

Spectrum Bids, Bets, and Budgets: Seeking an Optimal Allocation and Assignment Process for Domestic Commercial Electromagnetic Spectrum Products, Services, and Technology(1)

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Introduction

In less than two years, federal government spectrum auctions have generated more than \$20 billion in revenue through the sale of 2745 licenses, a remarkable amount(1) considering that radio frequencies are a resource that were always awarded without charge and still are for many users. In 1994, the Federal Communications Commission (FCC) conducted the first auction of licenses for electromagnetic radio frequency spectrum (spectrum). Since then, as illustrated in *Appendix A: Summary Results of Spectrum Auctions*, the FCC has completed eight spectrum auctions of ten-year licenses for narrowband and broadband personal communication services (PCS), direct broadcast satellite (DBS), multipoint distribution service (MDS), and specialized mobile radio (SMR) using the preferred auction method of simultaneous multiple round electronic (SMRE) bidding.(2) The federal government earned \$19.4 billion in net revenue from the winning SMRE bidders.(3) In February and June 1995, the FCC awarded four "pioneer preference" licenses for \$735 million based upon the narrowband and broadband PCS results.(4) The July 1994 "oral outcry" auction of 493 five-year licenses for interactive video and data services (IVDS) produced an additional \$214 million.(5) *Appendix A: Summary Results of Spectrum Auctions* illustrates the cumulative total of \$20.4 billion in net revenue for 2745 licenses, a considerable new source of revenue for the U.S. Treasury.

Clearly, the spectrum auctions, under the FCC's preferred auction method of SMRE bidding, have generated unprecedented public revenue. But will the auctions as administered by the FCC result in an optimal use of electromagnetic spectrum? If not, are better alternatives available?

This Comment will analyze the allocation and assignment of electromagnetic spectrum licenses for commercial use through competitive bidding (auctions) as authorized under Sections 921 to 927 of the National Telecommunications and Information Administration Organization Act (NTIAO Act)(6) and Section 309(j) of the Communications Act of 1934.(7) Five aspects will be covered. Part I describes the statutory mandate for reallocation and competitive bidding provided to the Department of Commerce and the FCC. Part II explains the physical properties of spectrum and its applications to wireless communications technologies, products, and services. Part III examines five methods of assignment used by or available to the FCC. Part IV explores seven auction methods and their relative appeal and application to FCC objectives. Part V reviews the FCC's preferred auction method of SMRE bidding and recommends a policy reorientation to promote spectrum capacity and a return to user fees.

I. Congressional Mandate

A. Competitive Bidding and Reallocation

Under Title VI of the Omnibus Budget Reconciliation Act of 1993,(8) Congress, to promote the efficient use and public benefit of commercially usable spectrum, authorized two significant changes in the allocation and assignment of electromagnetic radio frequency spectrum. First, Congress amended the NTIAO Act to direct the Department of Commerce's National Telecommunications and Information Administration (NTIA),(9) to identify and transfer federal government spectrum to the FCC for reallocation to nonfederal commercial use. Second, Congress created Section 309(j) of the Communications Act to require the FCC to employ competitive bidding under specified conditions in the assignment of spectrum for emerging telecommunications technologies. Together these two acts sought to promote emerging telecommunications technologies: (1) through reallocation to make spectrum available for commercial use, and (2) through the market mechanism of competitive bidding to ensure the award of licenses to those products, services, and technology offering the greatest benefits to society.(10)

B. NTIAO Amendment

The NTIAO Amendment provided for competitive bidding of electromagnetic spectrum by requiring the planning, identification, and distribution of frequencies designated for federal government use to nonfederal commercial uses.(11) This was accomplished in two stages.

First, in February 1994, the Secretary of Commerce (Secretary) submitted a preliminary report to Congress and President Clinton.(12) The preliminary report (1) identified qualified reallocable frequency bands, (2) recommended the immediate reallocation of more than 50 MHz of spectrum below 5 gigahertz (GHz), including 25 MHz below 3 GHz, for exclusive nonfederal uses, (3) sought public comment on the report, and (4) provided for direct discussion between commercial representatives and federal spectrum users.(13) As required, the schedule considered pressing need, residual equipment life, international coordination,(14) relative federal costs, and commercial benefits.(15) Six months later, the FCC submitted to the Secretary an analysis of public comments to the preliminary report, including the FCC's response to the comments,(16) and the NTIA withdrew federal assignments for the 50 MHz of frequencies designated for immediate reallocation.(17)

Second, in February 1995, the Secretary presented to Congress and President Clinton a final report identifying and recommending additional frequency bands to reallocate.(18) Those bands (1) were previously allocated on a primary basis to the federal government; (2) were not foreseeably needed by the federal government; (3) were available for transfer within fifteen years; (4) would not result in excessive public cost or loss of services or benefits in relation to the potential benefits attributed to the public by nonfederal use; and (5) had the greatest potential for productive uses and public benefits.(19) Simultaneously, the Secretary also recommended to Congress and President Clinton the reallocation of more than 200 MHz of commercially viable spectrum below 5 GHz, including 100 MHz of commercially attractive spectrum below 3 GHz.(20) The plan included mixed-use frequency bands where potential use of federal stations was "substantially less" than that of nonfederal stations.(21)

Title VI specifically permitted both the Department of Commerce and the FCC to go beyond the required elements of the plan.(22) As summarized in *Appendix B: Overview of Spectrum Reallocation Requirements and Final Plan*,(23) the NTIA's final plan exceeded the maximum requirements of Title VI for total, exclusive and below 3 GHz spectrum.

C. Section 309(j)

Section 309(j) mandated a detailed framework and timetable for FCC allocation of spectrum licenses. Congress sought to achieve several objectives including: (1) development and rapid deployment of new technology, products, and services, (2) promotion of economic opportunity, competition, and consumer access, (3) avoidance of unjust enrichment, and (4) efficient and intensive use of spectrum.(24)

Section 309(j) has five key elements. First, the FCC is authorized to conduct competitive bidding for mutually exclusive applications of initial license or construction permits where the licensee will receive compensation from subscribers (subscriber fees) for the receipt or transmission of signals over a licensed frequency.(25) Second, the FCC must develop a bidding methodology for each class of licenses as well as design and test multiple alternative auction methodologies. Third, the FCC must establish safeguards to protect the public interest in the selection of classes to be used for bidding, eligibility, and methodology.(26) Fourth, the FCC is to avoid license concentration, provide licenses to small businesses, rural telephone companies, minority- and women-owned businesses, and recover a portion of the value conferred in public spectrum use.(27) Finally, Section 309(j)(4) specifically authorizes the FCC's use of alternative payment schedules, tax certificates, bidding preferences, antitrafficking restrictions, transfer disclosures, performance requirements, area designation, and bandwidth assignments.(28)

Although the House Committee on Energy and Commerce expected revenues of \$7.2 billion over five years,(29) Congress specifically limited consideration of revenues. Congress prohibited the assignment of bandwidth, frequency, or power limitations where a finding of public interest, convenience, and necessity was based on the expectation of federal revenues.(30) In addition, federal revenue considerations could not be the sole or predominant reason to enact payment schedule regulation.(31) However, Congress allowed the FCC in such situations to consider consumer demand(32) and permitted the FCC to retain a portion of the proceeds generated by competitive bidding.(33) Together,

these sections sought to insulate FCC policy decisions from budgetary pressures.(34)

In Section 309(j), Congress set forth an aggressive timetable to conduct spectrum auctions. As required, the FCC issued a final PCS report and order,(35) regulations to implement Section 309(j),(36) and PCS licenses and permits(37) in, respectively, February, March, and May of 1994. In addition, the authority to issue licenses or permits under competitive bidding remained contingent upon the completion of the Department of Commerce's preliminary reallocation report, the FCC's rule making for PCS, and an FCC plan for ensuring adequate availability of frequencies for public safety licenses. In September 1997, a year prior to the expiration of authority, the FCC must report to Congress on all revenues obtained and expected, the methodologies used and their relative advantages and disadvantages, the statutory requirements of efficiency and effectiveness, the introduction of new technologies and companies, the timely launch of rural service, the participation of small businesses, rural telephone companies, minority- and women-owned businesses, and the statutory changes needed to improve the competitive bidding process.(38) Finally, by August 1998, the FCC must issue licenses and permits through competitive bidding for at least 10 MHz of spectrum reassigned from federal government use.(39) Competitive bidding authority expires in September 1998.(40)

Together, the NTIAO Amendment and Section 309(j) provide spectrum resources and the management structure of competitive bidding to promote spectrum utility. However, Section 309(j) leaves much discretion in the design of the assignment mechanism. In part, this may reflect congressional confidence in market mechanisms. More importantly, it reflects the physical character of the resource being allocated. What are the properties of electromagnetic spectrum that foster market allocation and assignment schemes as the means to achieve optimal utility and efficiency?

II.A Natural and National Resource

A. Physical Properties

The economic rationale of competitive bidding for the assignment of electromagnetic spectrum develops from its physical properties. Electromagnetic spectrum is a limited natural resource with unique physical properties. Effective management of these physical properties permits increased spectrum utilization.

