necessary, state courts are more than capable of competent adjudication. (One of the ironies of recent years is that for all the concerns about state parochialism, etc., the states

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essential issue is that the business model will determine what a party is prepared to bid. It likely will be significantly different from existing spectrum usage. Consider the ATV digital spectrum. This spectrum could be used to broadcast one ATV digital picture, several analog signals, a combination of analog TV and paging, messaging, and Internet e-mail services, etc. Capital expenditures for each business opportunity would need to be examined and would be reflected in bid prices.

were often far ahead of the FCC in deregulating telecommunications and promoting market competition.) No doubt, foreign and other parties participating in a national spectrum market may still have concerns about local favoritism or parochialism of state court. The American system accommodates these concerns every day through a mechanism known as Adiversity.@ Federal courts are available to parties of different states should the matter be of a certain monetary threshold, currently over $50,000 as provided in the Federal Rules of Civil Procedure. Property issues are settled in this fashion every day now. Spectrum is and should be no different.

Phase Three envisions that deeds to spectrum will be placed on file with the SR. Good title will pass with the deed. Failure to perform a deed search will have similar consequences as with land. Moreover, liability for noninterference will pass with the deed. Should a transmission originating with a particular spectrum band interfere with another frequency, recourse for ultimate damages will lie with the title holder of record on file with the SR.

The role of PFCs as the first line of spectrum management and coordination should remove or lessen the concern of some technical specialists and economists that the market and courts are not Acompetent@ to handle an allegedly complicated issue such as spectrum. Such concerns may exist even with the assistance by PFCs. In reality, courts handle complex technical issues all the time, ranging from very sophisticated scientific, patent and intellectual property matters to the arcana of financial derivative instruments, whose calculations and rudiments pose complications at least comparable to spectrum propagation matters.[62] Moreover, common law, the body of case law that develops over time, will adapt to new realities faster and more efficiently than attempts to determine prospectively outcomes through statutory or regulatory edicts. This last point is the true value and secret of the New Zealand experience.

V. CONCLUSION

America approaches the dawning of a new century with unparalleled opportunities. Technologies are literally transforming American society. The telecommunications revolution is the next portion of our voyage into the computer age. We can see now the dim outlines of the potential of connected computing through glass fiber and through the ether. Arthur C. Clarke, the famous author and inventor of the geo-synchronous satellite, once quipped that there is no distinction between magic and sufficiently advanced technology. The wonders of the wireless world approaching would seem like magic to its founding fathers, Marconi, Farraday, and Maxwell. A $2 trillion global market, millions of new jobs, services and industries are indisputably within reach. Yet something more precious awaits. The power of communications and computing will be available to more people to improve their lives than ever before. This may be the real magic of the era before us.

We can embrace dynamic change and the market to create a future of abundance and innovation. America deserves more than a spectrum management system that is Amore, better or different@ than the 60-year old regime now in place. We can create a new framework for a new century that is at once feasible and flexible. The basic premise of this plan is in place now elsewhere. It works. With the enhancements proposed here, it will work even better for America. The experience of other countries is a valuable wake-up call. All of us deserve to have the means to compete and win in the Information AgeCboth commercially and in the quality of our lives. Modernizing the spectrum management system for the 21st century is an excellent place to start.

ABOUT THE AUTHOR

[62] This is not surprising given how many physicists and abstract mathematicians are responsible for some of the extraordinarily complex calculations used in the instruments.

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