Electromagnetic spectrum is a "limited" or "scarce" natural resource possessing instantly renewable, nondepletable, degradable, and finite physical properties.(41) Spectrum is finite due to physical and technical limits. Only a portion of the electromagnetic spectrum is commercially viable.(42) Usable radio frequencies range from 9 kilohertz (kHz) to 40 GHz(43) but vary in their relative utility. As the frequency increases, information capacity increases and receiving distance decreases. Carrying distance is influenced by a frequency's ability to reflect, thereby extending the distance of the signal. Information is transmitted by "modulating" wave frequency.(44) Different uses require different modulation capacity and, in turn, different bandwidths.(45) Therefore, usable spectrum is constrained by the purposes for which it is used. Spectrum is nondepletable because the supply of radio waves is infinite. However, spectrum is degradable because overcrowding or interference may render spectrum unusable.(46)

Electromagnetic spectrum can be organized according to its essential physical dimensions of space, time, and frequency. First, a frequency may be reused in different geographic regions provided two transmissions do not interfere with each other.(47) Second, frequencies are not a depletable resource; instead, they are instantly renewed after use. Third, multiple frequencies may be used in the same area at the same time. However, use of one frequency constrains concurrent spectrum use in the same area. As power increases, the physical space a signal occupies increases, thereby interfering with the space of other signals.(48)

The utility of electromagnetic spectrum as a finite natural resource can be increased through effective management of distance, time, and power. Competitive bidding effectively utilizes the physical properties of electromagnetic spectrum to achieve maximum utilization and utility of a finite resource.

B. A Scarce Resource?

The federal government's past policies toward allocation and assignment assumed spectrum scarcity. Critics argue that the federal government created false scarcity through its spectrum licensing policies.(49) The federal government has taken both positions: that spectrum scarcity exists and that it does not exist.(50)

The federal government's current domestic policy position is that a sufficient supply of spectrum exists and spectrum can be reallocated to new and expanding uses to ensure its full, efficient use. The distribution of available spectrum between federal use, nonfederal use, and shared use supports this position.(51) In 1993, a House Committee found that the federal government reserved 40 percent of the electromagnetic spectrum for its use; a portion of this was shared with nonfederal users while retaining primary access.(52) In 1988, the NTIA, as manager of the federal government's use of radio frequency spectrum, concluded that the scarcity of broadcast frequencies no longer existed and "that substantial improvements in spectrum allocation and management can and should be achieved."(53) Past action of the NTIA has supported this theory. A consumer need, made possible by a recent technological development, was satisfied by reallocation of unused or underutilized spectrum. Cellular telephone service, a multibillion dollar industry that has created over 100,000 jobs, was developed out of a reassignment of 50 MHz of spectrum from federal government use to commercial use.(54)

However, a congressional committee found that spectrum scarcity was the product of technological development as technological advances significantly increased demand for electromagnetic spectrum. Originally, spectrum assignments reflected interference concerns rather than efficient use. Increases in private and nonfederal spectrum uses required spectrum-efficient technologies. In addition, many of the frequencies reserved for federal use were underutilized, inefficiently used, or even unused.(55) Consequently, public interest demands more efficient government and commercial use including implementing wire-based alternatives and reassigning federal spectrum for commercial use.(56)

These findings support the belief that federal regulation of electromagnetic spectrum has resulted in false scarcity. Proponents of the position advocate that technology consistently expands the spectrum supply by increasing utilization (*e.g.*, the efficiency) and quantity (*e.g.*, the range) of usable spectrum.(57) This perspective is consistent with the NTIA's position at the International Telecommunications Union (ITU) conference in 1982(58) as discussed in *Appendix C: A Market Approach to International Allocation*. While the NTIA believed that spectrum was sufficient to fulfill efficient, valuable needs, the critics believed that the federal government failed to effectively promote domestic spectrum allocation and assignment. False scarcity, which should not have developed given the inherent growth potential of technology, resulted.

The scarcity issue need not be determined to effectively allocate spectrum. As explained in *Appendix D: Market Mechanisms and Spectrum Scarcity*, a market mechanism for spectrum allocation and assignment maximizes social and economic utility under all three conditions. However, scarcity, no scarcity, and false scarcity theories help explain past federal spectrum policies. It is even possible that all three existed at different times.(59) But, what market or competitive mechanism is best suited to the development of new or expanded spectrum use?

III. Allocation and Assignment Alternatives

A. Prior Methods and Goals

As discussed earlier, the NTIA and the FCC share responsibility for domestic spectrum management. Under the Communications Act, the NTIA manages federal government use,(60) and the FCC manages nonfederal use by commercial, state, and local government entities.(61) The NTIA and the FCC mutually coordinate frequency allocations. The entire range of allocated spectrum, 9 kHz-300 GHz, is contained in the National Table of Frequency Allocations. As a member nation of the ITU, the Radio Regulations(62) and Final Acts(63) of ITU conferences hold treaty status and serve as the basis of domestic frequency allocations, assignments, and regulations.(64)

The FCC allocates, assigns, and regulates electromagnetic spectrum as required under the Communications Act to uphold "public interest, convenience and necessity."(65) FCC policy decisions as to frequency band use are governed

by the Administrative Procedures Act.(66) Operating bureaus of the FCC allocate spectrum in "blocks" according to service classes under their jurisdictions. Under Sections 309(e), (i), and (j), where there are mutually exclusive applicants for a new license to use electromagnetic spectrum, the FCC awards licenses through either comparative hearings,(67) lotteries,(68) or competitive bidding.(69) In select service classes, such as land mobile services, the FCC accords private coordinating groups official status to recommend frequency selections to the FCC.(70)

B. Assignment Mechanisms and Goals

At one time or another, the FCC has used five different assignment methods: first-come/first-served, comparative hearings, user fees, random selection, and competitive bidding. Each method offers unique benefits and distinct constraints upon public interest, convenience, and necessity.

Congress mandated in Section 309(j) four goals for subscriber services: (1) development and rapid deployment of new products, services, and technologies, (2) diversity in licensees, (3) financial return to the public, and (4) efficient and intensive spectrum use.(71) Consequently, the FCC established four values for PCS spectrum allocation and regulation: deployment speed, service competition, universality, and diversity.(72) What is the capability of each market mechanism to fulfill these goals and values?

1. First-Come/First-Served

First-come/first-served is the default assignment method. If the FCC does not receive "mutually exclusive applications" then it awards a license to the first qualified applicant. Processing costs are low. Legal challenges are limited to contesting whether the applicant is qualified. Limited legal challenges and limited administrative work make processing very quick. However, service competition, speed, universality, and diversity are likely to be low. Successful licensees are effective applicants, quick to locate and apply for available frequencies, rather than well-capitalized, capable service providers. Low levels of invested capital promote service delay by creating relatively more attractive speculative rather than service opportunities.(73) Subsequently, fewer services will be developed; spectrum use is likely to be less efficient and intensively used; and public financial benefit will be minimal with no revenue but very low administrative costs. However, with low capital requirements, licensee diversity should improve. Control functions, including licensee criteria, antitrafficking restrictions, minimum capital requirements, and service deadlines, should mitigate or at least minimize some of these undesired conditions. In sum, first-come/first-served neither provides an efficient or effective use of spectrum nor insures public interest, convenience, and necessity.

2. Comparative Hearings

Comparative hearings provide a marginal advantage over first-come/first-served. Authorized under Section 309(b) of the Communications Act, administrative hearings are conducted before administrative law judges.(74) Administrative cost and time increase significantly as qualifications must be checked and critically compared. While direct revenue increases slightly with administrative application fees, net revenue does not improve and may decline due to administrative costs. Licensing time increases with additional administrative steps and legal challenges. Comparative hearings that examine qualifications, prior operations, and ownership character likely result in awarding licenses to parties with service ability and experience as well as diversity in ownership and management. Licensees' up-front invested capital requirements increase due to additional costs of preparing, presenting, and defending qualifications for comparative hearings as well as incurring opportunity costs for lost competitions. This provides additional, but limited, incentive to develop the frequency. Additional economic activity increases the taxable income base, producing a gain in indirect revenue to the public from additional tax revenue. In sum, comparative hearings are an inefficient distribution method as they do not achieve optimal use or public interest.

3. User Fees

User fees offer significant advantages over comparative hearings. Under the Independent Offices Appropriations Act of 1952 (IOAA)(75) and the Consolidated Omnibus Reconciliation Act of 1985 (COBRA),(76) the FCC, as an administrative agency, possesses legal authority to assess user fees.(77)

User fees are difficult to price. Without a developed private market to establish the free market price of electromagnetic spectrum, the FCC would have to calculate "shadow prices"—the prices users would be willing to pay for a service not privately sold—for all frequencies to be assigned.(78) The federal government is very good at pricing core commodity products with consistent physical properties and large, established markets. Electromagnetic spectrum, however, is an inconsistent and speculative product with different frequency bands having significantly different physical properties and value varying by use. Therefore, even if a private market exists, spectrum does not lend itself to consistent, predictable pricing. Assuming that the FCC developed shadow prices based on foreign markets, pricing errors in the base market would resonate in the domestic market: a high shadow price would result in overinvestment in technology, and a low shadow price would result in underinvestment in technology. The inefficiencies of establishing a market price would produce higher costs and risks. Users would seek higher rates of return on capital.

Compared to comparative hearings, public revenues would increase. Significantly greater capital requirements and stable fees would reduce speculation by licensees thereby inducing faster building of systems. Universality of service, particularly in rural areas with lower density and lower incomes, would improve as licenses in these areas would cost comparatively less than those in major metropolitan areas with higher density and higher income, thereby reducing development costs. Spectrum use and efficiency would be higher due to increased investment in technology which would serve to offset the additional licensing costs. In sum, user fees prove more desirable than first-come/first-served and comparative hearings.

4. Random Selection

In 1981, Congress authorized the FCC to use random selection to assign electromagnetic spectrum.(79) Spectrum lotteries, as conducted by the FCC, proved a significant step backward in developing spectrum use, efficiency, and equity. The FCC failed to implement substantive screening requirements.(80) Unchecked speculation produced "license mills" charging small investors 10 to 100 times filing costs.(81) Returns on investment were "virtually nonexistent" given the odds, often facially defective applications, and the limited practical use of the winnings.(82) In 1991, the North American Securities Administrators Association issued a bulletin citing wireless lotteries as the largest investor fraud in the nation.(83)

Random selection, even with additional controls such as must-build, holding, and antitrafficking requirements, and increased application fees, remains unattractive. The assignment method reduces public income, defers development, limits diversity and universality, and promotes inefficient use. Random selection produces no direct public revenue while incurring high aggregate government and applicant administrative expenses. It defers development as unqualified, undercapitalized, and inexperienced parties, spurred by low investment requirements, win frequencies that require repackaging to become useful assets. Without a market, diversity declines. Universality suffers as qualified licensees avoid unattractive rural properties. Spectrum use and efficiency decline because many licenses will be in the hands of speculators rather than operators, or additional licenses are needed to construct a useful band of frequencies. In sum, random selection is less attractive than first-come/first-served, comparative hearings, or user fees.

5. Competitive Bidding

Under Section 309(j) of the Communications Act,(84) the FCC initiated in 1994 competitive bidding for six types of subscriber services: narrowband and broadband PCS, DBS, MDS, SMR, and IVDS.(85) Competitive bidding proves the market mechanism of choice. First, public revenue, in the short- and long-term, is maximized as the fair market value of the electromagnetic spectrum less auction administrative expenses goes to the U.S. Treasury, and taxes rise due to increased economic activity. Second, speed of development increases because high licensing costs induce successful bidders to launch services as soon as possible to recover large initial investment. Third, universality of service increases as low prices of rural licenses reduce development costs and attract investors unable or unwilling to make capital requirements necessary to develop major metro licenses. Fourth, high levels of spectrum efficiency and use are achieved as high spectrum costs foster large investments in technology to expand capacity. In sum, as illustrated in *Table 1: Summary of Assignment Methods, Values, and Goals*, competitive bidding maximizes spectrum investment and activity.(86)

IV. Competitive Bidding Systems

A. Criteria and Goals

Section 309(j)(3) requires the FCC to design and test "multiple alternative [bidding] methodologies under appropriate circumstances." (87) The FCC has stated its clear intention to do so (88) and seeks, within congressional guidelines, to "award licenses to eligible parties that value them the most." (89) But which bid systems will best fulfill this objective in direct transactions between the FCC and highest value users? (90)

The FCC has articulated both criteria and goals. To fulfill the substantial requirements of Section 309(j), the FCC stated three criteria: administrative simplicity, government experience, and low application costs. (91) Through Sections 309(j)(10), 309(j)(12), and 925, (92) Congress placed the FCC on a tight timetable to propose, execute, and evaluate spectrum auctions for new communications services. The FCC has stated its desire to develop competitive bidding structures that are "simple and easy to administer" as "unnecessary complexity in conception or execution is likely to cause delay and frustrate Congress's intent to speed new services to the public." (93) The FCC, as it had no experience in conducting spectrum auctions, anticipated relying upon the experience of other government agencies. (94) Reeling from the spectrum lottery fiascoes, the FCC sought bidding systems and rules that minimized costs for both applicants and the FCC. (95)

The FCC sought bid systems that would fulfill four goals mandated under Section 309(j)(3): revenue maximization, rapid development, efficient and intensive use, and licensee diversity. Four traditional bid systems—oral ascending, oral descending, sealed bid, and second-price sealed bid systems (96)—and three nontraditional bid systems—Japanese auction, sequential sealed, and SMRE—offer relative strengths and weaknesses in fulfilling these criteria and goals. (97) The FCC and prospective bidders evaluated these bid systems using game theory, an applied mathematical study of decision making that predicts participants' actions and gains in competitive situations such as designed markets and auctions. (98) The federal government has used game theory to design bidding structures for offshore oil leases and treasury bill auctions. (99) Under game theory, each bidding system produces unique results in critical auction factors such as winner's curse, escalation and default, collusion, and aggregation. Winner's curse results when, assuming similar uses, the party that most overestimates the value wins. (100) Escalation and default results from winner's curse or strategic opportunism as the winner defaults to a significantly lower bid. (101) Aggregation is the combining of licenses across bandwidth or geographic area. These factors determine the appropriateness of a bidding method for a particular use.

B. Traditional Bidding Systems

Under an ascending price or "English" auction, bidding is open and escalates until one party remains. The open character of the auction produces high prices and risks. High prices result as bidders are reassured by the continued interest of others. Risks result from the increased likelihood of collusion, winner's curse and escalation and default. While explicit or tacit collusion can be avoided through close, real-time monitoring, profit uncertainty, leading to winner's curse, and strategic opportunism foster escalation and default. Aggregation proves difficult. Increased costs and delays result as traders and holdouts reap profits from after-market transactions. (102)

In July 1994, the federal government conducted an "oral outcry" auction of 594 IVDS licenses, raising \$200 million. While total sales exceeded pre-auction estimates tenfold, several winners, including the auction's highest bidder at \$4.3 million for Miami, experienced winner's curse and defaulted on their bids. The FCC plans to re-auction these licenses and impose fines or penalties upon the defaulting parties. (103)

Under a descending price or "Dutch" auction, bidding is open, starts high, and descends until one party bids. Compared to English auctions, Dutch auctions produce lower bids while retaining similar risks. (104) Lacking rival bids that communicate independent valuations of the resource, bidders bid low to avoid winner's curse. (105) The open character provides close monitoring against collusion agreements. (106)

Under a sealed bid auction, bidding is secret and escalates until one party remains. Anonymous bids inhibit full price

expression by parties. Like the Dutch auction, parties in sealed bid auctions bid lower than they are willing to pay. Seeking to avoid paying more than necessary, the party willing to bid the most fails to do so.(107) However, sealed bid auctions are less susceptible to collusion because colluders cannot protect against the awarding of licenses to noncolluders or breaching colluders.(108) Winner's curse and escalation and default risks are significantly less in both open bid methods, as bidders lack competitive information or default mechanisms.

Under a "second-price sealed bid" or "Vickrey" auction, bidding is secret and escalates until one party is left, but the winning party only pays the price of the second-highest bid. Vickrey auctions produce high bids, lower risks, and lower revenue. While second-price sealed bid auctions award the resource to the party that values it the most, they only yield the second highest value. The difference between expressed values may increase as the second highest party withholds its true estimate of the value, fearing that such information may be used to its detriment in a subsequent auction.(109) Like sealed bid auctions, Vickrey auctions are resistant to collusion as well as escalation and default.(110)

C. Nontraditional Bidding Systems

Under a "Japanese" auction, bidding escalates in specified increments. Parties must bid at each increment or permanently drop out. A Japanese auction produces higher prices and lower risks than English auctions. The open format fosters maximum, real-price expression, producing higher bids and increasing probability that the highest value user will win the resource. Winner's curse is less likely as bidders know the number and identity of bidders. In addition, preset intervals eliminate blocking strategies and irrational bids that result in escalation and default situations.(111) However, a Japanese auction does not provide for aggregation.

Under a sequential-sealed bid auction, sealed "combinatorial" bids are taken for license groups and ascending oral bids are taken for individual licenses. Sealed bids are submitted prior to bidding and opened after oral bidding is completed. Oral bidding on individual licenses is conducted sequentially. Winning combinatorial bids would be compared to winning oral bids and would be awarded the license where the combinatorial bid proved greater than the sum of the individual oral bids. The increased profitability or service value of aggregation should be expressed in the form of superior combinatorial bids. However, the sequence of the resources auctioned will affect the outcome. Potentially higher value combinatorial bidders will not receive the benefits of simultaneous bidding as oral bidders do. Due to its structure, sequential bidding, especially sealed bids, requires time, a limited resource given the timetable mandated by Congress.(112)

Under SMRE bidding, both combinatorial and individual bids are made simultaneously in a series of predefined bidding rounds.(113) SMRE bidding fosters aggregation and maximizes use of bidding information. All bids remain open and can be increased or decreased until the last round closes. Due to its relative benefits as illustrated in *Table 2: Summary of Bid Systems, Benefits, and Game Theory Factors*, SMRE has become the preferred method of the FCC and, therefore, has been used to conduct all auctions except for the first auction for IVDS.

In July 1994, the FCC conducted a nationwide narrowband PCS auction using SMRE bidding.(114) Using electronic terminals, preregistered parties anonymously bid in forty-seven rounds over five days upon ten nationwide licenses for advanced paging and messaging services.(115) Six parties successfully bid \$617 million (net) for the licenses, ten times the pre-auction estimate.(116) Since then, the FCC has completed SMRE auctions for thirty narrowband licenses lasting 105 rounds, raising \$395 million; 99 A/B block broadband licenses lasting 112 rounds, generating \$7.034 billion; two DBS licenses lasting 19 and 25 rounds, receiving \$735 million; 493 MDS licenses lasting 181 rounds, yielding \$216 million; 1020 SMR licenses lasting 168 rounds, producing \$204 million; and 493 C block broadband licenses lasting 183 rounds, generating \$10.217 billion.(117)

V. Current and Recommended Auction Structures

A. FCC Preferred Auction Structure

Using SMRE bidding, the FCC will ultimately award, in six auctions, licenses for 2071 broadband PCS licenses contained in 120 MHz of spectrum, three units of 30 MHz and three of 10 MHz.(118) The FCC has conducted two auctions for three blocks encompassing a total of 90 MHz of the spectrum allocated for broadband PCS services. In March 1995, the FCC concluded the first broadband auction of blocks A and B consisting of 99 MTA 30 MHz licenses.(119) In December 1995, the FCC initiated an auction of the entrepreneurs' C block, consisting of 493 BTA 30 MHz licenses.(120) After completing the 30 MHz blocks, the FCC will auction 1479 10 MHz BTA licenses in the remaining D, E, and entrepreneurs' F blocks, either simultaneously or in series. Based largely upon a plan by Motorola, the choice of auction method and rules illustrate the FCC's reliance upon game theory and prior experience to fulfill the congressional mandates of Section 309(j).(121)

Under Section 309(j)(3)(C), the FCC sought to maximize revenue by employing (1) ascending price SMRE bidding, (2) preregistration disclosure, (3) up-front payments, and (4) transfer restrictions.(122) Ascending price bidding encourages high bids. SMRE bidding provides for aggregation premiums. Together these two methods counterbalance the bidders' propensity to overbid, collude, or escalate and default. Preregistration requirements include simultaneous disclosure of markets sought, disclosure of ownership and control in bidding entities, and a ban upon communication between bidding entities.(123) Disclosure enhances bidding accuracy, maximizes revenue, and reduces risk because parties estimate license values to competing parties given their composition and apparent aggregation strategies. The communication ban protects against collusion. Up-front payments (deposits) on each license sought determine aggregate size of licenses bid upon as well as discourage unplanned and strategic defaults like those that occurred in the July 1994 IVDS auction.(124) The payments, based on the population of licenses sought, have reached \$16 million for an individual license or \$150 million for national coverage.(125) Five-year transfer restrictions upon designated entities ensure such benefits go to parties that build rather than trade systems.(126) These rules maximize revenues and protect against unjust enrichment.

Under Section 309(j)(3)(A), the FCC sought rapid development and deployment of new services, products, and technologies by employing (1) auctions, (2) build-out requirements, and (3) transferability. Successful auctions award the resource to the highest valued use at the highest market price. The high use value and up-front cost of spectrum acquisition promote rapid development of the service and value-adding technology.(127) Speculation that results in warehousing remains unattractive.(128) Build-out requirements for designated entities ensure product and service development. Transferability of licenses ensures an active secondary market in new services offering more efficient and intensive use.

Under Section 309(j)(3)(D), the FCC sought efficient and intensive use by providing for aggregation and bidding groups. Aggregation enables lower costs or higher valued services which result in increased spectrum use. The premium that aggregation places on spectrum use forces increased efficiency and intensity of competing nonaggregated spectrum use.(129) Bidding groups, by expanding the universe of spectrum users (licensees), increase the potential and pressure to integrate uses. In addition, reduced capital outlay for each partner leaves more capital for technological development to expand spectrum efficiency and utility.

Under Section 309(j)(3)(B), the FCC sought licensee diversity by establishing (1) multiple partitioning and bandwidth schemes, (2) entrepreneurs' blocks, (3) designated entity rules, and (4) licensee bandwidth limitations. Selling spectrum on several different scales—nationwide, regional, MTA, BTA, MSA/RSA, and custom licensee partition(130)—permits investment opportunities of various scale within the same area. Different spectrum block sizes of 10 and 30 MHz permit different investment opportunities for various product or service types. Such diversity in investment scale and scope attracts a diverse group of licensees. Establishing entrepreneurs' blocks guarantees small business participation in PCS. Only firms with gross revenues of less than \$125 million in each of the previous three years and total assets of less than \$500 million may bid upon the two entrepreneurs' blocks, and firms with gross revenues of less than \$40 million in each of the previous three years are entitled to a 25 percent discount.(131) Finally, each licensee is limited to 40 MHz per market.(132) A PCS licensee who is "cellular career," holding a 20 percent interest in a cellular service encompassing 10 percent of the census population of the proposed PCS service area, is limited to 10 MHz. An interest of less than 5 percent will not count toward the 40 MHz limit, thereby permitting telephone companies to participate in several PCS licenses.(133) These spectrum limitations will protect against excessive concentration.(134)

The SMRE auctions are designed to fulfill the FCC's congressional mandate to establish competitive bidding systems

that (1) raise revenue while avoiding unjust enrichment, (2) promote rapid development and deployment of new products, services, and technology, (3) guarantee efficient and intensive spectrum use, and (4) ensure licensee diversity through the significant participation of small businesses. There is a significant flaw in the auction system.

B. Recommendation

The FCC's block allocation and SMRE auction system will ultimately fail to remain an optimal allocation and assignment process. The prospective theoretical superiority and operational success of SMRE auctions is

based upon a real estate concept of spectrum.⁽¹³⁵⁾ The FCC has created a competitive allocation and assignment system that optimizes the constructed property rights and assumed physical characteristics of an exclusive spectrum band. The FCC and NTIA allocate spectrum blocks to uses based on projected demand of products and services. An assigned licensee enjoys the right to use, exclude, and assign spectrum. Efficient use is predicated upon relative physical properties of frequency bands. The FCC's system of block allocation and competitive assignment, while promoting development of electromagnetic spectrum, fails to adequately provide for technological innovation.

Two recent technological developments render exclusive frequency licenses an inefficient means of spectrum management. First, bandwidth need not be inversely proportional to dynamic range. The underlying premise of spectrum band assignment is that accuracy and sensitivity decline as bandwidth increases. However, Steinbrecher Corp. of Burlington, Massachusetts has developed a broadcasting platform ("radio") that treats frequencies uniformly and provides immediate access to all usable bands. A Steinbrecher radio provides access upon demand to all frequencies without accuracy and sensitivity constraints.⁽¹³⁶⁾

Second, users may simultaneously use the same frequency without interfering with each other. The traditional spectrum assignment scheme divides a frequency by time and geography, limiting a frequency band to one user in a particular area at a particular time. However, Qualcomm of San Diego, California developed a spread-spectrum modulation scheme that permits concurrent frequency use.⁽¹³⁷⁾ The Qualcomm modulation scheme permits numerous users to employ the same frequencies at the same time while increasing effective usable capacity 140-fold.⁽¹³⁸⁾

These two technological developments challenge the theoretical foundations of block allocation and competitive bidding assignment. To date, the principle spectrum management policy has been to promote the development and deployment of spectrum dependent products and services. Technological development was seen as the means of increasing the supply of products and services. Recent and impending technological developments suggest an alternate policy model of promoting spectrum enhancing (enlarging) technological development. Development and deployment of spectrum products and services will follow.

Under such a policy re-orientation, a user fee system replaces auctions as the preferred method of spectrum management. Revenue recovery would be separated from licensing. There are significant barriers to establishing a user fee system. First, prior judicial rulings limit the power of administrative agencies to implement fees beyond direct administrative costs. Second, taxing an essential communication vehicle would raise significant First Amendment rights issues. Third, shadow prices for unit user fees would be difficult to establish without an established secondary market in spectrum use.

By the time the licenses currently up for auction expire in ten years, it is unlikely the basic spectrum rights and revenue assumptions will remain valid. Either the rules and rights accompanying spectrum auctions will have to change or the system of competitive bidding itself will require replacement.

Appendix C: A Market Approach to International Allocation

As a natural resource, spectrum allocation is a critical international property right issue. Developed nations have taken a market approach to electromagnetic spectrum resource allocation. Electromagnetic spectrum is treated as a "common property" resource rather than a "shared" natural resource. A first-come/first-served approach has predominated in international orbit-spectrum allocation. The initial user does not gain a proprietary right in that frequency.⁽¹³⁹⁾

International regulatory requirements guarantee the applicant the right to use spectrum without harmful interference.(140)

However, with the rapid development of satellite technology, spectrum allocation has become a significant area of contention, infused with issues of equity and fairness, between developed countries and lesser developed countries (LDCs). LDCs seek advanced planning of orbit-spectrum resources that guarantee them orbit positions. Developed countries seek to provide spectrum where LDCs have a present and practical need and can achieve optimal use of that spectrum, taking into account technical advances between allocation and use.(141) The developed countries' emphasis on consumer demand, market efficiencies, and technological improvements foreshadowed the federal government's use of competitive bidding. In effect, developed countries opened up international electromagnetic spectrum allocation to competitive bidding by LDCs. The United States believed guaranteed access was inherently inequitable because it deprived the international community of the opportunity to enjoy the fullest, most efficient use of electromagnetic spectrum.(142) In 1982, twenty-four years after the introduction of the first congressional bill to authorize domestic communications license auctions,(143) the Congress's Office of Technology Assessment forecast that technological development would likely "expand the effective utility of the available spectrum to satisfy future needs of all nations."(144)

The disagreement continues because the the LDCs and the developed nations hold fundamentally different beliefs as to the scarcity of usable electromagnetic spectrum. Developed countries maintain that electromagnetic spectrum, although a finite natural resource, is sufficient in supply to fulfill worldwide demand, provided it is used in an efficient, high utility, technologically advanced manner. LDCs maintain that electromagnetic spectrum is a scarce natural resource, inequitably distributed in a manner favoring established use.

A market solution, such as competitive bidding by nations or users to allocate spectrum on a worldwide scale, remains unlikely. The standard of living and per capita gross domestic product in developed nations are greater than that generally found in LDCs.(145) Generally, the value of comparable use would be greater in a developed nation than in an LDC. A competitive bid for LDC use would succeed only where LDC demand, the absolute marginal value of a particular service, was significantly greater than a developed nation's demand. Technological development accentuates the imbalance. First, technology requires developed capital markets and skills. Second, technology seeks out the highest "value-added" use, a function of relative cost benefit (percentage improvement) and market size (dollar volume). Other factors being equivalent, a technological development only migrates to LDCs where the potential per capita utility benefit (cost benefit) proves substantially greater than in developed nations.

Appendix D: Market Mechanisms and Spectrum Scarcity

If spectrum is scarce, then a market mechanism will award spectrum to those uses in order of their utility value until spectrum is "used up." As the value of the uses increases, so do incentives to invest in technology that will increase the number and capabilities of uses. Technological advances continue until the cost of expanded use through increased efficiency and expanded range reach the value assigned to the lowest valued use. Under a theory of scarcity, at some point, the cost of technological development no longer "pays," potential spectrum uses are not realized as they cannot afford a license, and the cost of technological development does not justify expanding spectrum capacity. Therefore, a market mechanism insures the greatest level of social utility by allocating and assigning frequencies to the most valued uses while funding a secondary market in technological development.

If spectrum is not scarce, a market mechanism again will award spectrum to users according to their relative utility value. Uses will compete for positions on the spectrum according to their particular operating requirements and the desired physical characteristics. Frequency band physical characteristics vary as to propagation properties, information capacity, and interference. Uses operating requirements vary as to transmission point, reception point, and bandwidth. For each use, there is a frequency band that provides optimal results and bands which prove incapable of providing the desired result.(146) If there is no scarcity, uses will compete for spectrum positions based on the value of the frequency bands' characteristics. A particular use will not only compete for a particular band against other similar uses but also against different uses that value that particular band for the same or different characteristics. The competition for a particular band will operate much like spectrum scarcity. Although there is spectrum for all uses, uses compete for scarce frequencies with particular characteristics. As the value of the frequency band increases so does the incentive to

invest in technology that will either decrease the amount of spectrum required for that use or make accessible that desired characteristic in another band. Under a theory of no scarcity, at some point, further technological development does not "pay," the supply of desired characteristics is no longer expanded, and unassigned uses seek a position on another frequency band with less desirable characteristics. Therefore, in a situation of no scarcity, a market mechanism insures the greatest level of social utility by allocating and assigning uses to particular frequency bands according to the bands' relative benefits, while funding a secondary market in technological development.

If false scarcity conditions exist, a market mechanism will operate as if true scarcity exists. A market mechanism will award spectrum to those uses in the order of their utility until spectrum is "used up." If a market mechanism effectively ends scarcity, then the market mechanism will operate as it would in a situation of no scarcity. A market mechanism will place uses into different frequency bands according to the value of the bands' characteristics to each particular use. However, false scarcity will operate differently than either scarcity or no scarcity in three ways.

First, there will be significant, sudden shifts in the supply of usable spectrum as regulatory mechanisms causing false scarcity are initiated, terminated, or revised. For example, Section 309(i) authorizes random selection to award a license or construction permit involving the use of electromagnetic spectrum.(147) In the 1980s and 1990s, the FCC operated spectrum lotteries without adequate financial, technical, or antitrafficking controls. A volatile speculative market developed, and in many instances, the FCC awarded licenses to "licensing mills" and other parties ill-equipped to build or operate a service that effectively utilized radio spectrum.(148) Universally extending, ending, or rewriting lotteries would produce sudden, significant shifts in the demand for and supply of electromagnetic spectrum.(149) Ultimately, a developed secondary market in license application would soften these shifts, but it would take time to develop.

Second, false scarcity will deter investment in technology to increase the spectrum capacity. Spectrum-based businesses would shift resources from technological development to lobbying and speculation. Businesses would invest in lobbying activities to change regulations responsible for creating false spectrum. Businesses would also invest in upstream speculative activities as a means of offsetting such costs. Subsequently, the amount of spectrum capacity will be less than that which would have existed under equivalent conditions of scarcity or no scarcity.

Third, false scarcity will increase switching costs. Currently, spectrum license holders enjoy a qualified right of renewal.(150) The spectrum auction law specifically maintains that right.(151) Switching frequencies is the exception rather than the rule. Equipment is purchased and operations maintained with the expectation of operating on the same frequency by changing frequencies unexpectedly, the licensee will likely incur equipment, facilities, marketing, and customer service costs greater than if the licensee had expected the prospect of switching. These costs are not viewed as a normal cost of doing business, rather they are extraordinary in character.(152) False scarcity involves significant, sudden shifts in the supply of usable spectrum as regulatory mechanisms causing false scarcity are initiated, terminated or revised. Short-term incentives are more volatile and, therefore, more likely to reach a level which would induce a licensee to switch frequencies. Regulations requiring frequency changes are more likely to occur, as there is less spectrum capacity than under equivalent scarcity and no scarcity circumstances and there is a comparatively greater inducement for regulatory action to free up spectrum for a new technology or higher valued use as with the NTIAO Amendments.

In sum, a market mechanism for electromagnetic spectrum allocation and assignment will achieve greater social and economic utility under conditions of either scarcity, no scarcity, or false scarcity by increasing the efficiency, range, and effectiveness of usable spectrum.

(1)An earlier version of this Comment won first place in the 1995 Comment

Competition of the *High Technology Law Journal*, University of California at Berkeley School of Law (Boalt Hall).

(1)B.A. Yale University, 1986; M.B.A. Georgetown University, 1990; candidate for

J.D. Georgetown University Law Center, 1996. The Author expresses his sincere appreciation to Susan Low Bloch and Dr. Daniel Ernst, Professors of Law at the Georgetown University Law Center, and to Mohab Khattab, candidate for J.D. at the Washington College of Law, American University, for their counsel in the preparation of this work.

(1)\$20 billion represents \$205 per household (97.3 million in 1994) or \$77 per resident

(260.3 million in 1994) in the United States. Bureau of the Census, U.S. Dep't of Com., Statistical Abstract of the United States: 1995, at 65, Table 2 (1996).

(2)PCS consists of a family of land-based, two-way mobile communications services

divided into narrowband services (*e.g.*, paging) and broadband services (*e.g.*, telephone). DBS provides satellite-based direct delivery of television programming to 18-inch receiver dish antennas. MDS is a land-based wireless cable service received on wire antennas. SMR consists of private dispatch communications and is used largely in the construction, service, and transportation industries. U.S. Department of Commerce, National Telecommunications & Information Administration, Spec. Pub. 94-31, U.S. National Spectrum Requirements: Projections and Trends, 13, 21, 101 (1995).

(3)The FCC has completed eight SMRE auctions for 10 nationwide narrowband PCS

licenses earning \$617 million, 30 regional narrowband PCS licenses earning \$395 million, 99 MTA A/B block broadband PCS licenses earning \$7.034 billion, a 110-degree orbit DBS license earning \$683 million, a 148-degree orbit DBS license earning \$52 million, 493 BTA MDS licenses earning \$216 million, 1020 MTA 900 MHz SMR licenses earning \$204 million, and 493 BTA C block broadband PCS licenses earning \$10.217 billion. Announcing the High Bidders in the Auction of Ten Nationwide Narrowband PCS Licenses; Winning Bids Total \$617,006,674, *Public Notice* (Aug. 2, 1994) (nationwide narrowband PCS); *FCC Announces Results of PCS Regional Narrowband License Auction*, FCC News, Nov. 8, 1994, at 1 (regional narrowband PCS); Commercial Mobile Radio Service Information Announcing the Winning Bidders in the FCC's Auction of 99 Licenses To Provide Broadband PCS in Major Trading Areas: Down Payments Due March 20, 1995, *Public Notice* (Mar. 13, 1995) (A/B block broadband PCS); *MCI Telecommunications Corporation Bids \$682,500,000 for Last Available Nationwide DBS Slot*, FCC News, Jan. 25, 1996, at 1. (110 degree orbit DBS); *Echostar DBS Corporation Wins 24 DBS Channels at the 148 Degree Orbital Location with a High Bid of \$52,295,000*, FCC News, Jan. 26, 1996, at 1-2 (148 degree orbit DBS); *FCC MDS Auction: Final Results*, FCC WWW, http://www.fcc.gov/wtb/6_cursum.gif (Mar. 4, 1996); *FCC 900 MHz SMR Auction: Final Results*, FCC WWW, http://www.fcc.gov/wtb/7_cursum.gif (Apr. 15, 1996); *FCC C-Block Auction: Final Results*, FCC WWW, http://www.fcc.gov/wtb/5_cursum.gif (May 10, 1996). MTA, BTA, and MSA/RSA are standard terms used to define the U.S. geographically. In the spectrum auctions, the FCC has used three standard systems to define the geographic scope of the licenses: (a) 51 Metropolitan Trading Areas (MTAs), (b) 493 Basic Trading Areas (BTAs), and (c) 306 Metropolitan Statistical Areas (MSAs) and 428 Rural Statistical Areas (RSAs). The FCC has also used a nonstandard system for defining 30 regional areas. *See infra* Appendix A (identifying geographic scope of licenses).

(4)The FCC awarded four pioneer preferences, a nationwide narrowband PCS license

earning \$33 million and three MTA A block broadband PCS licenses earning \$702 million, at substantial discounts off the average price paid at the respective SMRE auction. *In re* Amendment of the Commission's Rules to establish New Narrowband Personal Communications Services, *Memorandum Opinion and Order*, 9 FCC Rcd. 1309, 74 Rad. Reg. 2d 822 (P & F) (1994) (pioneer preferences—A block broadband PCS); Personal Communications Service Information Narrowband—Nationwide, *Public Notice* (Feb. 1, 1995) (pioneer preference—nationwide narrowband PCS).

(5)Private Radio Bureau Licensing Information 472 Applicants to Bid on Approximately 600 Interactive Video and Data Services (IVDS) Licenses, *Public Notice* (Jul. 20, 1994);

Announcing High Bidders for 594 Interactive Video and Data Service (IVDS) Licenses, *Public Notice* (Aug. 2, 1994).

(6)National Telecommunications and Information Administration Organization Act,

Pub. L. No. 102-538, 106 Stat. 3553 (codified at 47 U.S.C. §§ 921-27 (1988)).

(7)15 U.S.C.A. § 309(j) (West Supp. 1995).

(8)Pub. L. No. 103-66, §§ 6001-02, 107 Stat. 379, 379-401 (1993) (to be codified at 47 U.S.C. §§ 309(i) & (j), 922-27).

(9)Section 305 of the Communications Act authorizes the president to assign

frequencies to the federal government. Under Executive Order 12,046, the president delegated federal government spectrum management authority to the Department of Commerce. 43 Fed. Reg. 13,349 (1978). The NTIA, an organization within the Department of Commerce, manages federal government spectrum use through its Office of Spectrum Management (OSM). Under the Federal Advisory Committee Act, the Frequency Management Advisory Council (FMAC), consisting of 15 members appointed by the Assistant Secretary of Commerce for Communications and Information (also the Administrator of the NTIA), reports to the Secretary of Commerce through the Assistant Secretary and provides advice on major spectrum management issues including the implementation of new spectrum conserving technology. Federal Advisory Committee Act, Pub. L. No. 92-463, 86 Stat. 770 (Oct. 6, 1972). U.S. Department of Commerce, National Telecommunications and Information Administration, Spec. Pub. 88-21, NTIA Telecom 2000: Charting the Course for a New Century 656-57, 659-61 (1988) [hereinafter NTIA Telecom 2000].

(10)Congress mandated these changes through two acts: the Emerging Telecommunications Technologies Act of 1993, which amended the NTIAO Act, and the Licensing

Improvement Act of 1993, which amended the Communications Act to create § 309(i) and (j). While these two changes were effected through the same legislative act and share common principles and goals, § 309(j) only mandates that the FCC issue licenses and permits through competitive bidding for 10 MHz of spectrum reassigned from federal government use. 47 U.S.C.A. § 309(j)(9) (1995).

(11)The Assistant Secretary for Communications and Information and the Chairman of

the FCC must conduct joint spectrum planning for the issuing of licenses under § 309(j) and the sharing of spectrum between federal and nonfederal uses. 47 U.S.C.A. § 922 (1995); House Comm. on the Budget, H.R. Rep. No. 111, 103d Cong., 1st Sess. 245, 264-65 (1993).

(12)U.S. Department of Commerce, National Telecommunications and

Information Administration, Spec. Pub. 94-27, Preliminary Spectrum Reallocation Report inside cover (1994) [hereinafter NTIA Preliminary Reallocation].

(13)47 U.S.C.A. §§ 923(d)(1)-(2), (d)(4), (e)(2) (West 1995); NTIA Preliminary

Reallocation, *supra* note 12, at inside cover (providing preliminary identification of federal government spectrum that could be made available for reallocation to nonfederal users; inviting interested parties to submit written comments by May 11, 1994; announcing that NTIA staff will meet with the public to answer questions on the preliminary report on April 7, 1994 at the NTIA offices in Washington, D.C.; and sponsoring a series of meetings between federal government users of the proposed spectrum and commercial representatives beginning on June 24, 1994 at its offices in Washington, D.C.); U.S. Department of Commerce, National Telecommunications and Information Administration, Spec. Pub. 95-32, Spectrum Reallocation Final Report 1-3 (1995) [hereinafter NTIA Reallocation Final] (reporting that the NTIA received 51 written comments, conducted two public meetings, and met with 17 of the commenters to "obtain further expert analysis of the technical, regulatory, and commercial issues addressed in the Preliminary Report").

(14)International coordination is often conducted through the International Telecommunications Union (ITU), a specialized United Nations agency serving as a treaty organization

for its 160 member nations. The ITU maintains an international structure, including a Table of Frequency Allocations recorded with the International Frequency Registration Board (IFBR), similar to the U.S. Table of Assignments, to

promote efficient and orderly worldwide telecommunications. The Department of State, NTIA, and FCC are responsible for international spectrum negotiations related to U.S. national and foreign policy. NTIA Telecom 2000, *supra* note 9, at 655-56; Christian A. Herter, Jr., *The Electromagnetic Spectrum: A Critical Natural Resource*, 25 Nat. Resources J. 651, 657-59 (1985).

(15)47 U.S.C.A. § 923(e)(3) (1995).

(16)47 U.S.C.A. § 923(d)(3) (1995); FCC, Report from the FCC to Ronald H.

Brown, Secretary, U.S. Dep't of Commerce, Regarding the NTIA Preliminary Spectrum Allocation, 9 FCC Rcd. 6793 (1994) (analyzing the public comments of preliminary report).

(17)Memorandum from William Gamble, NTIA Deputy Associate Administrator, to

NTIA Interdepartmental Radio Advisory Committee, IRAC Doc. 28880 (August 9, 1994) *reported in* U.S. Department of Commerce, National Telecommunications and Information Administration, Spec. Pub. 95-32, Spectrum Reallocation Final Report 1-3 (1995) (withdrawing assignments to the federal government for 2390-2400 MHz, 2402-2417 MHz, and 4660-4685 MHz, but providing for continued federal use on a noninterference basis with nonfederal use, while not used during the FCC's reallocation and assignment plan).

(18)NTIA Reallocation Final, *supra* note 13, at iii.

(19)NTIA Reallocation Final, *supra* note 13, at 1-3; 47 U.S.C.A. § 923(a) (West

1995). Title VI mandated specific criteria. Foreseeable need shall include consideration of commercially available substitutes, frequency sharing, new technologies, nonradiating communications, degradation of federal operations, and excessive federal costs. Feasible availability will be determined assuming scientific progress, demand growth, and displacement costs. Productive use shall include consideration of equipment capabilities, assigned frequency proximity, and foreign government action. *Id.* § 923(c)(1)-(3). While Congress acknowledged that reallocation would impose costs on federal agencies, except where the president reclaimed reassigned frequencies, Title VI did not provide a mechanism to compensate federal agencies for the \$500 to \$600 million, or possibly as much as \$1.3 billion, in estimated reallocation costs. NTIA Reallocation Final, *supra* note 13, at vii, 3-3, 5-7 (summarizing the costs for the 15-year period defined by Title VI as provided by the 10 affected agencies).

(20)NTIA Reallocation Final, *supra* note 13, at iv (presenting a final spectrum reallocation plan for 235 MHz total spectrum including 135 MHz below 3 GHz).

(21)47 U.S.C.A. § 923(b) (1995); NTIA Reallocation Final, *supra* note 13, at iv.

(22)In addition, the FCC may make frequency allocations and license assignments not

included in the final plan as well as make changes in the plan. 47 U.S.C.A. §§ 925(b)(5), 927(b) (1995). NTIA Reallocation Final, *supra* note 13, at iv (reallocating 102 MHz for exclusive nonfederal use, and 52 MHz and 133 MHz for mixed use).

(23)*See infra* p. 539.

(24)47 U.S.C.A. §§ 925(b)(5), 927(b) (West 1995).

(25)*Id.* § 309(j)(1)-(2).

(26)*Id.*

(27)Id.

(28)Id. § 309(j)(4).

(29)H.R. Rep. No. 111, *supra* note 11, at 252.

(30)47 U.S.C.A. § 309(j)(7)(A) (West Supp. 1995).

(31)*Id.* § 309(j)(7)(B).

(32)*Id.* § 309(j)(7)(C).

(33)*Id.* § 309(j)(8).

(34)H.R. Rep. No. 111, *supra* note 11, at 252.

(35)*In re* Implementation of Section 309(j) of the Communications Act Competitive Bidding, *First Report and Order*, 9 FCC Rcd. 7373 (1994).

(36)*In re* Implementation of Section 309(j) of the Communications Act Competitive Bidding, *Second Report and Order*, 9 FCC Rcd. 2348 (1994).

(37)*In re* Implementation of Section 309(j) of the Communications Act Competitive Bidding, *Third Report and Order*, 9 FCC Rcd. 2941 (1994).

(38)47 U.S.C.A. § 309(j)(12) (West 1995).

(39)*Id.* § 309(j)(9).

(40)*Id.* § 309(j)(11).

(41)H.R. Rep. No. 111, *supra* note 11, at 247. *See also* Herter, *supra* note 14, at 651.

(42)Electromagnetic spectrum is a series of waves traveling outward from an electrical

stimulus through space in a continuous sequence of peaks and troughs. Frequency is the number of wavecrests per second (defined in hertz). Wavelength is the distance between contiguous wavecrests (defined in meters). A wave's frequency multiplied by its wavelength will equal the speed of light. Herter, *supra* note 14, at 652.

(43)This is the developed region of radio frequency spectrum. All spectrum below 20

GHz is allocated and used. NTIA Preliminary Reallocation, *supra* note 12, at 1-1. Commercially viable spectrum is between 200 MHz and 5 GHz, and commercially attractive spectrum is between 200 MHz and 3 GHz. The entire range of spectrum allocated in the United States is between 9 kHz and 300 GHz. NTIA Telecom 2000, *supra* note 9, at 663.

(44)For example, bandwidth is constituted by the "carrier" wave and corresponding

"sideband" waves.

(45)Television requires three hundred times the bandwidth of very low frequency (VLF)

point-to-point communications. Herter, *supra* note 14, at 653.

(46)*Id.* at 655.

(47)As previously noted, different frequencies enjoy different propagation characteristics. Very high frequency waves (VHF) are able to penetrate the atmosphere but are limited

by atmospheric particles and rain. Short waves do not penetrate the ionosphere but are carried great distances around the curvature of the earth by the reflection off the ionosphere. *Id.* at 653.

(48)*Id.* at 655.

(49)Nicholas W. Allard, *The New Spectrum Auction Law*, 18 Seton Hall Legis. J. 13, 20 (1993).

(50)Red Lion Broadcasting Co. v. FCC, 395 U.S. 367, 400 (1969) (spectrum scarcity); NTIA Telecom 2000, *supra* note 9, at 655-56 (1988) (no scarcity). *See infra* note 59.

(51)In 1988, the NTIA reported that federal, nonfederal, and shared use represented, respectively, 14%, 31.5%, and 62.5% of available spectrum. NTIA Telecom 2000, *supra* note 9, at 663. In 1995, the NTIA reported that spectrum in the 0-3 GHz range was allocated 14% to exclusive government use, 30% to exclusive nongovernment use, and 56% shared by both the federal government and the private sector. U.S. Department of Commerce, National Telecommunications & Information Administration, *Federal Spectrum Management: How the Federal Government Uses & Manages the Spectrum* 8 (1995). The measurements do not provide for different carrying capacities of different frequencies. *See supra* notes 43 and 47.

(52)H.R. Rep. No. 111, *supra* note 11, at 263 (citing House Comm. on Energy and Com.).

(53)NTIA Telecom 2000, *supra* note 9, at 9, 18.

(54)H.R. Rep. No. 111, *supra* note 11, at 264-65; The National Information Infrastructure: Agenda for Action, 47 Fed. Reg. 49,025, 49,036 (National Telecommunications and Information Administration 1993).

(55)It is likely that a proportion of the existing spectrum uses and capabilities are mismatched. Different frequency bands have different physical characteristics. Different uses

have different operating requirements. Rapid development of new uses and new technology makes it likely that the current portfolio of spectrum dependent service is not allocated and assigned for maximum utility of usable electromagnetic spectrum. *See supra* note 47.

(56)H.R. Rep. No. 111, *supra* note 11, at 263-64.

(57)Allard, *supra* note 49, at 20.

(58)*See supra* note 14.

(59)In contrast to arguments presented in *Red Lion*, spectrum may have progressed from

no scarcity, at the time of the Communication Act, to scarcity, at the time of *Red Lion* and reassignment of federal spectrum for cellular services, and finally to false scarcity with the introduction of lotteries. *Red Lion Broadcasting Co. v. FCC*, 395 U.S. 367 (1969). Scarcity would have developed because spectrum demand from technological and societal changes increased faster than spectrum supply from technological advances in spectrum efficiency and range. False scarcity would have developed because increasing supply from technological advances would have fulfilled

increasing demand but for a constraining factor upon supply from lotteries, resulting in undeveloped licenses due to warehousing and undercapitalization.

(60)See *supra* note 9.

(61)47 U.S.C. §§ 303(c), 305(a) (1988).

(62)*Radio Regulations*, World Radiocommunications Conference (Nov. 18, 1995).

(63)*Final Acts*, World Radiocommunications Conference (Nov. 18, 1995).

(64)NTIA Telecom 2000, *supra* note 9, at 656-57, 663.

(65)47 U.S.C.A. §§ 303, 309(j)(4)(C), (j)(7)(A)-(B) (West Supp. 1995).

(66)NTIA Telecom 2000, *supra* note 9, at 657. 5 U.S.C.S. § 583 (1995).

(67)Currently used to assign broadcast channels.

(68)Previously used to assign cellular, paging, low-power television, interactive video

and data services, and wireless voice and data transmission services. Jennifer Pia Brovey, Comment, *Personal Communications Services: Crossing the Line From Regulation to Implementation*, 2 CommLaw Conspectus 67, 76 (1994).

(69)Currently used for PCS, DBS, MDS, SMR, and IVDS.

(70)NTIA Telecom 2000, *supra* note 9, at 657-58, 663; 47 U.S.C.A. § 309(e), (i),

(j)(1)-(2) (1988 & West Supp. 1995).

(71)47 U.S.C.A. § 309(j)(3) (West Supp. 1995). In a subscription service, the end user (customer) pays for the service of spectrum access and use.

(72)Andrew C. Barrett & Byron F. Marchant, *Emerging Technologies and Personal Communications Services: Regulatory Issues*, 1 CommLaw Conspectus 3, 9 (1993).

(73)Low investment in the license would create a situation similar to land speculation.

The risk/return relationship of starting service is relatively unattractive compared to that of possessing spectrum because of the high capital requirements of launching service.

(74)Brovey, *supra* note 68, at 67; 47 U.S.C.A. § 309(b) (1995).

(75)Pub. L. No. 97-258, 96 Stat. 1051 (1982) (codified as amended at 31 U.S.C. § 9701 (1994)).

(76)Consolidated Omnibus Reconciliation Act of 1985, Pub. L. No. 99-272 § 5002, 100 Stat. 82 (1986) (codified at 47 U.S.C. § 158 (1994)).

(77)Under COBRA, user fees may be assessed without regard to actual use. Terrence

J. Schroepfer, *Fee-Based Incentives and the Efficient Use of Spectrum*, 44 Fed. Comm. L.J. 411, 419 (1992) (citing

Skinner v. Mid-America Pipeline Co., 490 U.S. 212 (1989) and Florida Power & Light Co. v. United States, 846 F.2d 765 (D.C. Cir. 1988), *cert. denied*, 490 U.S. 1045 (1989)).

(78)*Id.* at 420.

(79)*In re* Spectrum Efficiency in the Private Land Mobile Radio Bands in Use Prior to 1968, *Notice of Inquiry*, 6 FCC Rcd. 4126, paras. 22-23, 49-53, 65-70 (1991); Schroeffer, *supra* note 77, at 411.

(80)H.R. Rep. No. 111, *supra* note 11, at 248.

(81)Allard, *supra* note 49, at 26.

(82)Id.

(83)*Id.* at 26-27 n.48 (citing *Executive Update*, Investor's Bus. Daily, July 28, 1993, at 3.).

(84)47 U.S.C.A. § 309(j) (1995).

(85)*In re* Implementation of Section 309(j) of the Communications Act Competitive Bidding, *Notice of Proposed Rule Making*, 8 FCC Rcd. 7635, paras. 1-3 (1993) [hereinafter *Implementation of Section 309(j) Notice*].

(86)*See* Table 1 for a comparative summary of the five assignment methods.

(87)47 U.S.C.A. § 309(j) (1995).

(88)*Implementation of Section 309(j) Notice*, 9 FCC Rcd. para. 19.

(89)*Id.* para. 34.

(90)The FCC recognizes that it may fail to sell the license to the highest value user. It authorized a limited secondary market with low transactions costs to transfer the license to the highest value user. *Id.*

(91)*Id.* para. 18.

(92)15 U.S.C.A. §§ 309(j)(10), 309(j)(12), 925 (West Supp. 1995).

(93)*Implementation of Section 309(j) Notice*, 9 FCC Rcd. para. 18.

(94)Id.

(95)Id.

(96)*Id.* para. 36.

(97)This list is not intended to be a comprehensive presentation of potential bid systems.

Bidding systems can be combined and refined to produce a much larger number of applicable systems. Rather, this group represents a spectrum of four basic approaches and three derived systems.

(98)Peter Passell, *Game Theory Captures a Nobel*, N.Y. Times, Oct. 12, 1994, at D1;

Amanda Bennett, *Nobel in Economics Is Awarded to Three For Pioneering Work in Game Theory*, Wall St. J., Oct. 12, 1994, at B3.

(99)Bennett, *supra* note 98, at B14.

(100)*Revenge of the Nerds*, Economist, July 23, 1994, at 70, 70.

(101)Allard, *supra* note 49, at 53.

(102)*Implementation of Section 309(j) Notice*, 9 FCC Rcd. 7635, para. 35 (1993).

(103)Robert Aamoth, *Uncle Sam Hits the Jackpot*, Comm. Int'l, Sept. 1994, at 5, 5.

(104)*Implementation of Section 309(j) Notice*, 9 FCC Rcd. para. 42.

(105)Mark Lewyn, *A Feast for Small Fry—Or Desert for the Big Guys?*, Bus.Wk., Oct. 10, 1994, at 116, 116.

(106)Collusion would constitute an illegal antitrust agreement under either the Sherman

Act or § 5 of the Federal Trade Commission Act. Sherman Antitrust Act, Pub. L. No. 100-86, 101 Stat. 655 (1987) (codified as amended at 12 U.S.C. § 41); Federal Trade Commission Act, Pub. L. No. 97-290, 96 Stat. 1246 (1982) (codified as amended at 15 U.S.C. § 6a). *See* Dennis A. Yao & Susan S. DeSanti, *Game Theory and the Legal Analysis of Tacit Collusion*, 38 Antitrust Bull. 113 (1993).

(107)*Implementation of Section 309(j) Notice*, 9 FCC Rcd. para. 41.

(108)*Id.* para. 40.

(109)*Id.* para. 45.

(110)*Id.* para. 40.

(111)Allard, *supra* note 49, at 54.

(112)*Implementation of Section 309(j) Notice*, 9 FCC Rcd. para. 51.

(113)*Id.* para. 56.

(114)The FCC auctioned 2 MHz of spectrum in the 900 MHz band. The FCC had

reserved 3 MHz for narrowband PCS. William J. Franklin, *New Wireless Regulations—How Will They Affect You?*, Cellular Bus., May 1994, at 62, 66.

(115)Aamoth, *supra* note 103, at 5.

(116)Announcing the High Bidders in the Auction of Ten Nationwide Narrowband PCD

Licenses; Winning Bids Total \$617,006,674, *Public Notice* (Aug. 2, 1994) (nationwide narrowband PCS).

(117)*See* sources cited *supra* note 3.

(118)The FCC allocated 120 MHz of spectrum in the 2 GHz band from 1850 to 1990

MHz for broadband PCS; 20 MHz are reserved for unlicensed spectrum. The FCC plans to award 2074 licenses (2071 by auction and 3 as pioneer preferences) in six blocks (A-F). Each block is either 30 MHz or 10 MHz in bandwidth and divided into either 493 BTAs or 51 MTAs, two different Rand McNally systems (with a few changes) of defining the geographic scope of individual licenses. Broadband PCS Fact Sheet (1994), at 1 (in broadband A/B block PCS auction packet).

(119) Commercial Mobile Radio Service Information Announcing the Winning Bidders

in the FCC's Auction of 99 Licenses to Provide Broadband PCS in Major Trading Areas; Down Payments Due March 20, 1995, *Public Notice* (Mar. 13, 1995) (A/B block broadband PCS).

(120) FCC C-Block Auction: Final Results, *supra* note 4.

(121) Christopher Stern, *FCC's New Deal for PCS*, *Brdcst & Cable*, June 13, 1994,

at 10. Ninety-nine licenses for auction reflect three licenses retained for pioneer preferences. (2 licenses/MTA x 51 MTAs) - 3 pioneer licenses = 99 available licenses. *Id.* Alan Pearce, *Competitive Bidding or Cooperation?*, *Am. Network*, July 15, 1994, at 62, 62; Edmund L. Andrews, *More Than 70 Concerns Seek Wireless Licenses*, *N.Y. Times*, Nov. 2, 1994, at D2.

(122) Section 309(j)(3)(D) requires the FCC to use methods in awarding licenses that

recover "for the public a portion of the value of the public spectrum resource made available for commercial use," and avoid "unjust enrichment." Read together, these sections mandate revenue maximization. Absent other interests, awarding a license for less than the maximum value would unduly enrich the licensee.

(123) The broadband PCS deadline was November 2, 1994, five weeks before the

December 5, 1994 auction date.

(124) Within five days after an auction, successful parties must increase their payments

to 20% of their total bids. *George Gilder's Telecosm*, *Forbes Plus*, Apr. 11, 1994, at 99. Defaults reduce auction revenue by delaying development. Such a delay puts the licensee at a competitive disadvantage. The licensee either has less time before utilizing the band, or the spectrum dependent product or service comes to market later. Both will reduce the value of the license. *See also* Broadband PCS Fact Sheet, *supra* note 118, at 4.

(125) The up-front payment is either \$0.015 (F block) or \$0.02 (A, B, D, and E blocks)

per MHz per population in license area (MHz-pop). *See* sources cited *supra* note 3, at 3; Deborah Eby, *FCC Shakes the Money Tree for PCS Entrepreneurs*, *Am. Network*, Aug. 1, 1994, at 19. In the December 1994 auction of A and B blocks (30 MHz each awarded on MTA basis), the three largest up-front payments (calculated as population x block size in MHz x \$0.02) were New York at \$15.8 million (26.4 million pops x 30 MHz x \$0.02), Los Angeles-San Diego at \$11.5 million, and Chicago at \$7.2 million. Andrews, *supra* note 121, at D2; FCC Summary of Licenses to be Auctioned: Blocks A and B (1994) (in broadband PCS auction packet).

(126) Under § 309(j)(4)(E), Congress specifically required the FCC to employ disclosure,

up-front payments, and transfer restrictions to "prevent unjust enrichment."

(127) License payments will represent as much as one-third of total development cost. For

example, a Chicago broadband PCS license may sell for \$100 million and require an additional \$200 million to build the system. Lewyn, *supra* note 105, at 116.

(128) Speculation, the planned transfer of the resource to another party, should be unattractive as any higher valued use should have won the bid.

(129) Nonaggregated uses that cannot meet aggregated use bids for spectrum fall out.

(130) PCS licensees may sell to a local exchange carrier overlapping spectrum. Eby, *supra* note 125, at 19.

(131) *In re* Implementation of Section 309(j) of the Communications Act Competitive Bidding, *Sixth Report and Order*, 78 Rad. Reg. 2d (P & F) 934 (1995).

(132) Stern, *FCC's New Deal*, *supra* note 121, at 19.

(133) John Prendergast, *PCS Spectrum is Going Once, Going Twice*, Am. Network, Feb. 15, 1994, at 50.

(134) Lacking any set aside, the IVDS auction awarded minority-owned businesses 33% and women-owned businesses 38% of the licenses. Eby, *supra* note 125, at 19.

(135) *George Gilder's Telecosm*, *supra* note 124, at 99.

(136)Id.

(137)Id.

(138) A spread-spectrum, code-division multiple access (CDMA) modulation scheme

offers 20-fold capacity over analog modulation. CDMA modulation also permits use of entire cellular 11.5 MHz bandwidth. Analog modulation schemes use only one in seven cells to prevent interference. Therefore, $20 \times 7 = 140$. *Id.*

(139) Herter, *supra* note 14, at 661-62.

(140) Successful registration with the International Frequency Registration Board of the ITU of space allocated ensures space in the ITU's Table of Frequency Allocations.

(141) Herter, *supra* note 14, at 661-62.

(142) *Id.* at 662.

(143) In 1958, a House bill provided for television station license auctions. In 1988,

President Reagan proposed spectrum auctions as part of the fiscal year 1989 budget. In 1989 and 1991, John Dingell (D-Mich.) introduced two auction bills. The first, the Emerging Telecommunications Technology Act, was passed by the House, but failed to pass the Senate. H.R.2965, 101st Cong., 2d Sess. (1989). Rep. Dingell reintroduced the bill as the Emerging Telecommunications Technologies Act of 1991, which was later enacted. H.R. 531, 102d Cong., 1st Sess. (1991) (enacted). *See* Allard, *supra* note 12, at 15, 30.

(144) Herter, *supra* note 14, at 662-63 (quoting Off. of Tech. Assessment, Radiofrequency Use and Management:

Impacts From the World Administrative Radio

Conference of 1979 (1982)).

(145) In 1992, per capita gross domestic product was \$23,400 in the United States and

\$17,400 in Germany versus \$300 in Nigeria. World Almanac and Book of Facts 769, 755, 806, 833 (1995).

(146) For example, satellite communications and space tracking use VHF waves (30-300

MHz) that penetrate the earth's atmosphere rather than low frequency (LF) waves (30-300 kHz) that travel great distances close to the ground or short waves, which are a portion of the high frequency (HF) band (3-30 MHz) that travel extended distances by repeatedly bouncing between the ionosphere and the earth. However, the military is a significant user of the LF band even though LF bands carry little information and overseas broadcast services (*e.g.* Voice of America) prize HF band assignments despite the congestion of HF bands. In turn, the military would value HF bands but only for satellite operations (*e.g.* surveillance, navigation, satellite communications) and overseas broadcasting services would value HF bands but only for satellite operations (*e.g.*, Star in Asia, BsB Sky in Europe). Herter, *supra* note 14, at 653.

(147) 47 U.S.C.A. § 309(i) (West Supp. 1995).

(148) H.R. Rep. No. 111, *supra* note 11, at 248.

(149) Such changes would induce shifts in the supply and demand curves for spectrum and

therefore change the value of a spectrum license.

(150) *Cincinnati Bell Tel. Co. v. FCC*, 69 F.3d 752 (6th Cir. 1995); *Central Florida*

Enterprises v. FCC, 683 F.2d 503 (D.C. Cir. 1982), *cert. denied*, 468 U.S. 1084 (1983); *In re Amendment of Parts 21 and 74 of the Comm'n's Rules with Regard to Filing Procedures in the Multipoint Distribution Service and in the Instructional Television Fixed Service and Implementation of Section 309(j) of the Communications Act*, *Memorandum Opinion and Order on Reconsideration*, 10 FCC Rcd. 13821 (1995).

(151) "Nothing in this subsection, or in the use of competitive bidding, shall . . . [b]e

construed to convey any rights, including any expectation of renewal of a license, that differ from the rights that apply to other licenses within the same service that were not issued pursuant to this subsection." 47 U.S.C. § 309(j)(6) (Supp. 1995).

(152) Support for the additional expense and extraordinary character of changed frequency

costs can be found in the NTIAO Act. Under § 926, the president is given the authority to reclaim reassigned frequencies. "The Federal Government shall bear all costs of reclaiming frequencies pursuant to this section, including the cost of equipment which is rendered unusable, the cost of relocating operations to a different frequency, and any other costs that are directly attributable to the reclaiming of the frequency pursuant to this section." 47 U.S.C. § 926(c) (Supp. 1995). Where change is expected, a licensee may curtail investments in capital and operating expenses to reflect a mature product with a limited period within which to recover such incremental investments.